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REVIEW ARTICLE

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Challenges and Perceptions in Learning Chemistry Among Senior High School Students

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Abstract: This study investigates the challenges and perceptions of students in learning chemistry at Winneba Senior High School (SHS) in Ghana. Despite the importance of chemistry in the Senior High School curriculum, students often perceive it as a difficult subject due to its abstract nature, complex terminologies, and reliance on strong foundational knowledge in mathematics and science. Using a mixed-methods approach, the study collected data from 114 General Science students through structured questionnaires and interviews with 10 students and 5 teachers. The findings reveal that students face significant challenges, including insufficient background knowledge in mathematics and science (29.8%), inadequate teaching methods (19.3%), and limited access to laboratory resources (19.3%). Students also reported difficulties in understanding chemistry concepts (mean = 3.95) and found terminologies confusing (mean = 4.17). However, they enjoyed laboratory work (mean = 4.15), despite its challenges. The study highlights the role of motivation, with many students lacking the drive to study chemistry, which adversely affects their academic performance. Gender disparities were also noted, with female students expressing less interest in the subject. The study recommends investing in well-equipped laboratories, adopting context-based teaching methods, and incorporating culturally responsive pedagogy to make chemistry more relatable. It also emphasizes the need for professional development for teachers and the integration of technology to enhance learning. By contextualizing these findings within the Ghanaian educational system, this study contributes to the broader discourse on improving science education in resource-constrained settings and offers practical strategies for enhancing chemistry learning outcomes.

Keywords: Chemistry Education, Student Perceptions, Learning Challenges, Laboratory Resources, Teaching Methods

1. INTRODUCTION

Chemistry is a fundamental science subject that plays a critical role in the development of scientific literacy and technological advancement (Hofstein & Lunetta, 2004). It is a core subject in the Senior High School (SHS) curriculum, particularly for students pursuing science-related programs. However, despite its importance, students often perceive chemistry as one of the most challenging subjects due to its abstract nature, complex terminologies, and the requirement for strong foundational knowledge in mathematics and science (Chandrasegaran et al., 2007). This perception has been linked to poor academic performance and a lack of interest in the subject among students (Osborne et al., 2003). In Ghana, chemistry is a compulsory subject for science students at the SHS level, and its mastery is essential for success in national examinations such as the West African Senior School Certificate Examination (WASSCE). However, studies have shown that Ghanaian students consistently perform poorly in chemistry, with many citing difficulties in understanding key concepts and applying them in

practical and theoretical contexts (Adu-Gyamfi & Ampiah, 2016). This trend is particularly concerning given the country's emphasis on science and technology as drivers of economic development (Ministry of Education, 2010).

Several factors contribute to the challenges students face in learning chemistry. These include inadequate teaching methods, insufficient laboratory resources, and a lack of motivation among students (Hofstein & Mamlok-Naaman, 2007). Additionally, the abstract nature of chemistry concepts and the reliance on mathematical principles often make the subject inaccessible to students with weak foundational knowledge (Taber, 2002). The situation is further exacerbated by the use of inappropriate textbooks and limited access to modern laboratory equipment, which hinders effective practical learning (Bunce & Robinson, 1997). At Winneba Senior High School, like many other SHSs in Ghana, these challenges are prevalent. Despite the school's efforts to provide quality science education, students continue to struggle with chemistry, particularly in areas such as organic chemistry and chemical calculations (Owusu et al., 2020). This study seeks to explore the specific challenges faced by students at Winneba SHS and their perceptions of the subject, with the aim of identifying strategies to improve learning outcomes. Understanding the factors that contribute to students' difficulties in learning chemistry is crucial for developing targeted interventions that can enhance their academic performance and foster a positive attitude toward the subject. This study builds on existing research by providing a contextualized analysis of the challenges faced by students at Winneba SHS, with the ultimate goal of contributing to the broader discourse on improving science education in Ghana.

2. RELATED STUDIES

The challenges and perceptions of students in learning chemistry have been widely studied across different educational contexts. Research by Hofstein and Lunetta (2004) highlights the importance of laboratory work in enhancing students' understanding of chemistry concepts, emphasizing that practical experiences are critical for bridging the gap between theory and application. Similarly, Chandrasegaran et al. (2007) developed a diagnostic instrument to assess students' understanding of chemical reactions, revealing significant gaps in conceptual knowledge among secondary school students.

In Ghana, Adu-Gyamfi and Ampiah (2016) investigated the challenges faced by science teachers and students at the basic school level, identifying inadequate teaching resources and poor foundational knowledge as major barriers to effective science education. This finding aligns with Bunce and Robinson (1997), who emphasized the role of teaching methods in shaping students' attitudes toward chemistry. They found that traditional lecture-based approaches often fail to engage students, leading to disinterest and poor performance. The abstract nature of chemistry has been identified as a significant challenge by Taber (2002), who argued that students struggle to visualize and comprehend complex concepts such as atomic structure and chemical bonding. This difficulty is further compounded by the use of technical terminologies, which Johnstone (2000) described as a major source of confusion for learners. In a similar vein, Gabel (1999) highlighted the importance of using multiple representations (e.g., macroscopic, submicroscopic, and symbolic) to facilitate understanding, a strategy that is often underutilized in many classrooms.

The role of motivation in learning chemistry has also been extensively studied. Osborne et al. (2003) found that students' attitudes toward science significantly influence their academic performance, with many students perceiving chemistry as difficult and irrelevant to their daily lives. This perception is particularly prevalent among female students, as noted by Weinburgh (1995), who identified gender disparities in science achievement and interest. In contrast, Zusho et al. (2003) found that students who are intrinsically motivated tend to perform better in chemistry, suggesting the need for strategies that foster engagement and curiosity. Inadequate laboratory facilities have been identified as a major impediment to effective chemistry education in developing countries. Hofstein and Mamlok-Naaman (2007) emphasized the importance of well-equipped laboratories in promoting inquiry-based learning, while Bradley (1999) highlighted the challenges faced by schools in resource-constrained settings. In Ghana, Owusu et al. (2020) found that limited access to laboratory equipment negatively impacts students' ability to conduct experiments, thereby hindering their understanding of practical concepts.

The influence of teaching methods on students' performance has also been a focus of research. Talanquer (2011) argued that teachers' pedagogical content knowledge plays a critical role in shaping students' understanding of chemistry. Similarly, Gilbert and Treagust (2009) emphasized the need for context-based teaching approaches that connect chemistry concepts to real-world applications.

However, Tsaparlis (2000) noted that many teachers lack the training and resources to implement such strategies effectively.

The impact of students' prior knowledge on their ability to learn chemistry has been explored by Nakhleh (1992), who found that misconceptions often arise from inadequate foundational knowledge in mathematics and science. This finding is supported by Nurrenbern and Pickering (1987), who demonstrated that students struggle to apply mathematical principles to solve chemistry problems. In response, Bodner and Domin (2000) advocated for the use of problem-based learning to enhance students' critical thinking and problem-solving skills. Cultural and contextual factors also play a significant role in shaping students' perceptions of chemistry. Jegede and Okebukola (1991) found that students' cultural backgrounds influence their attitudes toward science, with many viewing it as a foreign and inaccessible discipline. This perspective is particularly relevant in sub-Saharan Africa, where Ogunniyi (2007) identified a disconnect between traditional knowledge systems and Western science education. Similarly, Aikenhead and Jegede (1999) emphasized the need for culturally responsive pedagogy to bridge this gap.

The role of technology in chemistry education has gained increasing attention in recent years. Blonder and Sakhnini (2012) explored the use of digital tools to enhance students' understanding of complex concepts, while Eilks and Byers (2010) highlighted the potential of multimedia resources to make chemistry more engaging and accessible. However, Kozma and Russell (2005) cautioned that technology alone is not a panacea and must be integrated thoughtfully into the curriculum.

3. METHODOLOGY

This study employs a mixed-methods research design, combining both quantitative and qualitative approaches to provide a comprehensive understanding of the challenges and perceptions of students in learning chemistry at Winneba Senior High School (SHS). The methodology is structured into several key sections: research design, population and sampling, data collection instruments, data collection procedures, and data analysis techniques. Each section is described in detail below.

Research Design

The study adopts a mixed-methods approach to capture both numerical data and in-depth insights into students' experiences. The quantitative component involves the use of structured questionnaires to gather data on students' perceptions, challenges, and academic performance in chemistry. The qualitative component includes semi-structured interviews with selected students and teachers to explore their perspectives on the factors affecting chemistry education. This dual approach ensures a holistic understanding of the issues under investigation, allowing for triangulation of data and validation of findings (Creswell & Plano Clark, 2017).

Population and Sampling

The target population for this study comprises all General Science students at Winneba SHS, with a focus on SHS Two and SHS Three students. A stratified random sampling technique is used to ensure representation across different grade levels and genders. A total of 114 students are selected for the quantitative phase, representing approximately 30% of the General Science student population. For the qualitative phase, purposive sampling is employed to select 10 students and 5 teachers based on their willingness to participate and their ability to provide rich, detailed insights into the challenges of teaching and learning chemistry (Etikan et al., 2016).

Data Collection Instruments

The primary data collection instruments include a structured questionnaire and an interview guide. The questionnaire is divided into four sections: demographic information, perceptions of chemistry, challenges in learning chemistry, and academic performance. It is designed using a Likert scale to measure students' attitudes and experiences. The interview guide, on the other hand, includes open-ended questions to explore teachers' and students' perspectives on the effectiveness of teaching methods, availability of resources, and strategies for improving chemistry education. Both instruments are pretested with a small group of students and teachers to ensure validity and reliability (Cohen et al., 2018).

Data Collection Procedures

Data collection is conducted over a period of four weeks. The questionnaires are administered to the selected students during a scheduled class period, with the assistance of their teachers to ensure a high response rate. The interviews are conducted individually in a quiet and private setting to encourage

open and honest responses. All participants are informed about the purpose of the study, and their consent is obtained before data collection begins. Ethical considerations, such as confidentiality and anonymity, are strictly adhered to throughout the process (Bryman, 2016).

Data Analysis Techniques

Quantitative data from the questionnaires are analyzed using descriptive and inferential statistics. Descriptive statistics, such as means, standard deviations, and percentages, are used to summarize the data, while inferential statistics, such as t-tests and chi-square tests, are employed to examine relationships between variables. Qualitative data from the interviews are transcribed and analyzed thematically to identify recurring patterns and themes. Thematic analysis involves coding the data, categorizing the codes into themes, and interpreting the findings in relation to the research questions. The integration of quantitative and qualitative data provides a comprehensive understanding of the challenges and perceptions of students in learning chemistry (Braun & Clarke, 2006).

4. RESULTS

Table 1 Response rate

Copies Sent	Copies Returned	Non- Returned Copies
122	114	8
100%	93%	7

Table 1 indicates the response rate for a survey or mailing campaign. A total of 122 copies were sent out, and 114 copies were returned, resulting in a high response rate of 93%. This suggests that the majority of recipients actively participated or responded to the initiative. On the other hand, 8 copies were not returned, accounting for 7% of the total sent. This low non-return rate implies that only a small fraction of recipients did not engage with the campaign. Overall, the high response rate of 93% reflects a strong level of participation or interest from the target audience.

Table 2 Demographic Characteristics of Study Participants

Details	Frequency (N)	Percentage(%)
Gender distribution		
Male	69	60.50
Female	45	39.50
Total	114	100.00
Age distribution		
12-15 years	21	18.40
16-19 years	62	54.40
20-23 years	31	27.20
Total	114	100.00
Participating category		
General Science SHS Two Students	54	47.40
General Science SHS Three Students	60	52.60
Total	114	100.00
Caregivers of respondents:		
Parents	71	62.30
Auntie/ Uncle	27	23.70
Brother/ Sister	16	14.00
Total	114	100.00
Religion of respondent:		
Christian	84	73.70
Muslim	22	19.30
Traditionalist	8	7.00
Total	114	100.00

Table 2, provide a detailed breakdown of the sample population. In terms of gender distribution, males constituted the majority at 60.50% (69 participants), while females made up 39.50% (45 participants), totaling 114 participants. The age distribution revealed that the largest group was 16-19 years old, accounting for 54.40% (62 participants), followed by 20-23 years old at 27.20% (31 participants), and 12-15 years old at 18.40% (21 participants). Regarding the participating category, General Science SHS Three Students were slightly more represented at 52.60% (60 participants) compared to General

Science SHS Two Students at 47.40% (54 participants). The caregivers of the respondents were predominantly parents, making up 62.30% (71 participants), followed by aunts/uncles at 23.70% (27 participants), and brothers/sisters at 14.00% (16 participants). Religiously, the majority of respondents identified as Christian (73.70%, 84 participants), followed by Muslims (19.30%, 22 participants), and Traditionalists (7.00%, 8 participants). Overall, the data highlights a diverse participant pool with a strong representation of males, older adolescents (16-19 years), SHS Three students, parents as primary caregivers, and Christians as the dominant religious group.

Figure 1 Existence or Otherwise of Standard Laboratory for Chemistry Practicals

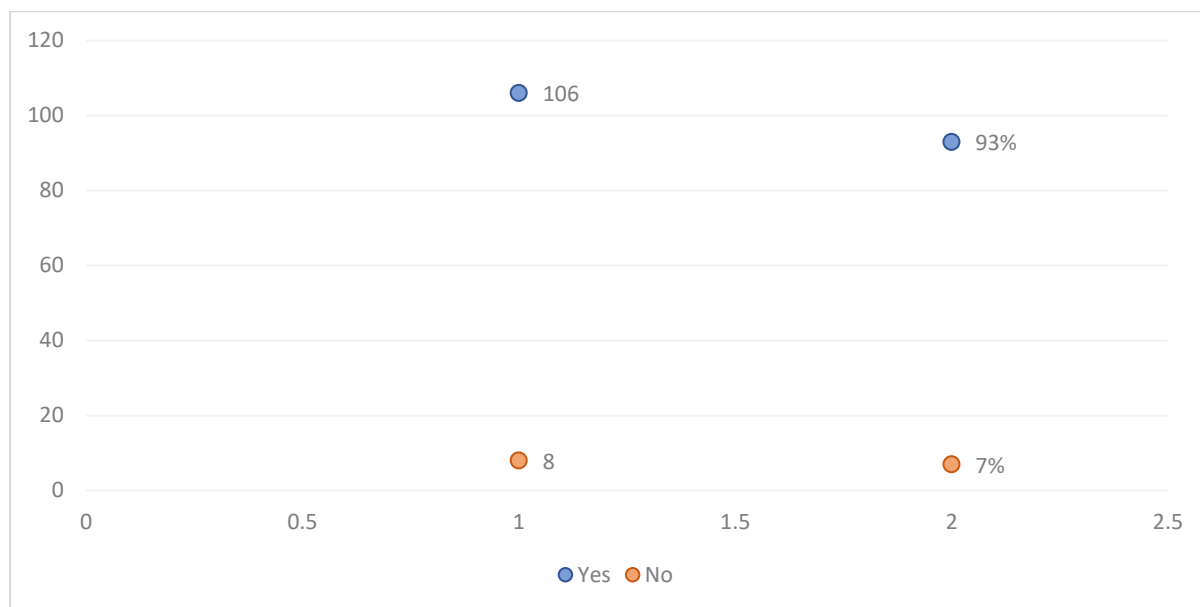


Figure 1, presents data on the availability of standard laboratories for chemistry practicals. The chart indicates that a significant majority, represented by 93%, responded "Yes," suggesting that standard laboratories for chemistry practicals are available. Conversely, only 7% responded "No," indicating a small fraction where such facilities are lacking. This data highlights that the majority of respondents have access to standard laboratories for conducting chemistry practicals, which is crucial for effective science education.

Figure 2: Assessment of Chemistry Practical Sessions

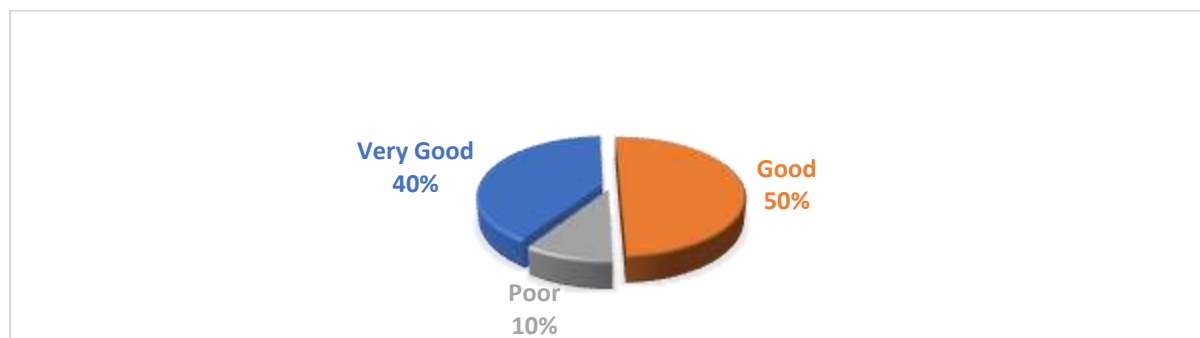


Figure 2, provides an evaluation of the quality of these sessions based on participant feedback. The data shows that 50% of respondents rated the sessions as "Good," indicating a generally positive perception. Additionally, 40% rated them as "Very Good," reflecting a high level of satisfaction among a significant portion of participants. However, 10% rated the sessions as "Poor," suggesting there is room for improvement in certain areas. Overall, the majority of respondents (90%) had a favorable view of the chemistry practical sessions, with only a small minority expressing dissatisfaction.

Table 3 Factors that contribute to students difficulties in learning chemistry at Winneba SHS

Variables	Frequency	Percent
The lack of interest in the subject	19	16.70
Inadequate teaching methods	22	19.30
Insufficient background knowledge in mathematics and science	34	29.80
The use of inappropriate chemistry textbooks	17	14.90
Limited access to laboratory equipment and materials	22	19.30
Total	114	100.00

Table 3 outlines the factors contributing to students' difficulties in learning chemistry at Winneba SHS. The most significant factor, reported by 29.80% of respondents (34 participants), is insufficient background knowledge in mathematics and science, highlighting a foundational gap that affects their understanding of chemistry. Inadequate teaching methods and limited access to laboratory equipment and materials each account for 19.30% (22 participants), indicating that both pedagogical approaches and resource availability are critical barriers. Additionally, 16.70% (19 participants) cite a lack of interest in the subject as a challenge, while 14.90% (17 participants) point to the use of inappropriate chemistry textbooks. Collectively, these factors underscore the multifaceted nature of the challenges faced by students, emphasizing the need for improved teaching strategies, better resources, and stronger foundational knowledge to enhance chemistry education at Winneba SHS.

Table 4 Mean and standard distribution of the Perceptions of Students towards Studying Chemistry at Winneba SHS

Statements	N	Mean	Std. Deviation
Chemistry topics and concepts are not easy to understand	114	3.95	.85
Organic chemistry is a difficult topic for me to learn	114	3.73	.78
It is not interesting to study chemistry due to its abstract nature	114	4.17	.59
The terminologies used in chemistry are very confusing and tedious	114	4.17	.81
Chemistry laboratory work is difficult but enjoyable	114	4.15	.91

Table 4 presents the mean and standard deviation of students' perceptions towards studying chemistry at Winneba SHS. The data reveals that students generally find chemistry topics and concepts challenging, with a mean score of 3.95 and a standard deviation of 0.85. Organic chemistry is also perceived as difficult, with a mean score of 3.73 and a standard deviation of 0.78. The abstract nature of chemistry makes it less interesting for students, as indicated by a high mean score of 4.17 and a low standard deviation of 0.59, suggesting a strong consensus on this point. Additionally, the terminologies used in chemistry are seen as confusing and tedious, with the same high mean score of 4.17 and a standard deviation of 0.81. Despite these challenges, students find chemistry laboratory work difficult yet enjoyable, with a mean score of 4.15 and a standard deviation of 0.91. Overall, the data highlights that while students face significant difficulties with the complexity and abstract nature of chemistry, they still find practical laboratory work engaging and enjoyable.

Table 5 Descriptive statistics of the impact of students' perceptions on their academic performance in chemistry at Winneba SHS

Statements	N	Mean	Std. Deviation
I score low marks in chemistry exams because I don't understand most of the concepts and topics	114	4.18	1.09
My understanding about chemistry will inform my future career choices	114	4.17	.88
I perform so well in organic chemistry topics during exams	114	2.82	1.29

I face difficulty in achieving a meaningful study session as a result of the confusing nature of technical terms and concepts	114	4.39	.95
I spend quality time studying only chemistry and this affect my performance in other subjects badly	114	3.39	.96
My academic progress is questionable due to my declining performance in chemistry subject	114	3.74	1.32
I lacks motivation to devote enough time to learn chemistry and this affect my academic achievement in the subject	114	4.25	.66
Difficulty in keeping to memory of the topics studied, thereby making the learning of the subject demotivating	114	4.03	.81

Table 5 provides descriptive statistics on the impact of students' perceptions on their academic performance in chemistry at Winneba SHS. The data indicates that students generally face significant challenges in understanding chemistry concepts, as reflected by a high mean score of 4.18 and a standard deviation of 1.09 for the statement about scoring low marks due to a lack of understanding. The confusing nature of technical terms and concepts is a major difficulty, with the highest mean score of 4.39 and a standard deviation of 0.95. Additionally, students report a lack of motivation to devote sufficient time to learning chemistry, which adversely affects their academic achievement, as shown by a mean score of 4.25 and a standard deviation of 0.66. Students also find it difficult to retain the topics studied, leading to demotivation, with a mean score of 4.03 and a standard deviation of 0.81. Despite these challenges, students recognize the importance of chemistry for their future career choices, with a mean score of 4.17 and a standard deviation of 0.88. However, their performance in organic chemistry is notably weaker, with a mean score of 2.82 and a higher standard deviation of 1.29, indicating variability in their experiences with this topic. Furthermore, students acknowledge that spending excessive time on chemistry negatively impacts their performance in other subjects, with a mean score of 3.39 and a standard deviation of 0.96. Overall, the data underscores the significant impact of students' perceptions and challenges on their academic performance in chemistry, highlighting the need for targeted interventions to improve understanding, motivation, and retention of the subject matter.

5. DISCUSSION

The findings of this study align with and expand upon existing literature on the challenges and perceptions of students in learning chemistry. The study reveals that students at Winneba Senior High School (SHS) face significant difficulties in understanding chemistry concepts, particularly due to the abstract nature of the subject and the reliance on mathematical principles. This finding is consistent with the work of Taber (2002), who argued that students often struggle with abstract concepts such as atomic structure and chemical bonding. Similarly, Johnstone (2000) highlighted the confusion caused by the technical terminologies used in chemistry, which was also a major concern for students in this study, as reflected in the high mean score (4.17) for the statement that chemistry terminologies are confusing and tedious.

The study also identified insufficient background knowledge in mathematics and science as a significant barrier to learning chemistry, a finding that resonates with Nakhleh (1992) and Nurrenbern and Pickering (1987). These scholars emphasized that students' inability to apply mathematical principles to solve chemistry problems often leads to misconceptions and poor performance. This underscores the need for integrated teaching approaches that strengthen students' foundational knowledge in both mathematics and science, as suggested by Bodner and Domin (2000). Another critical finding is the limited access to laboratory equipment and materials, which hinders students' ability to conduct practical experiments. This aligns with Hofstein and Mamlok-Naaman (2007), who emphasized the importance of well-equipped laboratories in promoting inquiry-based learning. The lack of practical experiences not only affects students' understanding of chemistry concepts but also diminishes their interest in the subject, as noted by Osborne et al. (2003). In this study, while students found laboratory work enjoyable (mean = 4.15), the lack of resources limited their opportunities to engage in hands-on learning, further exacerbating their difficulties.

The role of motivation in learning chemistry was also evident in the study. Students reported a lack of motivation to devote sufficient time to studying chemistry, which adversely affected their academic performance. This finding is consistent with Zusho et al. (2003), who found that intrinsic motivation is a key driver of academic success in chemistry. The study also revealed gender disparities in students'

attitudes toward chemistry, with female students expressing less interest in the subject. This aligns with Weinburgh (1995), who identified gender differences in science achievement and interest, emphasizing the need for gender-sensitive teaching strategies.

The study's findings on the impact of teaching methods further highlight the need for innovative pedagogical approaches. Traditional lecture-based methods were found to be ineffective in engaging students, a finding that echoes Bunce and Robinson (1997). Instead, context-based teaching approaches that connect chemistry concepts to real-world applications, as advocated by Gilbert and Treagust (2009), could enhance students' understanding and interest in the subject. Additionally, the use of multiple representations (macroscopic, submicroscopic, and symbolic) could help students visualize and comprehend complex concepts, as suggested by Gabel (1999). Cultural and contextual factors also play a significant role in shaping students' perceptions of chemistry. The study found that students' cultural backgrounds influenced their attitudes toward science, with many viewing it as a foreign and inaccessible discipline. This finding is consistent with Jegede and Okebukola (1991) and Ogunniyi (2007), who emphasized the need for culturally responsive pedagogy to bridge the gap between traditional knowledge systems and Western science education. Incorporating local examples and culturally relevant content into the chemistry curriculum could make the subject more relatable and engaging for students.

Finally, the study highlights the potential of technology in enhancing chemistry education. While digital tools and multimedia resources can make chemistry more accessible and engaging, as noted by Blonder and Sakhnini (2012) and Eilks and Byers (2010), their integration must be thoughtful and purposeful. Kozma and Russell (2005) cautioned that technology alone is not a panacea and must be used in conjunction with effective teaching strategies to achieve meaningful learning outcomes. The findings of this study underscore the multifaceted nature of the challenges faced by students in learning chemistry. Addressing these challenges requires a holistic approach that includes improving teaching methods, providing adequate resources, fostering motivation, and incorporating culturally responsive pedagogy. By building on existing literature and contextualizing the findings within the Ghanaian educational context, this study contributes to the broader discourse on improving science education and offers practical recommendations for enhancing chemistry learning outcomes at Winneba SHS and beyond.

6. CONCLUSION

This study has shed light on the significant challenges and perceptions of students in learning chemistry at Winneba Senior High School. The findings reveal that students struggle with the abstract nature of chemistry, insufficient foundational knowledge in mathematics and science, and limited access to laboratory resources. These challenges are compounded by inadequate teaching methods and a lack of motivation among students. The study underscores the need for targeted interventions to address these issues and improve chemistry education. By contextualizing these findings within the broader literature, this research contributes to the ongoing discourse on enhancing science education in Ghana and similar contexts. Ultimately, addressing these challenges will require a collaborative effort from educators, policymakers, and stakeholders to create an enabling environment for effective chemistry learning.

7. RECOMMENDATIONS

To address the challenges identified in this study, the following recommendations are proposed: First, schools should invest in well-equipped laboratories to facilitate hands-on practical experiences, as these are critical for understanding chemistry concepts. Second, teachers should adopt innovative and context-based teaching methods that connect chemistry to real-world applications, making the subject more relatable and engaging. Third, professional development programs should be organized to enhance teachers' pedagogical content knowledge and their ability to use multiple representations in teaching. Fourth, foundational knowledge in mathematics and science should be strengthened through integrated teaching approaches. Fifth, culturally responsive pedagogy should be incorporated to bridge the gap between traditional knowledge systems and Western science education. Sixth, schools should leverage technology, such as digital tools and multimedia resources, to make chemistry more accessible and interactive. Finally, strategies to foster intrinsic motivation among students, such as mentorship programs and career guidance, should be implemented to enhance their interest and performance in chemistry.

8. CONTRIBUTION TO KNOWLEDGE

This study contributes to the existing body of knowledge by providing a contextualized analysis of the challenges and perceptions of students in learning chemistry at Winneba Senior High School. It highlights the interplay between inadequate resources, poor foundational knowledge, and ineffective teaching methods, which collectively hinder students' academic performance. The study also emphasizes the role of cultural and contextual factors in shaping students' attitudes toward chemistry, a perspective that is often overlooked in the literature. By integrating quantitative and qualitative data, this research offers a comprehensive understanding of the issues at hand and provides practical recommendations for improving chemistry education. Furthermore, the study adds to the discourse on science education in developing countries, offering insights that can inform policy and practice in similar contexts. Overall, this research advances the understanding of how to create an enabling environment for effective chemistry learning, particularly in resource-constrained settings.

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