



(RESEARCH ARTICLE)



EVALUATION OF SENIOR SECONDARY SCHOOL PUPILS' PERFORMANCE IN CORE SCIENCE SUBJECTS AT WASSCE IN SOUTHERN SIERRA LEONE, 2016-2020

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ABSTRACT

This study evaluated senior secondary school pupils' performance in Biology, Physics, and Chemistry in the West African Senior School Certificate Examination (WASSCE) in the Southern Region of Sierra Leone. An ex-post facto design was used to analyse examination records from 20 selected senior secondary schools across five examination cycles, 2016–2020, corresponding to the 2015/2016–2019/2020 academic sessions. The analysis covered 82,756 subject registrations and used frequencies, percentages, weighted credit rates, trend charts, and an exploratory repeated-measures analysis of variance based on the five annual A1–C6 rates for each subject. Overall, 60,898 entries attained A1–C6, representing a combined credit rate of 73.6%. Chemistry recorded the highest five-year weighted credit rate (81.3%), followed by Biology (73.6%) and Physics (65.8%). Performance fluctuated across the period rather than following a consistent upward or downward pattern. Chemistry reached its highest credit rate in 2017/2018 (93.1%), while Biology and Physics recorded their highest rates in 2018/2019 (83.1% and 86.6%, respectively). The exploratory repeated-measures ANOVA did not show a statistically significant difference among the three annual subject-rate series, $F(2, 8) = 2.61$, $p = .134$. Because the analysis used only five annual aggregate observations per subject, this inferential result should be interpreted cautiously. The findings indicate the need for sustained, subject-specific monitoring and further school-level research, particularly to understand the comparatively lower and more variable performance observed in Physics.

Keywords: WASSCE; Biology; Chemistry; Physics; academic performance; Sierra Leone

1 INTRODUCTION

Education plays a central role in personal development and national progress. At the secondary-school level, it prepares young people for further study, employment, and responsible participation in society. Strong academic performance is therefore important not only for individual pupils but also for the wider education system (Olojo, 2021; Olojo et al., 2021).

Science education is especially important because it develops scientific knowledge, practical skills, critical thinking, and problem-solving ability. It also supports the development of a workforce for medicine, engineering, agriculture, environmental management, education, and other science-related fields (Aina, 2013). In Sierra Leone, Biology,

Chemistry, and Physics are important subjects for pupils who intend to continue into science-based programmes at tertiary level.

Despite this importance, science teaching and learning can be affected by several school and home-related conditions. Previous studies have discussed challenges such as inadequate learning materials, limited laboratory facilities, overcrowded classrooms, teacher-related factors, pupils' attitudes, and differences in parental and socioeconomic support (Akinsanya et al., 2014; Asikhia, 2010; Bala, 2011; Ogunshola & Adewale, 2012; Samikwo, 2013). These factors may help explain why achievement varies across subjects, schools, and examination years, although examination-result data alone cannot establish their effects.

Much of the available literature on secondary-school science achievement in West Africa comes from countries outside Sierra Leone. Akinodi (2020), for example, reported that performance can differ across Biology, Chemistry, and Physics and may fluctuate over time. However, there is limited published evidence describing multi-year WASSCE performance across the three science subjects in the Southern Region of Sierra Leone.

This study therefore evaluates pupils' credit-level performance in Biology, Physics, and Chemistry over five WASSCE examination cycles. It focuses on the proportion of subject entries that obtained grades A1–C6 and examines how those proportions changed from 2016 to 2020.

Research questions

- What was the overall credit-level performance of pupils in Biology, Physics, and Chemistry during the five examination cycles?
- What pattern was observed in pupils' Biology performance from 2016 to 2020?
- What pattern was observed in pupils' Physics performance from 2016 to 2020?
- What pattern was observed in pupils' Chemistry performance from 2016 to 2020?

1.1 Research hypothesis

H_0 : There is no statistically significant difference in the annual A1–C6 credit rates recorded for Biology, Physics, and Chemistry across the five examination cycles.

2 LITERATURE REVIEW

Pupils' achievement in science is shaped by the interaction between classroom instruction, access to learning resources, motivation, and the broader home and school environment. Studies have linked science achievement to the availability of textbooks, laboratory equipment, teaching materials, and appropriate instructional support (Asikhia, 2010; Samikwo, 2013). Where practical resources are limited, pupils may have fewer opportunities to connect scientific concepts with observation and experimentation.

Family and socioeconomic conditions may also influence achievement. Parental education, occupation, household resources, and academic encouragement can affect the learning support available to pupils outside school (Akinsanya et al., 2014; Bala, 2011; Ogunshola & Adewale, 2012). These factors do not determine performance on their own, but they may create unequal opportunities for study, revision, and access to learning materials.

Subject-specific differences are also important. Biology, Physics, and Chemistry require related but distinct forms of knowledge and problem solving. Akinodi (2020) reported changing patterns of performance across science subjects rather than a stable trend. This suggests that performance should be examined by both subject and year instead of relying only on a single combined result.

The present study contributes to this discussion by providing a five-year descriptive account of WASSCE science performance in Southern Sierra Leone. It does not attempt to establish the causes of the observed patterns; instead, it identifies where performance was strongest, where it was most variable, and where further investigation may be needed.

3 METHODOLOGY

3.1 Research design

The study adopted an ex-post facto design. This design was appropriate because the examination outcomes had already occurred and the researchers did not manipulate any of the conditions associated with pupils' performance.

3.2 Study setting, population, and sample

The study focused on senior secondary schools in the Southern Region of Sierra Leone. The population comprised pupils who sat the May/June WASSCE in Biology, Physics, and Chemistry during the 2016–2020 examination cycles. Examination records from 20 selected senior secondary schools were included through purposive sampling. The figures represent subject registrations rather than a count of unique pupils, because one pupil could be entered for more than one science subject.

3.3 Data source and performance classification

An examination-result inventory was used to compile the number of entries registered in each subject and the number obtaining grades A1–C6 or D7–F9 in each academic session from 2015/2016 to 2019/2020. In this study, A1–C6 was treated as credit-level performance, while D7–F9 was grouped as below-credit performance. No pupil names or other individual identifiers are reported in the manuscript.

3.4 Data analysis

The data were analysed using frequency counts, percentages, weighted five-year credit rates, means, standard deviations, and charts. Weighted credit rates were calculated by dividing the total number of A1–C6 entries by the total number registered for each subject. To examine the hypothesis, an exploratory repeated-measures analysis of variance treated academic year as the repeated unit and subject as the within-year factor. This approach was based on only five aggregate annual observations per subject; consequently, the inferential result is presented cautiously and should not be interpreted as pupil-level evidence. Because the omnibus test was not statistically significant, no post-hoc comparisons were conducted.

4 RESULTS

4.1 Overall performance across the three science subjects

Table 1 presents the number of subject entries registered in Biology, Physics, and Chemistry and the corresponding A1–C6 and D7–F9 outcomes for each academic session.

Table 1: Performance of pupils in Biology, Physics, and Chemistry, 2015/2016–2019/2020

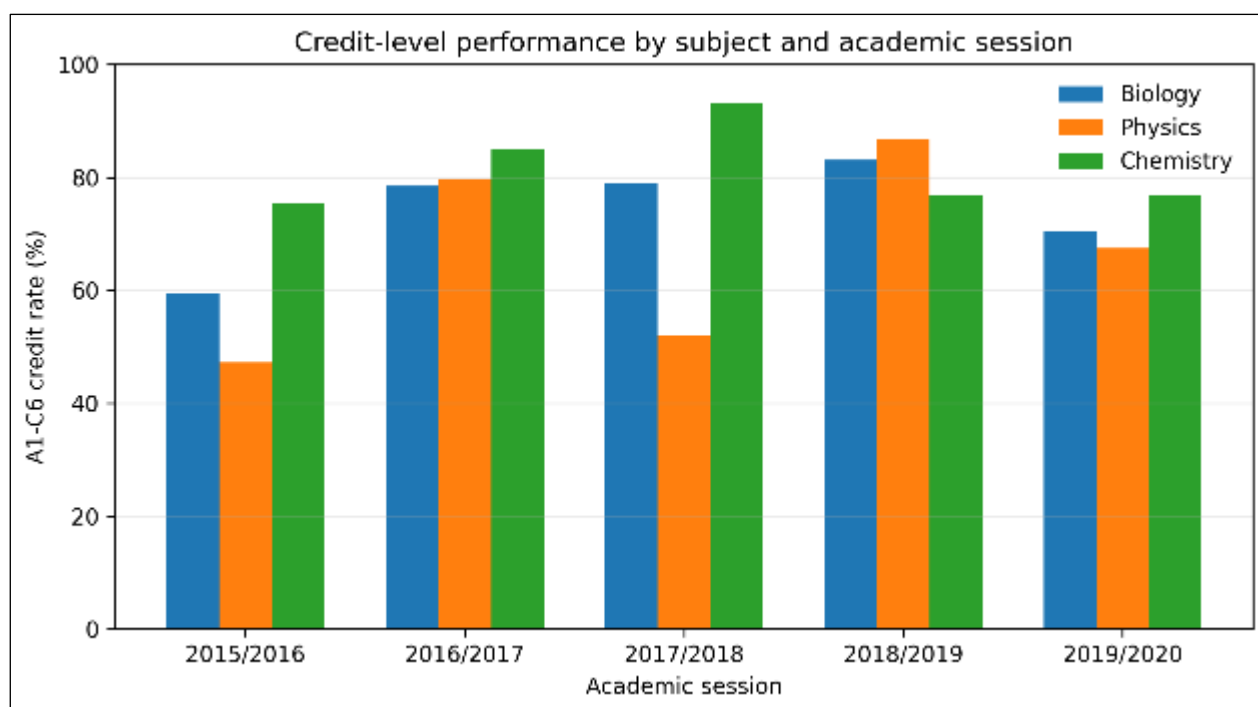
Academic session	Subject	Registered	A1–C6, n (%)	D7–F9, n (%)
2015/2016	Biology	6,691	3,974 (59.4)	2,717 (40.6)
	Physics	6,069	2,863 (47.2)	3,206 (52.8)
	Chemistry	6,072	4,580 (75.4)	1,492 (24.6)
2016/2017	Biology	6,022	4,730 (78.5)	1,292 (21.5)
	Physics	5,231	4,173 (79.8)	1,058 (20.2)
	Chemistry	5,189	4,403 (84.9)	786 (15.1)
2017/2018	Biology	5,641	4,453 (78.9)	1,188 (21.1)
	Physics	5,250	2,724 (51.9)	2,526 (48.1)
	Chemistry	5,258	4,894 (93.1)	364 (6.9)
2018/2019	Biology	5,578	4,637 (83.1)	941 (16.9)
	Physics	4,989	4,322 (86.6)	667 (13.4)
	Chemistry	5,155	3,964 (76.9)	1,191 (23.1)
2019/2020	Biology	5,563	3,922 (70.5)	1,641 (29.5)
	Physics	5,014	3,386 (67.5)	1,628 (32.5)
	Chemistry	5,034	3,873 (76.9)	1,161 (23.1)

Across the five examination cycles, the dataset contained 82,756 subject registrations. Of these, 60,898 attained grades A1–C6, giving an overall credit rate of 73.6%. The remaining 21,858 entries, or 26.4%, fell within D7–F9.

Table 2: Five-year summary of credit-level performance by subject

Subject	Total registered	A1–C6	D7–F9	Weighted credit rate (%)	Annual mean $\pm$ SD (%)
Biology	29,495	21,716	7,779	73.6	74.1 $\pm$ 9.4
Physics	26,553	17,468	9,085	65.8	66.6 $\pm$ 17.1
Chemistry	26,708	21,714	4,994	81.3	81.4 $\pm$ 7.5
All subjects	82,756	60,898	21,858	73.6	—

Chemistry recorded the strongest five-year credit-level performance, with 81.3% of entries obtaining A1–C6. Biology followed with 73.6%, while Physics recorded the lowest weighted credit rate at 65.8%. The annual standard deviation was largest for Physics, showing that its credit rate varied more sharply across the five sessions than the rates for Biology or Chemistry.

**Figure 1: A1–C6 credit rates by subject and academic session.**

4.2 Trend in Biology performance

Biology performance increased from 59.4% in 2015/2016 to 78.5% in 2016/2017 and remained at a similar level in 2017/2018 (78.9%). It reached its highest point in 2018/2019, when 83.1% of entries obtained A1–C6, before declining to 70.5% in 2019/2020. The pattern therefore shows improvement during the first four sessions followed by a noticeable decline in the final session.

4.3 Trend in Physics performance

Physics showed the greatest year-to-year fluctuation. The credit rate rose from 47.2% in 2015/2016 to 79.8% in 2016/2017, fell to 51.9% in 2017/2018, increased to a five-year high of 86.6% in 2018/2019, and then declined to 67.5% in 2019/2020. This wide variation suggests that Physics performance was less stable than performance in the other two subjects.

4.4 Trend in Chemistry performance

Chemistry recorded comparatively high credit rates throughout the period. Performance increased from 75.4% in 2015/2016 to 84.9% in 2016/2017 and peaked at 93.1% in 2017/2018. The rate then declined to 76.9% in 2018/2019 and remained at 76.9% in 2019/2020. Although Chemistry was the strongest subject overall, its performance was not continuously upward.

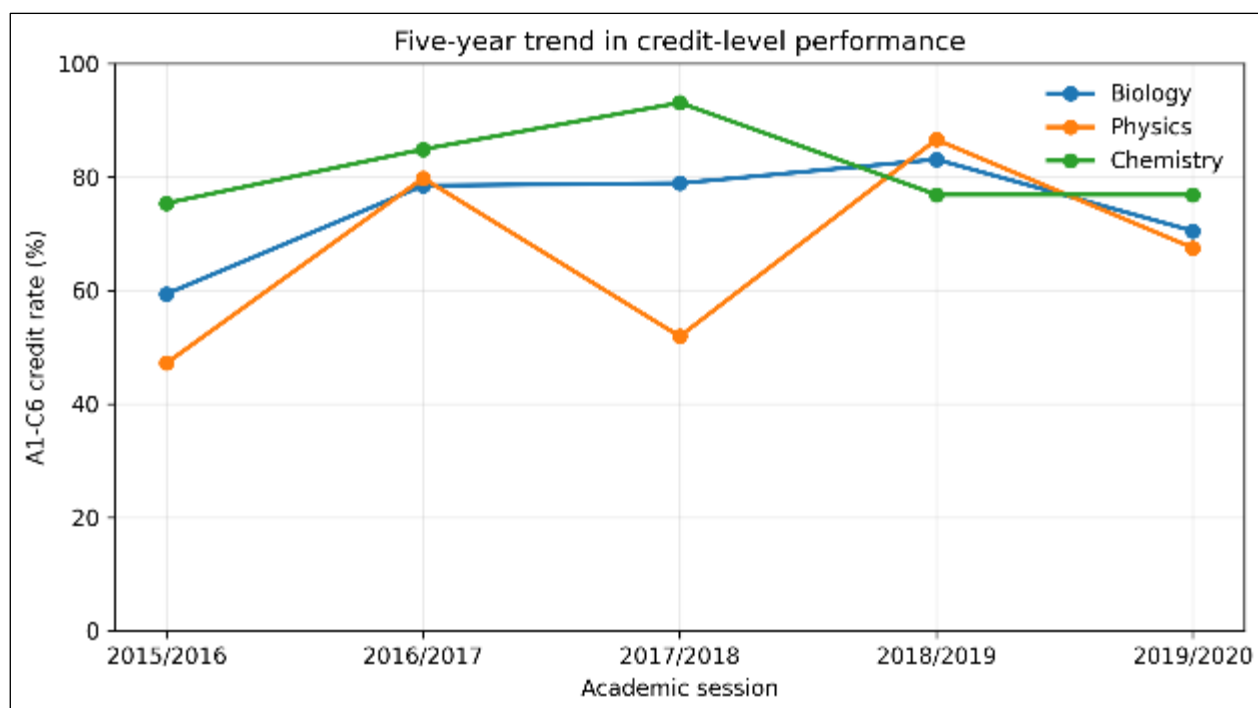


Figure 2: Five-year trend in A1-C6 credit rates for Biology, Physics, and Chemistry.

4.5 Exploratory test of differences among subjects

The exploratory repeated-measures ANOVA did not show a statistically significant difference among the three annual subject-rate series, $F(2, 8) = 2.61$, $p = 0.134$. The null hypothesis was therefore not rejected. This result does not mean that the subjects had identical descriptive performance; Chemistry still recorded the highest weighted credit rate and Physics the lowest. Rather, the difference was not statistically significant when the analysis was limited to five annual aggregate observations per subject.

Table 3: Exploratory repeated-measures ANOVA for annual A1-C6 credit rates

Effect	df	Error df	F	P	Decision
Subject	2	8	2.61	0.134	Not significant; do not reject H_0

Note. Academic year was treated as the repeated unit. The analysis is exploratory because only five annual aggregate observations were available for each subject.

5 DISCUSSION

The results show that credit-level performance differed descriptively across the three science subjects. Chemistry had the highest five-year weighted credit rate, Biology ranked second, and Physics had the lowest rate. This ordering is consistent across the detailed subject totals and the five-year weighted credit rates.

The pattern across years was uneven. Biology improved over the first four sessions but declined in the final year. Physics moved sharply between high and low rates and displayed the largest annual variation. Chemistry performed strongly during the first three sessions, reached a peak in 2017/2018, and then settled at a lower but still comparatively strong level in the final two sessions. Taken together, these trends show that performance did not follow a simple linear pattern.

The comparatively low and unstable Physics results deserve attention. Physics often requires pupils to combine mathematical reasoning, conceptual understanding, and practical application. The present study did not measure teaching quality, laboratory access, teacher availability, pupils' attitudes, or socioeconomic conditions, so it cannot determine why Physics performance was lower. Nevertheless, the pattern provides a clear basis for further investigation at school and classroom levels.

The inferential analysis should also be interpreted carefully. Although the weighted credit rates were meaningfully different in descriptive terms, the repeated-measures ANOVA was not statistically significant. This may reflect the small number of annual observations and the considerable year-to-year variation. A stronger test would require school-level or pupil-level data across a larger number of years, together with information about relevant school and learner characteristics.

The findings broadly support Akinnode's (2020) observation that science performance can change across subjects and examination periods. They also reinforce the importance of examining results in context. Examination trends are useful for identifying areas of concern, but they should be combined with evidence about teaching, resources, curriculum coverage, assessment practices, and learner support before causal conclusions are drawn.

Limitations

- The analysis was based on aggregated subject results rather than individual pupil records. It was therefore not possible to examine the influence of sex, school, district, socioeconomic background, teacher characteristics, or other pupil-level factors.
- The figures represent subject registrations, not unique pupils. A pupil who entered more than one science subject may therefore appear in more than one subject total.
- Only five annual observations were available for each subject. The repeated-measures ANOVA is therefore exploratory and has limited statistical power.
- The ex-post facto design identifies patterns but cannot establish the causes of the observed differences or changes in performance.
- The study covered selected schools in one region of Sierra Leone, so the findings should not automatically be generalised to the entire country.

6 CONCLUSION

This study examined five years of WASSCE performance in Biology, Physics, and Chemistry in selected senior secondary schools in Southern Sierra Leone. Across all three subjects, 73.6% of subject entries attained A1–C6. Chemistry recorded the highest weighted credit rate at 81.3%, followed by Biology at 73.6% and Physics at 65.8%. Performance fluctuated across the five examination cycles, with Physics showing the greatest variation. The exploratory repeated-measures analysis did not find a statistically significant difference among the three annual subject-rate series, but the small number of aggregate observations limits the strength of that conclusion. The results are best understood as a descriptive account that identifies subject-specific patterns and priorities for further investigation.

Recommendations

- Schools and education authorities should monitor WASSCE science results by subject and year so that support can be directed to areas showing persistent weakness or instability.
- The comparatively lower and more variable Physics performance should be investigated using school-level data, classroom observations, teacher interviews, and evidence about curriculum coverage, practical work, and learning resources.
- Future studies should use pupil-level or school-level records over a longer period and should include relevant background variables to explain why performance changes across subjects and years.
- Science departments should use examination trends as a starting point for reviewing instructional planning, practical activities, revision support, and assessment practices, rather than assuming that one factor alone explains the results.
- National or regional comparisons should be conducted only after consistent data definitions and reporting procedures have been established across schools and examination years.

STATEMENTS ON COMPLIANCE WITH ETHICAL STANDARDS

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Disclosure of conflict of interest

The authors declare that they have no competing interests.

Authors' contributions

Abu Bakarr Dabor carried out the study, including data collection and compilation, data analysis, interpretation of the findings, and preparation of the initial draft of the manuscript. Dr. Tamba Kebbie served in a supervisory role, providing guidance on the study design, research process, interpretation of the findings, and critical review of the manuscript. Both authors read and approved the final version of the manuscript.

Statement of ethical approval

The study analysed aggregated secondary examination records and did not involve direct interaction with pupils or access to personally identifiable information. No names or other personal identifiers were collected or reported.

Statement of informed consent

Formal informed consent was therefore not applicable to this secondary analysis.

Data availability

The aggregated data used in this study are available from the corresponding author on reasonable request, subject to any applicable institutional restrictions.

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