JOURNAL OF MULTIDISCIPLINARY RESEARCH AND DEVELOPMENT | ISSN 3031-9390
Vol. 2, No. 2, 2025, 197-214
https://doi.org/10.56916/jmrd.v2i2.1251

Factors Influencing Students' Performance in Chemistry in Selected Senior High Schools

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Keywords
Teacher quality
classroom environment
teaching and learning resources

Article History
Received 2025-04-20
Accepted 2025-06-29

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Abstract
This study examined the factors influencing students' academic performance in chemistry at selected senior high schools in Kassena-Nankana Municipality, Ghana. A quantitative research method, rooted in the positivist paradigm, which assumes the existence of a single objective reality and excludes subjective values was utilised in this study. Therefore, it relied on numerical data to achieve objectivity. A descriptive correlational research design was used as a blueprint for the quantitative data collection and analysis. This design establishes the degree of influence or relationship between the variables understudy using statistical analysis. The study involved 140 participants, selected from an accessible population of 279 third-year students across four senior high schools, using purposive and simple random sampling. Data collection instruments included test and a questionnaire, which was designed in a form of a five-point Likert scale. The findings indicate that teacher quality, classroom environment, and teaching and learning resources had negative influence on students' performance in chemistry. Consequently, regression analysis revealed that all three factors: Teacher quality, classroom environment and teaching and learning resources significantly negatively influenced students' academic performance in chemistry across the selected schools that were engaged in this study. The study thus concludes that among the selected schools considered for this study; teacher quality, classroom environment and teaching and learning resources are contributory factors to students' low performance in chemistry. It is therefore recommended that continuous professional development for chemistry teachers in the selected schools should be institutionalised by leadership of the schools to enhance students' learning outcomes in chemistry.

INTRODUCTION

Chemistry is a scientific field that derives from the foundations of physics and has applications in the biological sciences, engineering, technology, and earth sciences (Abanikannda, 2016; Davies, 2008; Suchocki (2014). For chemistry graduates, satisfying careers include those in biotechnology, toxicological, pharmaceutical, metallurgical, commercial, academic, health services, food processing, petroleum and petrochemical, and hazardous waste management industries (Ababio, 2013; Helmenstine, 2019). It is widely accepted that chemistry is an important subject to study in schools and that it plays a vital part in any nation's scientific and technological growth.

However, studies have looked at senior high school students' performance in chemistry over the years and the results show that students performed poorly in conceptual understanding of topics such as mole concepts, writing of chemical formulae and equations and performing calculations from them,

and concepts of chemical reaction equilibrium (Achor & Ukwuru, 2014; Supasorn & Waengchin, 2014). Students sometimes have misconceptions about concepts like electrolysis, redox reactions, acid and bases, state of matter, and organic molecules since chemistry is perceived as a difficult and sophisticated discipline (Chiu, 2007; Johnstone, 2006). Many students find it difficult to comprehend chemistry ideas, which have led to subpar performance in the subject. Many students struggle to understand chemistry concepts; consequently, their performance in the subject has not been the best, which could be attributed to many factors.

Previous studies across different countries have identified poor teaching techniques, teachers' attitudes, inadequate laboratories and a lack of scientific background as factors affecting students' poor performance in chemistry (Adesoji, 2003; Adeyegbe, 2005; Aghadiuno, 2002; Osuafor, 2001). Similarly, other contributing factors were identified by other research findings, including ineffective teaching methods and insufficient capital investment in the form of the availability of science resources (Friedman, 2000). Among all other factors, the most significant influence on students' learning is the teacher (Darling-Hammond, 2017). It has been established that teachers have a big influence on how well their students do in school. Since teachers are ultimately in charge of interpreting rules and guidelines based on actual experiences while interacting with pupils, they are crucial to the effectiveness of education (Afe, 2001). Academic performance will suffer if the tutoring teacher is incompetent.

Students' academic achievement may also be influenced by the classroom environment, which includes the emotional tone, degree of competition, and inclusivity. The classroom environment fosters a sense of safety, respect, and community. Students' motivation in learning is recognized to be greatly influenced by their learning environment (Hornstra et al., 2015; Rathunde & Csikszentmihalyi, 2005).

Most African countries suffer from a persistent lack of high-quality teaching materials, particularly in rural areas. According to Adeogun (2001), student performance was higher in schools with more instructional resources than in those with fewer. The calibre and quantity of teaching and learning tools have an impact on how well students achieve. This implies that schools with more resources; textbooks, charts, photographs, real objects for students to see, hear, and experiment with have a higher likelihood of turning out exam-worthy students than do schools with less resources.

For students to succeed in their studies, attitude, motivation, and genuine interest are crucial traits. It promotes interest in studying chemistry when people have a positive attitude toward the subject. The secondary science curriculum should aim to improve students' attitudes and academic performance. According to Delmang and Gongden (2016), a student's attitude and interest may have a big impact on whether or not they decide to study science. Chemistry teaching and learning are made more effective by attitudes. Students' educational experiences are greatly influenced by the teachers' attitudes. If the teacher in question has a stellar reputation, is consistently prepared, focused, and enthusiastic about the lessons and spends time simplifying challenging concepts, the students will consciously try to be in class.

Academic achievement, which is defined as academic success at school, is expressed as a score or a percentage (Ajayi, 2009). One of the reasons that chemistry is studied worldwide is because academic performance is a key indicator for students. Conversely, students in similar educational environments have differing levels of academic success (Imomotimi, 2013). Learning is more than just memorizing the right answers; it's also about developing concepts and bringing about enduring, good change (Broman, Bernholt & Parchmann, 2018).

A review of West African Senior School Certificate Examination (WASSCE) results from 2019 to 2021 reveals consistently low pass rates in chemistry across senior high schools in the municipality. For

example, Table 1 presents the results of the students in chemistry in one of the selected schools according to the WASSCE results over the years.

Table 1: Analysed Chemistry Results of a Selected School for some Selected Years

No of Candidates	Year	A1	B2	B3	C4	C5	C6	D7	E8	F9	Total Pass (%)	Total Fail (%)
111	2019	0	0	0	0	0	4	3	6	98	11.7	89.3
131	2020	0	0	0	0	1	3	2	11	114	3.1	87.0
159	2021	0	0	0	0	0	4	1	13	140	2.5	95.9

Source: Field Data from a Selected School WAEC (Chief Examiners' Report) (2019, 2020, 2021).

From Table 1, the results from one of the selected schools show a disturbing trend in terms of students' performance in chemistry within the municipality. This trend has sparked concerns among educators, parents, and policymakers about the quality of chemistry education in the study area.

Research Objectives

The main objective was to assess the factors influencing students' achievement in chemistry in selected senior high schools in the Kassena-Nankana municipality of the Upper East Region of Ghana.

Specific Objectives

1) To determine the influence of teacher quality on students' performance in chemistry in the selected Senior High schools.
2) To determine the influence of classroom environment on students' performance in chemistry in the selected Senior High schools.
3) To determine the influence of teaching and learning resources on students' performance in chemistry in the selected Senior High schools.

LITERATURE REVIEW

Conceptual Framework

With the help of variables that make it easier to meet the goal of the study, the conceptual framework describes how researchers define the research question and create a theoretical review (Berman, 2013). A conceptual framework, according to Maxwell (2013), is a figure that shows the relationships between various factors and the scientific investigation of occurrences. The conceptual framework is a model that classifies variables and shows how independent and dependent variables are related. It is used in all studies. Figure 1 depicts the conceptual framework that underlies this inquiry.

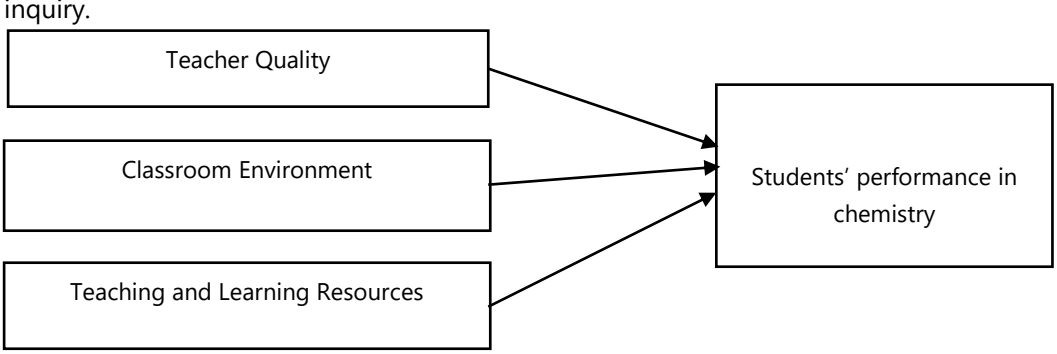

Figure 1. Conceptual Framework of this Study

From Figure 1, the factors considered to influence students' performance in chemistry in this study are teacher quality, classroom environment and teaching and learning resources. The extent to which these factors play out will eventually determine the outcome of students' performance in chemistry. Teacher quality in this context encompasses teacher qualification, subject knowledge, teaching experience, pedagogical skills and enthusiasm positively influence students' motivation, engagement, and comprehension in chemistry that could lead to improved academic performance. Also, classroom environment entails the physical classroom setup, classroom culture, peer interactions, teacher-student relationships and supportive classroom environment which can foster student engagement, confidence, and active participation in chemistry that could affect students' academic performance. Teaching and learning resources in this study comprise availability of textbooks, laboratory facilities, access to internet, and supplementary materials that can influence students' performance in chemistry. Adequate teaching and learning resources enhance students' access to information, hands-on experiences, and understanding of chemistry concepts and that could positively influence performance in chemistry.

Teacher quality

It is vital to take into account how a teacher's quality affects learners' performance. Teachers are essential elements of a productive educational system and essential assets for the progress of education. It is well known that teachers are the most important part of the educational system and that their success is dependent on the success of any government-sponsored educational programme. Abe (2014) asserts that the quality of a nation's instructors may have an impact on its educational standards. Hiring certified, experienced teachers is the most important step in boosting learners' success levels.

Ajayi (2017) states that a teacher should be able to excite students in addition to having organizational abilities, subject matter expertise, and the ability to simplify difficult concepts. A successful teacher possesses creativity, the ability to include students in valuable activities throughout the teaching session, control over the details of learning, and the ability to regularly assess students' academic progress through written and spoken quizzes as well as official and informal exams. Teachers with strong content knowledge in chemistry are better equipped to deliver clear and accurate explanations of the subject matter. This clarity in instruction helps students grasp challenging concepts more easily (Ingersoll & Strong, 2011). Chemistry often involves problem-solving and critical thinking. Instructors with expertise in the field can help students solve problems and provide advice on how to approach difficult chemical topics (Jegstad & Sinnes, 2015).

Chemistry can be made more interesting and relevant for students by showing them how principles are applied in real-world situations. This method aids students in seeing how what they are studying has real-world applications (Ritchie, 2000). Teachers can use tactics for differentiated instruction when they recognize that students have a range of learning styles and skills. By adjusting instruction to each student's needs, this method makes sure that every student has the chance to achieve (Tomlinson & Allan, 2000). Teachers can assess students' knowledge and modify their instruction by regularly using formative assessments, such as concept checks, quizzes, and peer evaluations (Black & Wiliam, 2004).

One important area of educational study is the influence of teacher quality on students' academic achievement. Investigators have explored the complex dynamic between educators and learners, seeking to understand how teacher quality affects students' academic performance. Darling-Hammond's (2017) research emphasizes how crucial teacher credentials are in determining how well pupils do academically. Key markers of teacher quality have been discovered, and these include qualifications such as topic expertise, certification, and educational background. According to Darling-

Hammond's meta-analysis, there is a correlation between higher student accomplishment in a variety of topics and grade levels and teachers with substantial degrees.

The quality of teaching practices implemented by educators is a central focus in understanding the correlation with students' performance. (Hattie 2013) conducted an extensive meta-analysis and identified several high-impact teaching practices. Teachers employing strategies such as formative assessment, feedback, and classroom management were associated with improved student learning outcomes. This underscores the notion that the application of effective teaching practices contributes significantly to teacher quality and, subsequently, student performance.

The relational aspect between teachers and students has garnered attention in recent years. Pianta and Hamre (2012) explored the role of positive teacher-student relationships in influencing academic success. Their research demonstrated that a supportive and positive teacher-student relationship is linked to higher student engagement, motivation, and ultimately, academic achievement. This emphasizes the importance of the socio-emotional dimension of teacher quality in the educational process. Ongoing professional development is considered a crucial component of teacher quality. Hawkins (2019) investigated the impact of teacher professional development on student outcomes. Their findings indicated that teachers engaged in continuous learning and professional growth were better equipped to adapt to evolving educational contexts, leading to enhanced student performance. This underscores the dynamic nature of teacher quality and the need for educators to stay abreast of current pedagogical practices.

Classroom environment

The school is a unique social setting where learners receive education, training, and personality development that will help them become future assets to the community. A well-arranged and aesthetically pleasing classroom can foster a productive learning environment. It can help learners feel more at ease and concentrate better. A classroom's physical layout should support learning. The attitudes of students toward learning and their general well-being can be positively impacted by a well-designed classroom (Tanner, 2013). Students might feel more a part of the classroom community when an inclusive environment that values variety is created. Their performance and motivation can both benefit from inclusivity (Chang et al., 2014).

A well-run classroom can reduce disturbances that could impair performance by creating a safe and conducive learning environment with consistent rules and discipline techniques (Emmer & Stough, 2001). Clear expectations and regulations must be established and upheld for effective classroom management, this guarantees that there are no distractions and that the learning atmosphere stays concentrated, and enabling learners to focus on their studies. A more effective and productive learning environment is facilitated by good classroom management techniques (Emmer & Stough, 2001).

Chemistry can be a challenging subject, and some students may experience anxiety related to their performance. A supportive teacher-student relationship can help alleviate this anxiety by creating a safe and non-judgmental environment for learning, which can lead to improved focus and performance (Putwain, Woods & Symes, 2010). Studies underscore the role of teacher-student relationships in enhancing students' motivation, engagement, and performance in chemistry (Martin, 2007; Roe & Smith, 2009). In chemistry, students often encounter difficult concepts and problem-solving challenges. Hill et al. (2004) stressed that teachers who have strong relationships with their students are more likely to provide additional academic support, such as tutoring or extra resources, which can be instrumental in improving students' performance. An organized and well-structured classroom layout can also enhance students' performance in chemistry. For chemistry courses, access to well-equipped laboratory facilities is crucial. These facilities should include a range of scientific

instruments, safety equipment, and sufficient workspace for conducting experiments and investigations. A well-maintained laboratory environment can significantly impact students' hands-on learning experiences and comprehension of chemical concepts (Aziz, 2000). Additionally, the physical environment of the classroom, including access to resources and technology, plays a crucial role in shaping students' learning experiences (Aziz, 2000; Linn & Hsi, 2000).

Studies have delved into the impact of the physical aspects of the classroom on student performance. For example, Smith, (2022) found that well-lit and well-ventilated classrooms positively correlated with higher academic achievement. Classroom layout, seating arrangements, and the availability of instructional materials were identified as influential factors shaping students' learning experiences. The social dynamics within the classroom play a crucial role in determining students' performance. Johns-Smith (2023) explored the impact of effective classroom management on student outcomes. Their research suggested that clear expectations, consistent discipline, and engaging instructional strategies created a positive learning atmosphere, fostering improved academic performance among students.

Teaching and learning resources

Resources include both material and immaterial items, such as lab equipment, charts, visual aids, textbooks, and course outlines, among others. When teachers have access to relevant resources, their ability to teach is greatly improved. Quality textbooks and curricular materials are essential resources that provide students with the necessary content, explanations, and examples to support their learning in chemistry. Textbooks often serve as the primary source of information for students. When textbooks are well-written and aligned with the curriculum, they can aid students in developing a deep understanding of key chemistry concepts (Madsen et al., 2015). Besides textbooks, curricular materials may include supplementary resources such as workbooks, online modules, and practice problems. Hancock and Betts (2015) indicated that these materials can help students reinforce their knowledge and practice problem-solving skills, which are essential in chemistry. Curricular materials, including textbooks, should align with the curriculum and learning objectives set by educational institutions. When materials are well-matched with what is taught in the classroom, students can better prepare for exams and assessments (Datar & Lewis, 2011). Libraries also play key role in promoting critical thinking and facilitating reference material access (Kusi, 2012; Tenopir & King, 2004).

Research in high school settings by Tai, Sadler, and Loehr (2005) revealed intriguing relationships between the kinds of laboratories used and students' academic achievement. It was noted that while a heavy emphasis on laboratory procedures in high school chemistry was linked to poorer college grades, high school students who participated in a variety of laboratory activities tended to receive higher grades. Visual aids, such as diagrams, charts, and multimedia presentations, can also help students visualize complex chemical concepts and processes. This visual support enhances comprehension and retention of information (Tversky et al., 2002). Multimedia tools, including videos, interactive simulations, and 3D models, make chemistry lessons more engaging and interesting for students. When learning is enjoyable, students are more likely to invest time and effort, leading to improved performance (Mayer, 2001). Visual aids and multimedia tools cater to different learning styles, allowing students to absorb information through visual and auditory channels. According to Pashler et al. (2008), this accommodates diverse learning preferences and can lead to better understanding. Visual aids and multimedia tools can reinforce key chemistry concepts by providing real-world examples, animations of chemical reactions, and dynamic representations of molecular structures (Andre, 2005). Pashler et al. (2008) and Schnotz et al. (2003) demonstrated that incorporating visual aids into instruction can lead to better recall and application of knowledge.

According to Anderson (2020), there is a direct link between students' academic success and the availability of high-quality textbooks. Their study found that students who had access to well-designed and up-to-date textbooks demonstrated higher levels of understanding and performance in various subjects. The integration of technology into teaching practices has become increasingly prevalent. Zheng et al. (2024) conducted a meta-analysis examining the impact of technology use on student performance. Their findings revealed that judicious integration of technology tools in the classroom positively influenced students' engagement and achievement. Interactive simulations, educational software, and online resources were identified as contributors to improved learning outcomes. Research by Hmelo-Silver and Duncan (2007) and Baker et al. (2010), emphasized the advantages of digital resources in accommodating various learning styles and offering individualized learning experiences. Technology integration into chemistry education creates dynamic and rich learning environments (Talanquer, 2011; Stains et al., 2018).

METHODS

Research Method and Design

A quantitative research method was utilised in this study. Saunders and Tosey (2015) argue that the quantitative approach is rooted in the positivist research paradigm, which assumes the existence of a single objective reality and excludes subjective values. Therefore, it relies on numerical data to achieve objectivity. The strength of the quantitative approach lies in its ability to facilitate a critical analysis of numerical data for larger sample sizes and its efficiency in administering questionnaires. A descriptive correlational research design was used a blueprint for quantitative data collection and analysis. This design establishes the degree of influence or relationship between the variables understudy using statistical data.

Sample and Sampling Techniques

The sample size for this study was 140 participants out of an accessible population of 279 from four selected senior high schools in the Kassena-Nankana Municipality. Both simple random sampling and purposive sampling techniques were employed in selecting the sample. The selection of the schools was by purposive sampling because the researchers needed to select schools that are offering general science programmes with students studying chemistry as a subject. Due to the nature of this study, the researchers wanted students who have studied year one, year two and year three chemistry syllabi and have adequate knowledge about factors influencing their performance in chemistry to take part in the study, hence, year three science students in the selected schools were purposively selected for the study.

Purposive sampling was also used to engage all year three science students from selected schools A, C, and D since these schools have smaller numbers with only one science class in year three, the entire students in these intact classes were selected for the study. The number of students engaged in the study from these schools A, C and D were 37, 26 and 32 respectively. The third-year science students in school B were 126, which was a large number for all of them to be included in the study, thus, a simple random sampling was used to select 45 students for the study. The participants in selected schools A, B, C and D constituted a total sample size of 140.

Data Collection Techniques

The data was collected using a questionnaire and a teacher-made test. The questionnaire was developed by the researchers, which was based on a five-point Likert scale to gather participants' responses on factors influencing students' performance in chemistry. The responses were quantified and subjected to statistical analysis. The reliability of the questionnaire instrument was ascertained by

determining the Cronbach alpha reliability index, which was calculated as 0.700 being within the acceptable threshold for used. According to Santos and Brito (2012), Cronbach's alpha is a reliability metric that shows the percentage of variation explained by the underlying construct's true score. Higher values on this coefficient, which has a range of 0 to 1, indicate more reliability.

Additionally, the teacher-made test which was a multiple-choice type of objective test had a wider coverage of the content learnt in chemistry based on first, second- and third-year chemistry syllabus for senior high schools in Ghana. In all, sixty (60) multiple-choice questions were used. Test re-test reliability index was determined by correlating the first test scores with the second test scores after the two tests were administered to a group that shares similar characteristics with the study participants. The correlation coefficient was found as 0.670, which equally fell within the threshold of being acceptable for used. The test items after the pre-testing were then administered to the 140 participants across the four selected senior high schools within the municipality to determine their performance in chemistry. Quantitative data were gathered from the test scores and statistical analysis was made accordingly.

Data Analysis Techniques

Descriptive statistics such as mean and standard deviation were used to analyse the data on factors influencing students' performance in chemistry. With the five-point Likert scale, this study adopted the mean value's degree of interpretation as 1.81 - 2.60 (low), 2.61 - 3.40 (moderate), 3.41 - 4.20 (high), and 4.21 - 5.00 (very high) to guide the interpretation of the extent to which various factors influence students' performance in chemistry (Bosire, 2005 cited in Nnko, 2024). Additionally, ANOVA statistics were offered to evaluate the regression models' overall significance. Regression studies were performed to evaluate the factors influencing students' performance in chemistry. For every study issue, regression analyses including parameter estimates, standard errors, t-statistics, and p-values were carried out. Statistical Package for the Social Sciences (SPSS) version 20.0 was used to analyse the data.

Ethical Consideration

No single participant was compelled to be part of the study. Participants' consent was sought before they were included in the study. Authorities of the selected senior high schools in the study area were duly informed through a letter of permission to undertake the study. All participants were assured of high level of confidentiality and anonymity regarding information that they volunteered concerning this study.

RESULTS AND DISCUSSION

Demographic Analysis

This section presents the demographics of the participants in terms of male and female students' participation in the study as well as ages of the students (Table 1).

Table 1. Students' Demographic Information

Variable	Category	Frequency	Percentage
Gender	Male	98	70.0
	Female	42	30.0
Age	14-16 years	33	23.6
	16-18 years	65	46.4
	18-20 years	27	19.3
	20 years above	15	10.7

Source: Field Data (2023)

As shown in Table 1, most of the participants, 98 (70.0%) were male students with female students, 42(30.0%) being the minority. Females' enrolment in science programmes at the senior high school level in Ghana has been low over the years. In terms of age, many students, 65 (46.4%) were within the category of 16-18 years.

Research Objective 1: To determine the influence of teacher quality on students' performance in chemistry in the selected Senior High schools

Table 2 displays the number of participants, means and standard deviation of the eight items that measure teacher quality in this study**.**

Table 2. Students' Responses on Teacher Quality

S/N	Item	N	M	SD
1	My chemistry teacher explains concepts clearly and understandably.	140	2.421	1.151
2	My chemistry teacher encourages questions and class participation.	140	2.443	1.177
3	My chemistry teacher makes us perform practical regularly.	140	1.793	1.042
4	My chemistry teacher provides helpful feedback on my assignments and tests.	140	2.221	1.046
5	My chemistry teacher cares about my performance and progress	140	2.907	1.240
6	My chemistry teacher motivates me to learn chemistry	140	2.564	1.310
7	My chemistry teacher is available for extra help when needed.	140	2.173	1.116
8	My chemistry teacher relates the subject to real-life examples.	140	2.186	1.135
Overall Weighted Parameter		**140**	**2.337**	**1.097**

Source: Field Data (2023)

From Table 2, based on the overall weighted mean, the students rated teacher quality low as a factor that influenced their performance in chemistry (M = 2.337, SD = 1.097). Teacher quality in terms of organising chemistry practical sessions for students had the least mean score (M = 1.793, SD = 1.042). Most teacher quality items were rated low indicating the extent to which students' performance in chemistry was poorly affected by this quality indicator. However, a moderate mean score was awarded for the teachers' concern for students' performance and progress (Mean=2.907, SD = 1.240). This suggests that the chemistry teachers were quite supportive in terms of their care about students' performance and progress in chemistry, although the overall teacher quality was low.

Table 3 also presents parameter estimate and ANOVA statistics for predictor A. The study conducted a simple linear regression analysis to ascertain the perceived effect of teacher quality on the performance of students in chemistry in the Kassena-Nankana Municipality.

The results, as shown in Table 3, revealed that the influence of teacher quality on students' performance in chemistry is significant (p = 0.002). The negative nature of the parameter estimate (-2.053) from the results indicates that when teacher quality changes, the students' performance in chemistry changes negatively by 2.053 units. Therefore, teacher quality in this current study negatively

influences students' academic performance in chemistry across the selected schools in the municipality. Again, the p-value for the t-statistic of the constant is <0.001, which shows that, the constant is significant at the 5% significance level. The ANOVA F-statistic is 10.078, and the p-value is 0.002, showing that the model is highly significant.

Table 3. Parameter estimate and ANOVA statistics for predictor A (Teacher Quality)

Variable	Estimate	Std. Error	*t*-statistic	*p*-value	ANOVA *F*-Statistic	ANOVA *p*-value
Constant	23.413	1.669	14.031	<0.001	10.078	0.002
Teacher Quality	-2.053	0.647	-3.175	0.002		

*Significant at p < 0.05)
Source: Field Data (2023)

Research Objective 2: To determine the influence of classroom environment on students' performance in chemistry in the selected Senior High schools

The variable, classroom environment as a factor that influences students' performance in chemistry is shown in Table 4 with various items highlighting the mean and standard deviation values. The overall mean and standard deviation provide a comprehensive understanding of the students' rating of classroom environment as a factor that influences their performance in chemistry.

Table 4. Students' Responses on Classroom Environment

S/N	Item	N	M	SD
1	The classroom environment in my chemistry class is conducive to learning.	140	2.992	1.333
2	Students feel safe and respected in our chemistry classroom.	140	3.050	1.436
3	Our chemistry teacher creates a positive and inclusive atmosphere in the classroom.	140	2.107	1.051
4	There are sufficient resources and materials available for chemistry learning in our classroom.	140	2.286	1.177
5	The classroom temperature and lighting are comfortable for learning chemistry.	140	2.814	1.477
6	Our chemistry class is kept clean and well-maintained.	140	3.857	1.116
7	The seating arrangement in the classroom allows for easy interaction and collaboration.	140	3.0071	1.442
	Overall Weighted Parameter	**140**	**2.514**	**1.129**

Source: Field Data (2023)

The overall mean of (M=2.514, SD = 1.129) suggests a nuanced picture. This indicates that per the students' rating, while there is a general trend towards a low influence of classroom environment on students' performance in chemistry, some factors moderately influence their performance as shown in Table 4. For instance, in areas where the mean was high such as the cleanliness and maintenance of the classroom (M = 3.857, SD = 1.116), students generally indicated a high rating of their classroom environment as a factor influencing their performance in chemistry. The low standard deviation

suggested that there was a high level of agreement among students regarding the cleanliness and upkeep of the classroom, indicating that this aspect of the environment is consistently valued.

On the other hand, dimensions with low means, such as the creation of a positive and inclusive atmosphere by the teacher (M = 2.107, SD = 1.051) and the availability of sufficient resources and materials for learning (M = 2.285, SD = 1.177) were aspects of classroom environment that had low influence on students' performance in chemistry.

The parameter estimates and ANOVA Statistics for predictor B (classroom environment) are presented in Table 5.

Table 5: Parameter Estimate and ANOVA Statistics for Predictor B

Variable	Estimate	Std. Error	*t*-statistic	*p*-value	ANOVA *F*-Statistic	ANOVA *p*-value
Constant	23.337	1.822	12.810	<0.001	7.930	0.006
Classroom Environment	-1.644	0.584	-2.816	0.006		

***Significant at p < 0.05**
Source: Field Data (2023)

The parameter estimates for both the slope (constant) and the classroom environment factor are highly significant at 5% significance level as shown in Table 5. The ANOVA p-value of 0.006 which is less than the 5% significance level revealed that the model is adequate. The negative value (-1.644) of classroom environment revealed that the variable (classroom environment) influenced negatively on the students' performance in chemistry among the selected senior high schools.

Research Objective 3: To determine the influence of teaching and learning resources on students' performance in chemistry in the selected Senior High schools.

Table 6 presents students' responses on teaching and learning resources providing valuable insights into the adequacy and effectiveness of these resources on their performance in chemistry.

Table 6: Students' Responses on Teaching and Learning Resources

S/N	ITEM	N	M	SD
1.	There are enough textbooks available for each student to use in our chemistry class	140	2.707	1.295
2.	Our chemistry teacher incorporates real-life examples and case studies into lessons to enrich our understanding.	140	2.329	1.365
3.	Our school provides adequate internet access for conducting research and accessing online resources related to chemistry.	140	1.850	1.092
4.	The library offers a wide range of chemistry-related books and references for students to borrow.	140	3.271	1.398
5.	Our chemistry teacher utilizes educational applications or software to facilitate learning outside of the classroom.	140	1.921	.922
6.	Supplementary materials like worksheets, handouts, or online resources are regularly provided to aid in learning chemistry.	140	2.136	1.177
7.	The school provides multimedia resources such as projectors or computers for enhancing chemistry lessons.	140	2.633	1.435
8.	Our chemistry class has access to laboratory equipment and materials for practical experiments.	140	3.121	1.476

Overall	**140**	**2.496**	**1.270**

Source: Field Data (2023)

From Table 6, the results revealed a range of students' rating of teaching and learning resources on their performance in chemistry across various dimensions. Notably, students expressed a moderate view regarding the availability of laboratory equipment and materials for practical experiments (M = 3.121, SD = 1.476). This suggests that students had access to essential resources for hands-on learning experiences, although there was some variability in their responses, indicating potential differences in experiences or preferences among students across the selected schools.

Additionally, students indicated a moderate influence of the availability of chemistry-related books and references in the library on their performance in chemistry (M = 3.271, SD = 1.398). This signifies that to some extent students agreed that the library offers a wide selection of resources for supplementary learning, though there remains some variance in opinions. Conversely, students expressed a more critical stance towards the adequacy of internet access for conducting research and accessing online resources related to performance in chemistry (M = 1.850, SD = 1.092). The low mean coupled with a relatively high standard deviation suggests a consensus among students that internet access was inadequate, with notable variability in the extent of dissatisfaction among them. The low mean for educational apps/software (M = 1.921, SD = 0.922) suggests a general disagreement among students regarding their integration into the learning process, with limited variability in responses indicating a widespread sentiment as it affects their performance in chemistry. Overall, the mean value (M = 2.496, SD = 1.270) shows low influence of teaching and learning resources on the students' performance in chemistry per their rating.

Table 7 displays the parameter estimate and ANOVA Statistics for predictor C (teaching and learning resources).

Table 7: Parameter Estimate and ANOVA Statistics for Predictor C

Variable	Estimate	Std. Error	*t*-statistic	*p*-value	ANOVA *F*-statistic	ANOVA *p*-value
Constant	22.642	1.646	13.756	<0.001	7.370	0.007
Teaching and Learning Resources	-1.613	0.594	-2.715	0.007		

***Significant at p < 0.05**
Source: Field Data (2023)

The parameter estimation shows a statistical significance (p = 0.007) suggesting that the influence of the teaching and learning resource factor on students' performance in chemistry is not the result of random variation. Additionally, the F-statistic of 7.370 and a p-value of 0.007, which is less than the significance level of 0.05, show that the model fits the data well according to the ANOVA results. This shows that the dependent variable's variance can be explained by the model to a considerable extent, and that there is statistical significance in the relationship between the teaching and learning resource factor and the students' performance in chemistry in the study area. The negative estimate clearly shows that teaching and learning resources as a factor negatively influenced the students' performance in chemistry.

Discussion of Findings

The study showed that teacher quality in this current study negatively influences students' academic performance in chemistry across the selected schools in the municipality. This result is

consistent with a study conducted by Darling-Hammond (2017), who highlighted the role that teacher credentials have in determining students' academic progress. The study's negative parameter estimate on teacher quality (-2.053) supports Darling-Hammond's claim that employing certified, experienced instructors has a positive, substantial influence on learners' performance levels. On the other hand, learners' academic performance will suffer if teachers are of low quality as indicated in this current study.

Once more, the study's finding about the value of instructors' subject-matter expertise in chemistry instructions are consistent with findings by Ingersoll and Strong (2011). According to Ingersoll and Strong, instructors who possess a good foundation in the subject matter may provide students with clear explanations, mentor them through problem-solving techniques, and help them develop a deeper comprehension of the material. This is consistent with the finding of this study, which showed that students valued their professors' accurate explanations and hands-on examples.

Similarly, the study's finding on the importance of continuous professional development correlates with the study's finding of Ingersoll and Strong (2011), who emphasized the role of ongoing learning in enhancing teacher quality and improving student outcomes. The significant ANOVA results (F-statistic = 10.078, p = 0.002) indicate a strong relationship between teacher quality and student performance in chemistry. This supports Darling-Hammond's (2017) findings that teacher qualifications and teaching practices significantly influence students' academic performance.

As regards the influence of classroom environment on students' performance in chemistry, this current study found a low influence. This suggests that on the average, the classroom environment was not good enough to positively influence students' performance in chemistry. This finding is in consonance with Tanner's (2013) study, which asserts that a neatly arranged and aesthetically pleasing classroom can foster a supportive learning environment that increases students' focus and participation as it leads to improved academic performance. Conversely, a classroom that does not support students' engagement in active learning will have low or no influence on students' performance.

Furthermore, Emmer and Stough (2001) emphasize the significance of effective classroom management in creating a safe and conducive environment for improved learning, which reduces disruptions and enhances students' performance. Consistent with this, the negative parameter estimates (-1.644) for the classroom environment suggests a significant negative influence on students' performance in chemistry. Studies underscore the role of teacher-student relationships in enhancing students' motivation, engagement, and performance in chemistry (Martin, 2007; Roe & Smith, 2009). Positive teacher-student relationship as an important aspect of classroom environment facilitates open communication and provides additional academic support, which can mitigate anxiety and improve student outcomes (Putwain, Woods & Symes, 2010). Additionally, the physical environment of the classroom, including access to resources and technology, plays a crucial role in shaping students' learning experiences (Aziz 2000; Linn & Hsi, 2000). While the availability of resources and materials for chemistry learning received a relatively lower mean score (M = 2.285), integrating technology and creating comfortable learning spaces can enhance students' engagement and performance.

This current study found that teaching and learning resources as a factor negatively influenced the students' performance in chemistry within the study area. Students expressed a more critical stance towards the adequacy of internet access and well-resourced libraries for conducting research and accessing online resources related to their performance in chemistry. Per the findings, internet access was inadequate, with notable variability in the extent of dissatisfaction among them regarding the use

of educational apps/software. This suggests a general disagreement among students regarding their integration into the learning process, with limited variability in responses indicating a widespread sentiment as it affects their performance in chemistry.

These findings are in line with the views of Kusi (2012) and Tenopir and King (2004), who highlighted the function of libraries in promoting critical thinking and facilitating reference material access. This study's outcomes recognize the potential of online and digital tools, like interactive simulations and e-textbooks, to improve students' comprehension of chemistry subjects. Research by Hmelo-Silver and Duncan (2007) and Baker et al. (2010), which emphasized the advantages of digital resources in accommodating various learning styles and offering individualized learning experiences, are consistent with this. The study also acknowledges the significance of integrating technology into chemistry education, which is in consonance with research by Talanquer (2011) and Stains et al. (2018), who highlighted the contribution of technology to the creation of dynamic and rich learning environments. Furthermore, this current study underscores the role of visual aids and multimedia tools in improving students' comprehension and retention of chemistry concepts. This is supported by research by Pashler et al. (2008) and Schnotz et al. (2003), who demonstrated that incorporating visual aids into instruction can lead to better recall and application of knowledge.

CONCLUSION

Teacher quality as a factor was rated with a low overall mean score by the participants indicating that it negatively influenced students' performance in chemistry across the selected schools engaged in this study. Regression analysis revealed a negative estimate on teacher quality as a variable that significantly influenced students' academic performance in chemistry. Therefore, teacher quality is a determinant of students' academic performance in chemistry.

Again, the study revealed that classroom environment as a factor was also poorly rated (low overall mean score) by the participants, revealing that it influenced students' performance in chemistry negatively. Regression analysis further ascertained that classroom environment as a variable significantly influenced students' performance in chemistry with a negative estimate that indicated that the influence was poor. Thus, classroom environment is a key factor that influences students' performance in chemistry.

Another factor considered in this study was teaching and learning resources. The study found that participants equally rated this factor with a low overall mean score indicating how it unfavourably influenced students' performance in chemistry across the selected schools. Consequently, the poor influence of teaching and learning resources was significant based on the output of regression analysis that revealed a negative estimate on this variable. Teaching and learning resources thus play key role in influencing students' performance in chemistry.

RECOMMENDATIONS

Based on the findings of this study, the following recommendations are put forward.

1. School leadership in the selected schools should organize continuous professional development programs for chemistry teachers focusing on enhancing their pedagogical content knowledge, classroom management, and the use of innovative teaching strategies to actively engaged students.
2. School leadership in the selected schools should ensure suitable classroom environment through regular monitoring and provision of the needed resources.

3. There should be adequate allocations of relevant teaching and learning resources by key actors in education to the selected schools to enable chemistry teachers and students conduct regular hands-on experiments and activities.

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