

Influence of Chemistry Curriculum Implementation on Students' Academic Performance in Chemistry in Public Senior Schools in Nandi Central Sub County, Kenya

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ABSTRACT

Chemistry remains one of the least-performed subjects in the Kenya Certificate of Secondary Education (KCSE), with public senior schools in Nandi Central Sub County recording persistently low mean scores despite government interventions such as the Strengthening of Mathematics and Science in Secondary Education (SMASSE) programme. This study examined the extent to which the Chemistry curriculum was implemented in public senior schools in Nandi Central Sub County and its influence on students' academic performance in Chemistry. The study was anchored on Curriculum Theory and adopted a convergent parallel mixed-methods design, combining a causal-comparative quantitative approach with a phenomenological qualitative approach. Data were collected from 27 Chemistry teachers, 334 Form Four students and 8 principals drawn from a sample of 8 public senior schools selected through stratified and simple random sampling, using questionnaires, an interview schedule and document analysis. Quantitative data were analysed descriptively and the null hypothesis was tested using one-way Analysis of Variance (ANOVA) at the 0.05 level of significance, while qualitative data were analysed thematically. Findings showed that most schools consistently used schemes of work (81.5% of teachers) and detailed lesson plans (81.5% of teachers; 76.3% of students), although inadequate lesson time was widely reported as a constraint (66.6% of teachers; 78.7% of students). The ANOVA results revealed a statistically significant difference in Chemistry performance across levels of curriculum implementation, $F(3, 330) = 9.891$, $p = .000$, leading to rejection of the null hypothesis. The study concludes that effective and consistent implementation of the Chemistry curriculum, reinforced by close principal supervision, significantly enhances students' academic performance in Chemistry. It is recommended that teachers adhere closely to schemes of work and lesson plans, schools allocate sufficient instructional time, and school leadership sustain regular monitoring of curriculum delivery.

Keywords: Chemistry curriculum implementation; academic performance; syllabus coverage; lesson planning; senior schools; Kenya

1. INTRODUCTION

Curriculum implementation refers to the process of translating an intended curriculum, as designed by policy makers and curriculum developers, into actual classroom practice (Fullan, 2019). It is the interaction between teachers, learners and curriculum content that determines how far planned learning objectives are realised (Snyder, Bolin & Zumwalt, 2021). In Chemistry education, effective curriculum implementation is typically indicated by consistent use of schemes of work, timely syllabus coverage, systematic lesson planning and adequate allocation of instructional time (Tyler, 1949). Students' academic performance, in turn, is the manifestation of the knowledge, skills and competencies learners acquire, as reflected in examination scores (Adewale, 2020; Kimani, Mwangi & Otieno, 2022).

Despite the importance attached to Chemistry as a gateway subject to science-based careers, performance in the subject has remained persistently low in Kenya. The Kenya National Examinations Council (KNEC, 2021) reported an average KCSE Chemistry mean score of 23.4 (grade D plain) between 2019 and 2023, a level that locks many students out of science-oriented career pathways. Contributing factors identified in the literature include inadequate teaching

resources, inconsistent assessment practices and incomplete or inconsistent curriculum implementation (Cheruiyot & Kiprotich, 2022; Korir & Ochieng, 2023). Although the Kenyan government, through initiatives such as the Strengthening of Mathematics and Science in Secondary Education (SMASSE) programme and its guiding Activity Student Experiment Improvisation-Plan Do See Improve (ASEI-PDSI) approach, has sought to upgrade teachers' pedagogical practice, performance in Chemistry in Nandi Central Sub County has continued to lag behind national expectations.

Local studies conducted within Nandi Central Sub County have documented broad challenges in Chemistry education (Cheruiyot & Kiprotich, 2022) and gaps in teaching methodology (Korir & Ochieng, 2023), but none has specifically established the extent to which the Chemistry curriculum itself, in terms of scheme-of-work adherence, syllabus completion, lesson planning and time allocation, is implemented, and how this relates to students' performance. This gap justified the present study, which sought to establish the extent to which the Chemistry curriculum was implemented in public senior schools in Nandi Central Sub County, Kenya, and its influence on students' academic performance in Chemistry.

1.1 Research Question

To what extent is the Chemistry curriculum being implemented in public senior schools in Nandi Central Sub County, Kenya?

1.2 Hypothesis

H01: There is no significant influence of Chemistry curriculum implementation on students' academic performance in Chemistry in public senior schools in Nandi Central Sub County, Kenya.

1.3 Significance of the Study

The findings of this study are of value to several stakeholders in Chemistry education. Chemistry teachers stand to gain evidence-based insight into how consistent use of schemes of work, lesson plans and timely syllabus coverage relate to learner outcomes, which can inform their day-to-day instructional planning. School principals and heads of department can draw on the findings to strengthen supervisory practices, such as classroom observation and monitoring of syllabus coverage, that were shown to reinforce effective curriculum implementation. Curriculum developers, particularly at the Kenya Institute of Curriculum Development (KICD), may find the findings useful in reviewing how implementation guidelines translate into practice in rural, resource-constrained settings. Finally, the study contributes to the broader body of localized evidence on curriculum implementation in Kenya, addressing a gap left by prior studies that focused on urban counties or on other aspects of Chemistry instruction rather than on the extent of curriculum implementation itself.

2. LITERATURE REVIEW

2.1 Theoretical Framework

The study was anchored on Curriculum Theory, whose foundational exposition is credited to Tyler (1949) in *Basic Principles of Curriculum and Instruction*. Tyler emphasised four elements central to sound curriculum practice: formulating clear educational objectives, organising content

logically, selecting appropriate learning experiences, and aligning assessment with intended outcomes. Applied to Chemistry education, the theory directs attention to concrete implementation indicators, namely the scheme of work, lesson plans, syllabus completion and time allocation, as the practical mechanisms through which intended curriculum objectives are translated into classroom experience (Hernandez, 2016; Snyder, 1996). The theory's strength lies in providing a structured framework for ensuring that instruction is coherent, sequenced and measurable; critics, however, note that an overly prescriptive application can constrain teacher creativity and encourage a narrow focus on content coverage rather than deeper conceptual learning (Schubert, 1986; Eisner, 1994; Pinar, 2012). For this study, Curriculum Theory provided the lens through which the researcher assessed how closely schools adhered to schemes of work, lesson plans, syllabus completion and time allocation, and how these practices related to students' performance in Chemistry.

2.2 Empirical Review

A growing body of research links disciplined curriculum coverage to improved Chemistry outcomes. In Brazil, Almeida and Silva (2020) surveyed 300 students and interviewed 25 Chemistry teachers in São Paulo and found that schools adhering to a well-planned scheme of work and timely syllabus completion achieved higher student performance than schools with delayed coverage, with teachers who meticulously followed lesson plans and allocated adequate time to practical sessions recording improved student engagement, although balancing theory and practical lessons within the available time remained a challenge. In Canada, Roberts and Langley (2023) analysed performance data from 400 students and surveyed 30 teachers in Ontario and similarly established that schools allocating more instructional time to Chemistry lessons, particularly extended laboratory sessions, achieved better outcomes in both theory and practical components, although disparities in time allocation across schools, arising from differing administrative policies, produced uneven results. In France, Bernard and Dupont (2021) interviewed 20 teachers and observed lessons in 10 senior schools in Paris and reported that structured lesson plans enabled teachers to deliver content on topics such as stoichiometry and chemical bonding more effectively, resulting in higher student participation and retention, although some teachers lacked the training needed to develop comprehensive lesson plans.

In Ethiopia, Tesfaye and Abebe (2020) found that effective time management during lessons, including specific time blocks for theory, practical work and revision, was crucial for full syllabus coverage, although large class sizes and heavy teacher workload constrained implementation. In South Africa, Nkosi and Mahlangu (2023) established that teachers who followed detailed lesson plans were more effective in delivering complex topics such as thermodynamics and electrochemistry, resulting in better conceptual understanding, although some schools lacked the infrastructure to support planned practical activities. In Ghana, Owusu and Mensah (2019) found that students in schools that completed the syllabus on time significantly outperformed those in schools with incomplete coverage, an effect attributed to the availability of more time for revision and practical work.

Within Kenya, Muthoni (2024) found that schools completing the Chemistry syllabus on time recorded higher KCSE performance, while Wanyama (2023) demonstrated that teachers who adhered to well-structured schemes of work were more effective in delivering content and

engaging learners, although some teachers deviated from schemes of work owing to time constraints.

Collectively, these studies affirm that syllabus completion, lesson planning and instructional time allocation are central determinants of Chemistry performance. However, most of this evidence originates from urban or comparatively well-resourced settings (Bernard & Dupont, 2021; Roberts & Langley, 2023), leaving the dynamics of curriculum implementation in rural, resource-constrained sub-counties such as Nandi Central under-examined. Few of the reviewed studies are explicitly anchored in curriculum theory, and localized Kenyan evidence on curriculum implementation and Chemistry performance remains limited mainly to urban counties (Muthoni, 2024; Wanyama, 2023). The present study addressed these gaps by combining quantitative and qualitative evidence, grounded in Curriculum Theory, to examine the extent of Chemistry curriculum implementation and its influence on students' performance within Nandi Central Sub County.

3. METHODOLOGY

3.1 Research Design and Locale

The study was conducted in Nandi Central Sub County, Nandi County, Kenya, an area with a mix of rural and urban public senior schools offering the national Chemistry curriculum under varied resource conditions. A convergent parallel mixed-methods design was adopted (Creswell & Creswell, 2023), combining a causal-comparative quantitative strand, appropriate for examining an already-implemented curriculum without manipulating variables, with a phenomenological qualitative strand that captured principals' lived experiences of curriculum supervision.

3.2 Target Population and Sample

The target population comprised principals, Chemistry teachers and Form Four students drawn from public senior schools in Nandi Central Sub County (Table 1). A sample representing approximately 30 percent of the population was drawn, consistent with Mugenda and Mugenda's (2019) recommendation of a 10-30 percent sample for generalisation in educational research. Eight schools were selected through stratified sampling across four school clusters (C1-C4, corresponding to the former national, extra-county, county and sub-county school categories), followed by simple random sampling within each stratum. All principals in the sampled schools were included, while teachers were selected through stratified (by gender) and purposive sampling. The student sample size ($n = 342$) was determined using the Yamane (1967) formula at a 95 percent confidence level, and proportionately allocated across the four clusters (48, 111, 129 and 54 students respectively) according to each cluster's share of the total student population.

Table 1: Target Population and Sample Size

Category	Population	Sampling procedure	Sample size
Schools	27	Stratified + simple random	8
Principals	27	Stratified + simple random	8
Chemistry teachers	90	Stratified + purposive	27
Form Four students	2,358	Proportionate + simple random	342

Source: Field data (2026)

3.3 Instrumentation

Data on curriculum implementation were collected using structured questionnaires administered to Chemistry teachers and Form Four students, covering perceptions of scheme-of-work adherence, syllabus completion, lesson planning and time allocation on a five-point frequency scale (Always, Often, Neutral, Rarely, Not at all). A semi-structured interview schedule was administered to principals to explore their supervisory role in curriculum implementation, while a document analysis schedule was used to extract Chemistry mean scores from school records for four consecutive terms (Term 1-3, 2024, and Term 1, 2025).

3.4 Validity and Reliability

Content validity was established by aligning the instruments with the study objective and securing expert judgement from Chemistry education lecturers. Reliability was assessed through a test-retest procedure with 20 students in a non-participating school, administered two weeks apart; the resulting Pearson correlation coefficient of $r = .737$ ($p = .012$) indicated satisfactory internal consistency (Tavakol & Dennick, 2019).

3.5 Data Analysis

Quantitative data were analysed using the Statistical Package for Social Sciences (SPSS), generating frequencies, percentages and means. The null hypothesis was tested using one-way Analysis of Variance (ANOVA) at the 0.05 level of significance, comparing mean Chemistry performance across categories of curriculum implementation. Qualitative data from interviews and document analysis were analysed thematically and used to corroborate the quantitative findings. Ethical clearance was obtained from The Catholic University of Eastern Africa, the National Commission for Science, Technology and Innovation (NACOSTI) and the Nandi Central Sub-County education office (Kothari, 2019); informed consent, anonymity and voluntary participation were observed throughout data collection.

4. RESULTS

4.1 Response Rate and Sample Characteristics

All 27 questionnaires administered to teachers were returned (100 percent response rate), while 334 of the 342 student questionnaires were returned and usable (97.7 percent). All 8 sampled principals were interviewed. The sampled schools spanned all four school clusters, with Cluster

Two and Cluster Three schools each constituting 37.5 percent of the sample and Clusters One and Four each constituting 12.5 percent, ensuring representation across varied resource and infrastructure contexts. Most sampled schools (62.5 percent) had between three and five Chemistry teachers, a staffing level generally considered adequate to support teaching and practical supervision.

4.2 Extent of Chemistry Curriculum Implementation

Table 2 summarises teachers' and students' perceptions of curriculum implementation practices, expressed as the combined percentage reporting that the practice occurred “Always” or “Often.”

Table 2: Teachers' and Students' Perceptions of Chemistry Curriculum Implementation

Curriculum implementation indicator	Teachers % (Always/Often) n=27	Students % (Always/Often) n=334
Chemistry scheme of work is consistently followed during lesson planning and delivery (<i>teachers only</i>)	81.5	—
Syllabus is covered in a timely manner to prepare students for examinations	59.2	48.0
Teachers attend Chemistry lessons punctually (<i>students only</i>)	—	65.2
Detailed lesson plans/notes are consistently used to guide teaching	81.5	76.3
Lack of detailed lesson plans negatively affects curriculum implementation	55.5	71.8
Adequate lesson time is allocated to cover the syllabus	66.6	78.7
Inadequate lesson time hinders effective curriculum implementation	66.6	78.7
Proper curriculum implementation positively impacts KCSE performance	81.5	92.5

Source: Field data (2026)

The findings indicate strong adherence to structured planning: 81.5 percent of teachers reported consistently following the Chemistry scheme of work, and 81.5 percent reported consistent use of detailed lesson plans, a pattern corroborated by 76.3 percent of students. Similarly, 81.5 percent of teachers and 92.5 percent of students agreed that proper curriculum implementation positively influenced KCSE performance. However, timely syllabus completion was less

consistent, endorsed by only 59.2 percent of teachers and 48.0 percent of students, and inadequate lesson time was widely cited as a constraint on implementation by both teachers (66.6 percent) and students (78.7 percent).

Notably, students perceived several implementation practices more favourably than teachers did, particularly regarding the negative effect of inadequate lesson planning and time on curriculum delivery (71.8 percent and 78.7 percent among students, against 55.5 percent and 66.6 percent among teachers). This divergence may reflect students' direct experience of disrupted lessons and incomplete topic coverage in the classroom, compared with teachers' tendency to rate their own instructional practices somewhat more favourably. Nonetheless, both groups converged strongly on the view that proper curriculum implementation positively influenced KCSE performance, suggesting a shared recognition, across the different vantage points of teachers and learners, that fidelity to schemes of work, lesson planning and time allocation was central to Chemistry achievement in the Sub County.

4.3 Qualitative Findings on Curriculum Supervision

Interviews with principals revealed that active supervisory practices, including classroom observation, review of schemes of work and lesson plans, and monitoring of syllabus coverage, were central to sustaining curriculum implementation. As one principal explained:

"I supervise Chemistry curriculum by observing lessons, checking teachers' schemes of work and lesson plans, and monitoring syllabus coverage. I ensure laboratories are safe and equipped, organise in-service training, and encourage teacher collaboration"
(Principal 4).

Principals further reported liaising with education officers, parents' associations and development partners to mobilise resources and facilitate teacher training, reinforcing the structural conditions needed for effective curriculum implementation.

4.4 Trends in Students' Chemistry Performance

Document analysis of school mean scores across four consecutive terms (Table 3) showed a gradual improvement, with the number of schools recording mean scores below 3.00 declining from three in Term 1, 2024 to two by Term 1, 2025, and the number of schools scoring above 5.00 rising from two to three over the same period, alongside the persistence of a small group of consistently low-performing schools.

Table 3: Distribution of Schools by Chemistry Mean Score

Term	Below 3.00	3.00 - 5.00	Above 5.00
Term 1, 2024	3	3	2
Term 2, 2024	2	4	2
Term 3, 2024	2	3	3
Term 1, 2025	2	3	3

Source: Document analysis (2026)

4.5 Test of Hypothesis

The null hypothesis (H01) was tested using one-way ANOVA comparing mean Chemistry performance across categories of curriculum implementation (Table 4). The analysis yielded $F(3, 330) = 9.891$, $p = .000$, below the 0.05 significance threshold. The null hypothesis was therefore rejected, indicating a statistically significant difference in students' Chemistry performance associated with the level of Chemistry curriculum implementation.

Table 4: One-Way ANOVA — Chemistry Curriculum Implementation and Students' Performance

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2598.948	3	866.316	9.891	.000
Within Groups	28903.663	330	87.587		
Total	31502.611	333			

Source: Field data (2026)

5. DISCUSSION

The findings demonstrate that Chemistry curriculum implementation in Nandi Central Sub County was generally structured, with most teachers reporting consistent use of schemes of work and lesson plans. This aligns with Bernard and Dupont (2021), who found that structured lesson plans enabled more effective content delivery and higher student engagement, and with Nkosi and Mahlangu (2023), who linked detailed lesson planning to improved learner conceptual understanding. However, the comparatively weaker adherence to timely syllabus completion mirrors concerns raised by Tesfaye and Abebe (2020) in Ethiopia, where large class sizes and heavy teacher workload constrained time management for full syllabus coverage.

The widespread perception that inadequate lesson time hindered implementation resonates with Roberts and Langley (2023), who found that disparities in time allocation across schools, driven by differing administrative policies, produced uneven Chemistry outcomes in Ontario. In the Nandi Central context, principals' testimonies suggest that where school leadership actively

monitored schemes of work, lesson plans and syllabus coverage, and mobilised resources through partnerships with parents and development partners, implementation was more consistent, a pattern consistent with Wanyama (2023), who found that regular monitoring of lesson plans and records of work by principals reduced learning gaps and improved instructional quality.

The statistically significant ANOVA result ($F(3, 330) = 9.891, p = .000$) provides quantitative confirmation that the extent of curriculum implementation was not incidental to students' Chemistry performance but a substantive determinant of it, consistent with Owusu and Mensah (2019) and Muthoni (2024), both of whom established a significant link between timely syllabus completion and superior examination outcomes. Read together with Curriculum Theory (Tyler, 1949), the findings affirm that clearly defined objectives, coherent content organisation, and alignment between instruction, time allocation and assessment are central mechanisms through which curriculum implementation translates into improved learner outcomes. The modest improvement observed in school mean scores across the four terms reviewed further suggests that sustained attention to these implementation practices can incrementally raise performance, although the persistence of a subgroup of low-performing schools indicates that gains have not yet been uniform across the Sub County.

Taken together, the results suggest that closing the gap between planning documents and classroom practice, particularly around instructional time, is where the greatest performance gains for Chemistry in Nandi Central Sub County are likely to be found. Because scheme-of-work adherence and lesson planning were already comparatively strong, further investment in teacher supervision alone may yield diminishing returns unless it is paired with structural measures, such as timetable adjustments or additional laboratory periods, that directly address the time constraints reported by both teachers and students. This implies that education authorities and school administrations should treat time allocation for Chemistry as a distinct policy lever, rather than assuming that improvements in planning and supervision will automatically translate into adequate instructional time on their own.

6. LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

The study was confined to eight public senior schools in Nandi Central Sub County and relied on self-reported perceptions of curriculum implementation, corroborated with document analysis and principal interviews; the findings should therefore be generalised to similarly resourced rural sub-counties with appropriate caution. The cross-sectional nature of the quantitative data also limits the extent to which causal claims can be made about the long-term effect of curriculum implementation on performance. Future research could adopt a longitudinal design to track how sustained curriculum implementation practices, such as scheme-of-work adherence and syllabus completion, influence Chemistry performance over multiple academic years. Further studies could also compare curriculum implementation and its influence on performance across different school categories and counties, including urban-rural and public-private comparisons, to establish how contextual factors shape the relationship between curriculum implementation and academic achievement.

7. CONCLUSION

The study concludes that Chemistry curriculum implementation in public senior schools in Nandi Central Sub County was generally structured around consistent use of schemes of work and lesson plans, but constrained by inconsistent syllabus completion and inadequate instructional time. Variations in the extent of curriculum implementation were associated with statistically significant differences in students' Chemistry performance, confirming that fidelity and consistency in curriculum delivery, reinforced by active principal supervision, are key determinants of academic achievement in Chemistry. Effective curriculum implementation should therefore be treated not as a routine administrative requirement but as a substantive lever for improving Chemistry outcomes in resource-constrained, rural school settings.

8. RECOMMENDATIONS

Based on the findings, the study makes the following recommendations. First, Chemistry teachers should adhere closely to schemes of work and lesson plans, and prioritise timely syllabus coverage to safeguard adequate time for revision and practical work. Second, school leadership should sustain regular monitoring of curriculum delivery, including classroom observation and review of schemes of work and lesson plans, coupled with feedback mechanisms that support teachers in addressing implementation gaps. Third, education authorities and school administrations should review time allocation for Chemistry lessons, including the balance between theory and practical sessions, so that the time constraints reported by both teachers and students are addressed directly rather than left to individual schools to resolve. Fourth, schools should collaborate with parents, communities and development partners to mobilise additional resources and support that can supplement government provision and sustain consistent curriculum implementation, particularly in schools with limited infrastructure. Finally, education authorities should incorporate structured mentorship and in-service training for principals and heads of department on supervisory practices for curriculum implementation, given the central role that active school leadership played in reinforcing scheme-of-work adherence, lesson planning and syllabus completion in the sampled schools.

Implementing these recommendations in a coordinated manner, rather than in isolation, is likely to be more effective. For instance, additional instructional time secured through timetable review will yield limited benefit unless teachers also have the planning support and supervisory feedback needed to use that time productively, while resource mobilisation from parents and development partners is most useful when directed towards addressing the specific gaps, such as laboratory time and materials, that schools themselves identify through routine monitoring.

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