University Students' Experiences of Secondary School Science Education: Analysis of Attitudes and Background Variables

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Abstract: University students' experiences and attitudes about a program of study and their career choices are to a greater extent influenced by their secondary school experiences. These experiences also apply to science subjects including chemistry. This research, therefore, sought to explore university students' experiences of secondary school chemistry education by examining their background variables as related to the pursuing of general science program. In this study participants reported different experiences and perceptions of science education in general and chemistry lessons in particular during their secondary school years. Using a mixed-method research approach 260 university students from the Greater Accra region of both urban and rural areas were surveyed and interviewed. Descriptive statistics and other statistical procedures were used to analyse the data. The results showed that students past experiences of science programs and particularly chemistry lessons had significant impact on their decision to study chemistry. It was also found that students' background variables such as gender, previous secondary school attended (rural/urban) and teachers' instructional practices had influence on attitudes to pursue a chemistry course. The results provide further evidence of the benefits of the use of well-equipped science laboratories and technology as supporting course resources for science education.

Keywords: Ghana, university students, science education, chemistry

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Introduction

According to the World Development Report (World Bank, 2024), the integration of science and technology into national development strategies is crucial for promoting sustainable growth, improving quality of life, and addressing pressing challenges facing societies around the world. Scientific education, therefore, is to enable students to acquire knowledge and the necessary skills that would expand the level of creativity toward the application of science and technology. Studies have shown that background science knowledge plays a crucial role in pursuing a science study program and that students' past educational experiences affect their choice of study program and future career. Various studies have shown that students' past school experiences have significant impact on students' attitudes toward subjects or study programs (Haught et al., 2015). Haught et al. (2015) suggest that individuals' memories of their school experiences significantly influence their beliefs about a course of study and the broader educational process. This notion aligns with the hierarchical nature of science, where new concepts are constructed upon a pre-existing foundation of knowledge. For students, a robust understanding of foundational concepts is crucial; without it, they are likely to face difficulties in comprehending advanced topics. This hierarchical framework underscores the importance of early learning experiences in shaping future academic success.

Moreover, Miller and Shifflet (2016) emphasize that memories do more than form the basis for understanding; they also provide insights into an individual's current perceptions and beliefs. These reflections of past educational encounters help to anchor personal interpretations of educational content and influence ongoing cognitive engagement with learning.

Science, and for that matter, chemistry is often considered a challenging subject due to its abstract theories, complex calculations, and extensive memorization of chemical reactions and formulas. Some students may find it daunting and struggle to grasp certain concepts, leading to frustration or disinterest (Guido, 2013). Some studies explained that the principal aim of science education was to enable young people to make wise and sound decisions in their daily life and subsequent contribution to the technological and economic growth of the country. However, this hinges on good instructor experiences fostering positive attitudes to science subjects. Students are therefore, ushered into different levels of education. Typically, at the Senior High School

(SHS) level in Ghana, various topics are treated in detail to prepare the student enough for the tertiary educational level. Physics, Chemistry, Biology, Astronomy, and Geology are all included in the secondary school science curriculum, which has been constructed using an integrated scientific approach. However, some research has indicated that each science subject, including chemistry, needs to be taught as a stand-alone subject to provide students with the essential information and the right attitude toward the subject for academic achievement (Kurniawan et al., 2019).

The formation of positive attitudes for academic achievement depends on several other factors including teaching methods and instructional practices in the class. Many researchers have identified several factors that could have an impact on the quality of science teaching and learning, including the teacher's content knowledge and pedagogical skills. Factors such as instructional activities (Bakaç et al., 2011; Tomara et al., 2017), engaging laboratory works (Snětinová and Kácovský, 2019; Holmes and Lewandowski, 2020), teacher attitudes (Thibaut et al., 2018; Mami, 2021), and the use of scientific developmental strategies (Civelek et al., 2014; Maulidah and Prima, 2018; Abdusselam and Karal, 2020; Aragaw et al., 2022), contribute to the formation of positive attitudes for academic achievement (Holmes and Lewandowski, 2020).

The formation of positive attitudes by using engaging laboratory activities act to help students to confirm theoretical ideas. The fact that chemistry laboratory activities appeal as a way of allowing students to study with understanding and, at the same time, engage in a process of generating knowledge by doing science is proven (Holmes and Lewandowski, 2020). It has been observed that particularly chemistry, a course offered in most Ghanaian tertiary educational institutions, becomes very challenging to many students due to inadequate teacher preparation and inadequate as well as inappropriate instructional materials.

It is evident that chemistry teachers in most tertiary institutions do their possible best to improve the knowledge and interest of young chemists in the field of chemistry. But it has been noted that, a period after a student has taken a few chemistry courses, most students begin to lose hope and continue with the mindset that the course in general is difficult. Local researchers have echoed low enrolment rates of chemistry students in the universities without explaining why (Baidoo-An, 2022) and the alarming rate of lack of interest in science subjects is a big concern (Osei et al., 2023) as there is no literature on students' views about the study of this subject, making research into students'

perspectives on this specific subject important. In addition to addressing a potential gap in research by exploring the link between secondary school experiences and higher education outcomes, and serving as a foundation for further studies, this study provides insights into how secondary school science education shapes students' attitudes toward science. Identifying these factors contributes to global research on educational practices, aiding policymakers and educators in improving science curricula and fostering positive attitudes, which are critical for producing skilled professionals in science-related fields.

Literature Review

Generally, it has become a norm to hear students in senior high schools across nations refer to chemistry as being difficult, abstract, and unnecessary to humans, but teachers have recognized the benefits of chemistry in our societies despite its complexity. Especially in Brazilian classrooms, it has been observed that the lack of student interest in chemistry always results in discouraging teachers from searching for innovative and creative teaching and evaluation methodologies. According to Ana Luiza de Quardros et al., (2011), in a study done in certain Brazilian high schools, some teachers reported that one of the main variables affecting students' performance and ultimately, their hatred of learning is the incorrect way in which the concepts are delivered. These educators emphasized that the concepts taught to students should allow them to genuinely study chemistry rather than just memorizing definitions, formulas, and meaningless terminology. Instead, the notion should become a way of thinking for the students (Ana Luiza de Quadros et al., 2011).

Also, Baidoo-Anu (2022) reported that, between-school streaming has been a practice in various countries such as Portugal, Belgium, Luxembourg and in Ghanaian educational complex. The practice aims to achieve the shared objective of categorizing students based on their perceived academic capabilities and primarily, to establish a learning environment that is more uniform, enabling teachers to offer instruction that is better suited to the needs of their students, while allowing students to benefit from interacting with peers who are academically comparable to them. However, with all the positives of the practice of between-school streaming, there are some disadvantages associated. A common disadvantage is the socio-emotional effect on students. About 80% of students in the study reported that they experience low self-esteem and low academic

self-efficacy. Upon discovering that they have been assigned to category C schools, students tend to underestimate their academic skills and abilities. Only a few were confident about their academic capabilities even though they experience low self-esteem (Baidoo-Anu, 2022).

Osei et al. (2023) conducted a study in a well-resourced school located in the central region of Ghana to investigate the reasons why chemistry topics were perceived as challenging by students. The study involved 96 participants, specifically third-year science students, whose identities were kept confidential. The choice of third-year students was based on their greater exposure to many topics in the syllabus compared to junior students. The research methodology included the use of questionnaires and an interview guide with the students. The difficulty level of the topics was categorized based on their mean score, with a range of 1.80 to 3.00 indicating difficult topics and a range of 1.00 to 1.79 indicating relatively easier topics. The findings revealed that 67% of the topics, particularly those involving mathematical aspects, were considered difficult by the students. Examples of challenging topics included acid-base and salt concept, rates of reaction, energy changes, and bond enthalpies. On the other hand, topics such as the structure of the atom, nuclear chemistry, and solubility were perceived as relatively easier. According to the results obtained, students attribute the poor performance and difficulty of most chemistry topics to several factors. These factors included ineffective teaching techniques, lack of practical activities, and the absence of additional tutoring opportunities (Osei-antwi, 2023).

Ali (2012) highlights that students often struggle to generate original ideas or explanations that could enhance their understanding of a subject. Instead, they tend to rely on rote memorization, reproducing information verbatim rather than articulating the concepts, meanings, or ideas in their own words. This limitation is particularly evident when lessons require engagement with more advanced or complex content. Students frequently fail to establish conceptual connections, provide reasoned explanations to support their viewpoints, or pose meaningful questions. For example, in a lesson on balancing chemical equations, students demonstrated the ability to produce correctly balanced equations for practice problems. However, this success was attributed to their memorization of answers rather than a genuine understanding of the underlying principles. “When asked to explain the rationale behind assigning specific coefficients to

certain atoms and compounds, students were unable to provide a coherent justification, indicating a lack of conceptual comprehension" (Ali, 2012, p. 6).

Theoretical Framework

This study is grounded in Constructivist Learning Theory, linked to Self-Determination Theory (SDT) which posits that learners actively construct knowledge through interactions with their environment and personal experiences. Constructivist Learning Theory, articulated by scholars such as Piaget (1950) and Vygotsky (1978), emphasizes that learning is an active, contextualized process wherein individuals integrate new information with their existing cognitive frameworks. In this study, students' experiences in secondary school science education are understood not as passive absorptions of knowledge but as dynamic processes shaped by their engagement with curricula, teaching methods, and the broader learning environment. These experiences significantly influence their overall perceptions, educational outcomes, and readiness for higher education.

Within this framework, learners play a central role in shaping their educational journeys through active participation in classroom interactions, scientific experiments, and problem-solving activities. Such engagements enable them to construct a deeper understanding of scientific concepts and their application in real-world scenarios. Vygotsky's perspective on the social nature of learning highlights the importance of collaboration and interaction, as students' experiences are enriched through meaningful exchanges with peers and teachers. Group experiments, discussions, and cooperative projects in secondary school science education foster not only comprehension but also motivation and a sense of community in learning.

Furthermore, the socio-cultural and institutional contexts of Ghanaian secondary schools serve as critical influences on students' experiences. The availability of resources, the quality of teaching, and the alignment of curricula with local and global scientific needs are pivotal factors that frame their learning. These contextual elements interact with students' active engagement, shaping their ability to internalize knowledge and develop a constructive perspective toward science education. By employing Constructivist Learning Theory, this study provides a holistic lens to examine how students actively construct their understanding of science within Ghana's educational

landscape, thus offering insights into the interplay between education, context, and aspirations.

Purpose of the Study

Educational research in Ghana has focused more on general educational challenges, curriculum development, teaching methodologies, or Science, Technology, Engineering, and Mathematics (STEM) issues and less on chemistry as a single subject. This research sought to evaluate university students' experiences of secondary school chemistry education. It is also to examine students' background variables as related to the pursuing of a general science program.

Research Questions

The questions explored by this study were:

1. *What are students' views/attitudes toward chemistry?*
2. *What is the relationship between students' background variables (urban-rural, gender and method of teaching) and attitude towards learning chemistry?*
3. *What are the challenges facing students learning chemistry?*

Method

1. *Research Design and Study Location*

The study adopted a mixed-method approach, combining quantitative analysis to identify trends and patterns with qualitative insights to provide depth and context. This design enhances the robustness and comprehensiveness of the findings.

The study was conducted at universities in the Greater Accra region of Ghana. Greater Accra has 34 recognized universities and higher education institutions. These include a mix of public, private, and specialized institutions, offering a range of undergraduate, postgraduate, and professional programs (see Figures 1a and 1b). Universities are located within various communities (see Table 1b). Out of 34 universities and high institutions in the region two universities (one private and one

public) were selected using stratified random sampling to ensure representativeness and diversity. While only two universities were sampled, the study's robustness is upheld by over 250 student participants, ensuring diverse perspectives and meaningful statistical power. The large participant pool enhances representativeness, mitigating limitations of institutional variety and strengthening the study's generalizability.

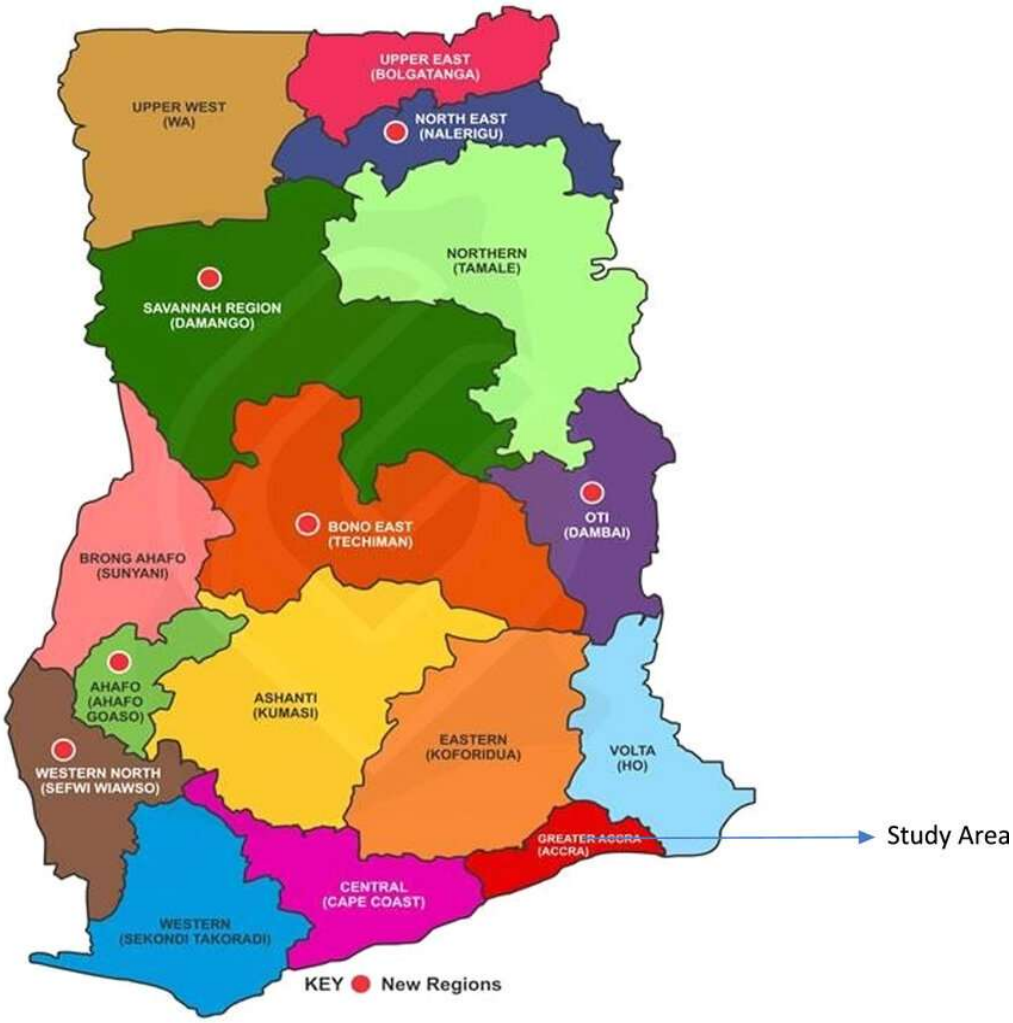

Figure 1a. Ghana map showing the study area, Accra (Opoku-Ntim et al., 2019)

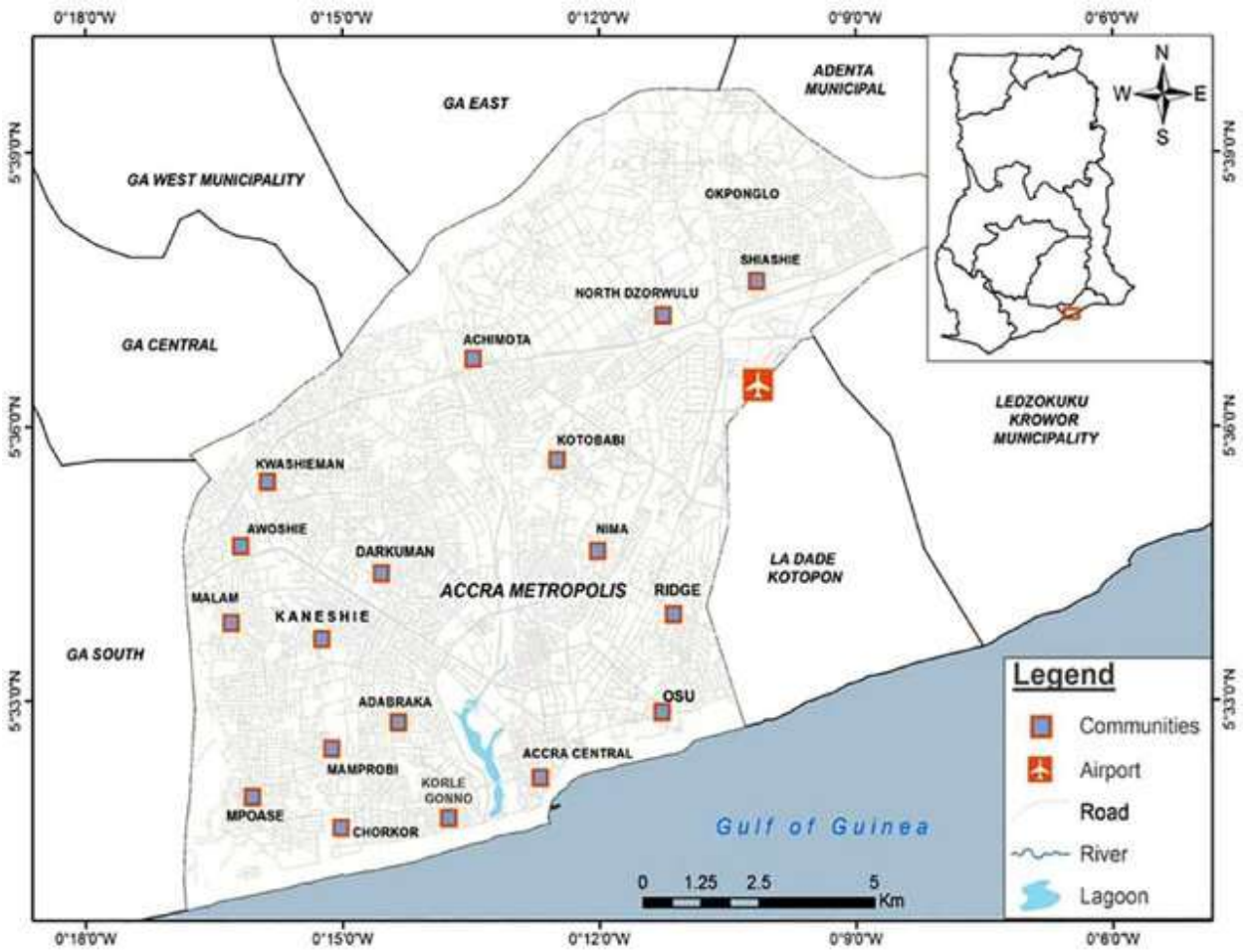

Figure 1b: Map of Greater Accra university locations; Source: Accra Metropolitan Assembly (2023)

2. Population and Sample

A total of 260 students participated in the study. The study targeted science students (chemistry, biology, physics, and mathematics) enrolled in undergraduate programs. Participants were drawn from both urban (62%) and rural (38%) secondary school backgrounds, ensuring variability in their educational experiences. A stratified sampling method was employed to balance demographic factors such as gender (46.7% female and 53.3% male), year of study (first-year: 38%, second-year: 18.35%, third-year: 19.15%, fourth-year: 24.5%).

Participants were recruited voluntarily, with ethical considerations addressed through informed consent. They were assured of their right to withdraw at any point without repercussions.

3. Data Collection Instrument

A structured survey was developed to gather data on students' attitudes, perceptions, and challenges in secondary-level science education through a systematic process. The foundation of this process involved a comprehensive review of the existing literature, which identified common themes and validated survey items through studies such as those by Williams et al. (2003), Hudson et al. (2010), and Miller and Shifflet (2016). This step ensured the incorporation of established insights into the survey design, fostering both relevance and robustness.

To further enrich the survey and tailor it to the target demographic, qualitative input was sought. An open-ended question was distributed to university students, encouraging them to reflect on their secondary school experiences with science subjects. This feedback offered nuanced perspectives and highlighted specific areas of concern and interest that were then integrated into the survey framework.

Using the insights from the literature and qualitative responses, an initial set of 19 survey items was drafted. These items underwent rigorous review by experts from the university's science department to assess their relevance and clarity, ensuring alignment with the study's objectives and enhancing the validity of the instrument.

The survey then proceeded through a pilot testing phase, during which it was further refined based on feedback from the trial respondents. The finalized version consisted of 14 carefully curated items. Its reliability was evaluated using Cronbach's alpha, yielding a value of 0.85, which indicates a high degree of internal consistency as per Shrestha (2021). This process underscores the survey's robustness and its capacity to provide reliable insights into secondary-level science education.

4. Ethical Considerations

The study adhered to institutional ethical guidelines. Participants' anonymity was maintained, and pseudonyms were used in qualitative data analysis to protect identities. Written informed consent was obtained, and participants were informed of their rights.

5. Data Analysis Procedures

The research addressed three main questions using appropriate statistical and qualitative techniques. For Research Question 1, descriptive statistics were used to analyze students' ratings of the importance of specific competencies in chemistry,

biology, physics, and mathematics. For Research Question 2 and the hypothesis, a series of independent-sample t-tests and One-Way ANOVA were conducted to evaluate differences in experiences based on gender, secondary school location (urban/rural), and year of study. For Research Question 3, frequency analysis was conducted to identify common challenges reported in chemistry and to compare these with challenges in other science subjects.

Results

The results of the study are reported in line with the key research questions, and indicators on students' views analysed as shown in Table 1a. In the evaluation of the choice of students studying general science program (Tables1a and 1b), the descriptive statistics showed that students were mostly influenced by their parents rating the score of students (M=5.1, SD=1.1), followed by students' self-engagement (M=5.01, SD= 1.05) and teacher quality (M=4.63, SD=1.2). These scores were within the Strongly Agree and Agree Classification, while the rest of the 14 items ranging between 3.0 and 2.51 were those influenced by other reasons such as job opportunities, institutional reputation (M=2.71, SD=1.25), financial considerations (M=2.51, SD=1.24 and desire for intellectual challenge rated the lowest (M=2.51, SD=1.29).

Table 1a: Students views and influence in studying general science program

	N	Mean	Std. Deviation
1. Parental influence	260	5.06	1.05
2. Self-engagement and prior experiences	260	5.01	1.05
3. Teacher quality	260	4.63	1.19
4. Curriculum	260	4.39	1.37
5. Personal skills and strength			
6. Availability of laboratory facilities	260	3.22	1.38
7. Interest and passion	260	3.22	1.31
8. Carrier aspirations	260	3.04	1.31
9. Peer influence	260	3.03	1.08
10. Educational background	260	2.91	1.11
11. Perceived job opportunities	260	2.72	1.33
12. Institutional reputation	260	2.71	1.25
13. Financial considerations	260	2.51	1.24
14. Desire for intellectual challenge	260	2.51	1.29
Valid N (listwise)			

From *Table 1a* it can be seen that students' views about learning chemistry can vary widely depending on factors such as their prior experiences with the subject, their teacher's quality, the curriculum, and their personal interests and goals. A further analysis was undertaken to find students who have a positive attitude towards studying science subjects, particularly chemistry (see Table 1b).

Table 1b: Students general interest to study

No.	Item	Responses		Frequency	%	Chi-Square
7	Interest and Passion	Yes	195	195	75.0	0.004
		No	65	65		

The results revealed that a significant majority (75%) of respondents affirmed "Interest and Passion", and the responses showed a statistically insignificant deviation from the expected distribution, indicating a strong alignment among participants of their positive thoughts regarding the item. The culture course seems to have succeeded in accomplishing a task with some humanizing effect.

1. *Attitudes towards Chemistry*

Table 2: Attitudes Toward Chemistry

Item	N	Mean	Std. Deviation
Practical Application	260	4.89	1.369
Engaging Teaching Methods	260	4.48	1.539
Relevance to Future Careers:	260	4.38	1.832
Real-Life Examples	260	4.25	1.504
Supportive Learning Environment	260	4.05	1.668
Innovative Resources	260	3.98	1.421
Recognition and Rewards	260	3.97	1.717
Career Opportunities	260	3.93	1.585
Integration with Other Subjects	260	3.87	1.714
Societal Importance	260	3.86	1.692
Perceived Difficulty	260	3.85	1.634
Lack of Resources	260	3.72	1.689
Teaching Methods	260	3.67	1.504
Limited Practical Exposure	260	3.59	1.547
Perception of Career Opportunities	260	3.58	1.446
Cultural Factors	260	3.52	1.374
Valid N (listwise)	260		

Corrected Item-total correlations = 0.00

The attitude scores in Table 2 above shows more positive attitudes among students for learning chemistry. The highest score is 4.89 for the item Practical Application on a 6-point scale, which equates to the Somewhat Agree range. Six other items relating to students' negative attitudes to chemistry lessons are related to perceived difficulty, lack of resources, unfavourable teaching methods, limited practical exposure, lack of job opportunities and cultural factors. These items have mean scores below 3.90 which are firmly in the negative attitude category, implying that the participants did not like chemistry in high school**.**

2. Influence of Background Variables on Student Attitudes and Choices

The analysis showed that attitude scores were significantly related to students' experience of chemistry lessons in secondary school at p= .05 confidence level (see Table 3 and 4 below). Participants with good experiences of chemistry lessons (M=71.7) had significantly higher levels of motivation compared to those without such experiences (M=61.3). Participants with positive experiences of the way chemistry was taught (teaching methods) in secondary schools were also found to have positive attitudes towards chemistry as a subject (M=71.7) when compared to those who did not have such experience (M=61.3). It was found that there were significant differences between students coming from well-equipped science secondary schools from the urban areas and students who attended secondary schools in the rural areas. Post-hoc analysis using ANOVA showed that the mean score of students from the rural secondary schools was significantly lower (M=68.8) when compared to those from urban areas (M=73.3) (see Table 5).

Table 3: Secondary school experience and attitudes

Secondary Education	N	Mean	Std. Deviation	Sig. (p)
No	100	61.3	6.69	.000
Yes	160	71.7	9.57	

*. The mean difference is significant at the 0.05 level.

Table 4: t-test: Students' experience of teaching methods and attitudes

Experience of teaching method	N	Mean	Std. Deviation	Sig (p)
No	119	63.8	7.99	.000
Yes	141	70.3	9.87	

*. The mean difference is significant at the 0.05 level.

Table 5: Students' previous schools and attitudes

Previous Secondary	N	Mean	Std. Deviation	ANOVA (P)
Rural	100	68.8	8.56	.05
Urban	160	77.3	15.20	
Total	260			

* The mean difference is significant at the 0.05 level.

3. Urban/Rural Schools and Attitude Scores

The ANOVA analysis indicates that the secondary school attended has significant effect on students' attitudes (p=.033) at the .05 confidence level. The multiple comparison table (Tukey HSD) shows that main differences occurred between those who attended urban secondary and those who attended rural secondary schools (Mean Difference =-9.4495, p=.026) (Table 6 and 7).

Table 6: ANOVA of urban/rural secondary schools and attitudes

ANOVA

Attitude Scores

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1935.570	4	477.893	2.635	.033
Within Groups	21579.663	128	173.404		
Total	23495.234	132			

Table 7: Tukey HSD Multiple Comparison: Urban/rural schools and attitudes

Multiple Comparisons

Dependent Variable: Attitude Scores

	(I) Rural secondary	(J) Urban secondary	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
						Lower Bound	Upper Bound
Tukey HSD			-9.44995*	3.10355	.026	-17.9276	-.7523

*. The mean difference is significant at the 0.05 level.

4. Gender and Attitudes Towards Chemistry

The step taken here was to contrast the mean scores of males on each of the 16 items of the chemistry attitude scale with females' mean scores to assess whether there was a significant effect due to gender. A significant difference was found in students' attitudes because of gender, implying that gender had effect on their attitudes toward

studying science program (chemistry). The research data analysis of the attitudes of male and female students showed significant differences. Females are less willing to study chemistry (see Table 8). One key reason for the disparity in Ghana, where more male students pursue science and chemistry than females, is perhaps gender stereotypes and societal expectations. In many communities, traditional beliefs and cultural norms still discourage girls from engaging in Science, Technology, Engineering, and Mathematics (STEM) fields. These stereotypes suggest that science is "too difficult" or "better suited for boys", which can negatively influence girls' confidence, interest, and encouragement from parents or teachers to pursue these subjects.

Table 8: Means and t-test: Gender affects attitude

Item	Means for groups	t.	p.
Students' attitude	Student gender	3.05	(.062)*
	Male student = 3.02		
	Female student = 2.57		
	N = 260		

*P<.05

5. Challenges facing chemistry students

We also calculated the overall scores for all participants on three of the major challenges. Overall, quantitative data analysis showed that the participants rated infrastructure and laboratory facilities as having a huge effect on their chemistry learning (55.77%). 25% of the participants named teacher shortages and qualifications as a challenge, followed by limited resources at 19.23% (See Table 9).

Table 9: Overall challenges in learning chemistry

Response	Frequency	Percent
Limited Resources	50	19.23
Teacher Shortages and Qualifications	65	25.0
Infrastructure and Laboratory Facilities	145	55.77
Total	260	100

Chemistry students in Ghanaian secondary schools face various challenges, some of which are, as participants noted, perceived difficulty and language barrier especially complex concepts. Even when teachers are available, they may lack sufficient training or qualifications to effectively teach complex topics in chemistry.

Discussion

This study explored university students' experiences of chemistry lessons in high school. Generally, students had a positive attitude towards the choices they have made, but with some variations. It was found that the majority of the students were influenced by their parents and to a larger degree by the students themselves in their decision regarding their study program. Students' self-determination is linked to the Self-Determination Theory (SDT) also supported by Piaget (1950) and Vygotsky (1978) emphasizing the importance of intrinsic motivation, autonomy, and competence. The influence of parents on the other hand may stem from a combination of cultural, economic, and social factors that prioritize family cohesion, financial stability, and traditional values.

This is not surprising due to perhaps strong emphasis on family cohesion and respect for elders. In the Ghanaian context parents are often seen as wise and experienced individuals whose guidance is highly valued. Children are expected to heed their parents' advice and follow traditions. In many African families, parents financially support their children through education. As a result, parents often feel entitled to have a say in their children's educational and career decisions, viewing it as an investment in their future. The study involved students from both urban and rural areas of Greater Accra and access to information about different career paths and educational opportunities may be limited. Parents, who may have limited exposure to diverse career options themselves, tend to influence their children based on their own experiences and perceptions of success.

Generally, participants liked chemistry, but few students liked the subject in high school, supporting previous research showing that chemistry is not a popular subject and job and career prospects is lower than other programs such as medicine, engineering or biochemistry (Barmy and Defty, 2006; Williams et al., 2003). Again, students view chemistry as a difficult subject, with limited practical exposure. Chemistry is a practical

subject that requires hands-on experimentation to fully understand concepts. However, many schools in Ghana, especially in the rural areas, may lack well-equipped laboratories or may not prioritize practical learning experiences due to misallocation of resources between urban and rural secondary institutions to the disadvantage of the latter. Without adequate practical exposure, students may struggle to connect theoretical concepts with real-world applications, leading to disengagement with the subject (Williams et al., 2003; Erinosho, 2013; Patil et al., 2019). However, those who liked chemistry found it to be less difficult (Oon and Subramaniam, 2013). As noted in this study, the majority of the participants were from the cities (urban areas) with perhaps well-equipped science departments in secondary schools, the fact that students had relatively positive attitudes could explain this result.

It was found in the study that teaching methods and instructional practices in the classroom had a significant effect on students' attitudes toward learning chemistry. This finding is consistent with other studies which say that effective teaching methods not only facilitate the transmission of knowledge but also inspire and sustain students' motivation to learn by engaging them actively, making learning meaningful, fostering autonomy, providing constructive feedback, creating a supportive environment, offering variety and flexibility, setting clear goals, and nurturing intrinsic motivation (Ramaila and Reddy, 2018).

Variables such as gender, urban/rural secondary school setting and teaching methods had significant effect on their attitudes toward chemistry. With respect to gender, it was found that fewer female students were studying chemistry and other science subjects. This finding is consistent with the studies of (Barmby and Defty, 2006; Saleh and Subramaniam, 2019) stating that female students generally do not like chemistry and other science programs. However, other studies (Achor and Gbadamosi, 2020; de Barros Vidor et al., 2020) found no statistically significant difference in students' attitudes and thoughts according to gender. Nonetheless, gender can indeed influence students' choices of science subjects in Ghana, as it does in many other countries. In this study, like in numerous other societies similar to the study area, there are cultural and societal norms that may influence how individuals perceive certain subjects as being more suitable or appropriate for one gender over another. For example, there may be stereotypes or perceptions that certain science subjects, such as chemistry or engineering, are more suited for males, while subjects like biology or nursing are more

suited for females. These stereotypes can impact students' perceptions of their own abilities and interests. Additionally, access to educational resources and opportunities may also differ based on gender, further influencing students' choices. For instance, if certain schools or communities prioritize resources and encouragement for male students in science subjects, it can perpetuate gender disparities in STEM (science, technology, engineering, and mathematics) fields.

The overall analysis of this study found that memories of students' experiences in their schools or academic environments can significantly impact their decisions regarding future careers and their relationships with relevant courses as found in this study. Positive experiences can inspire students to pursue further education and careers in a particular field, while negative experiences may deter them. If students have positive memories associated with a particular subject or course, such as engaging and supportive teachers, exciting projects, or success in learning and understanding the material, they are more likely to develop an interest and passion for that subject (Hazari et al., 2017). These positive memories can motivate students to pursue further education and careers related to that subject. Conversely, negative memories, such as struggling with difficult material (prevalent in rural secondary schools), feeling unsupported or discouraged by teachers, or experiencing bullying or discrimination in the academic environment, can lead students to develop a dislike or aversion to certain subjects. These negative memories may influence students to avoid pursuing further education or careers in those areas. In schools with well-equipped science laboratories, studies have found effective teaching processes and the use of techniques that encourage student engagement in the course and positively impact student thinking (Samsudin et al., 2020; Nuñez et al., 2021). In a similar study it was found that the use of technology has a particularly successful impact on students' attitudes and perceptions of science programs including chemistry courses (Hochberg et al., 2018; Maulidah and Prima, 2018; Bakri et al., 2020).

Conclusion and Implication

The majority (75%) of the participants were generally positive to chemistry programs and liked the course, but not all of them. Chemistry, physics, and biology are all distinct scientific disciplines, each with its own set of challenges for students. However, there are some specific challenges that chemistry students may face compared to those

studying physics and biology. One of the negative attitudes to chemistry as found in this study is perceived difficulty. Chemistry often deals with abstract concepts such as atomic structure, chemical bonding, and quantum mechanics. Understanding these concepts may be challenging for some students as they require a strong foundation in mathematics and a willingness to think abstractly. While all sciences use mathematics to some extent, chemistry often requires more mathematical rigor than biology.

Results on students' background variables had significant impact on their attitudes towards chemistry courses. Variables leading to negative attitudes have had negative impact on the study of chemistry at the tertiary level resulting in fewer students at the university due to either weaker educational foundation in chemistry in secondary schools or perceived difficulty of the subject. Students may struggle with mathematical concepts such as stoichiometry, chemical kinetics, and thermodynamics. Chemistry often involves hands-on laboratory work, which requires proficiency in techniques such as titration, spectroscopy, and chromatography. Developing these skills can be challenging and time-consuming for students. While these challenges may seem daunting, they can also be opportunities for growth and learning. With dedication, perseverance, and support from teachers and peers, chemistry students can overcome these challenges and develop a deeper understanding and appreciation of the subject.

For a comprehensive chemistry education, there is the need for textbooks, laboratory equipment and chemicals. Most secondary schools in Ghana may face problems providing resources. Both theory and practical in chemistry need resources and limitation for resources may affect practical aspect of learning chemistry.

For Ghana to keep pace in science and technology development, training of science teachers in general and chemistry in particular, as well as provision of well-equipped laboratories in secondary schools has to become a priority. The quality of teaching in secondary chemistry education may have significant impact on students' experiences when resources are equally allocated in both rural and urban areas. Teachers who are well trained and experienced and are passionate about the subject can make a positive difference in students' learning outcomes. However, the availability of qualified teachers may be a challenge in many schools, creating variabilities in chemistry students' experiences.

It is important to note that experiences of university students may vary because of individual schools and personal circumstances. It is also worth mentioning that these

factors are not unique to Ghana and can be applied to students' experiences in chemistry education in other countries from the developing countries as well. Efforts by government, educational institutions, and educators to improve the quality of secondary chemistry education could help enhance students' experiences and prepare them for further studies in chemistry-related fields at the university level. A key limitation of this study is focusing the attention of participants on chemistry education. It is therefore recommended that future research should be conducted across other disciplines as well as the coverage of a broader area.

The Contribution of the Authors

AMA and CYF collected the data, coded the data, and discussed the results. Both authors interpreted the results and contributed to the practical implications of the article.

Ethical statement

This research adhered to the highest standards of ethical conduct, as established by institutional and international guidelines. The study protocol was submitted to the Institutional Review Board (IRB) of the chemistry department, where it underwent a rigorous review process to ensure compliance with ethical principles and regulatory requirements, which was approved prior to the conduct of the study. Consent was obtained from the participants who signed an informed consent form after they were told that their participation was voluntary, anonymous, and their responses would be kept confidential. Participants were also informed that they could withdraw from participation at any time they wanted without any consequences. The ethical guidelines were adhered to through honesty in communication, trustworthiness in writing, confidentiality, and the sharing of reflections, ideas, and findings with respondents.

References

Abdusselam, M. S., & Karal, H. (2020). The effect of using augmented reality and sensing technology to teach magnetism in high school physics. *Technology, Pedagogy and Education, 29*(4), 407–424. https://doi.org/10.1080/1475939X.2020.1766550

Accra Metropolitan Assembly. (2023). *The Assembly*. Retrieved December 3, 2024, from https://www.ama.gov.gh/the-assembly

Achor, E. E., & Gbadamosi, O. B. (2020). Raising the achievement and retention levels of secondary school students in physics through brain-based learning strategy in Taraba State, Nigeria. *BSU Journal of Science, Mathematics and Computer Education, 1*, 1–13.

Ali, T. (2012). A case study of the common difficulties experienced by high school students in chemistry classroom in Gilgit-Baltistan (Pakistan). *SAGE Open, 2*(2), 1–13. https://doi.org/10.1177/2158244012447299

Aragaw, A. M., Alemu, S. A., & Seyoum, D. G. (2022). Improving secondary school students' physics achievement through scaffold simulated analogical reasoning strategy. *Pedagogical Research, 7*, em0136. https://doi.org/10.29333/pr/12391

Baidoo-Anu, D. (2023). Between-school streaming: Unpacking the experiences of secondary school teachers and students in category C schools in Ghana. *International Journal of Educational Research Open, 3*, 100188. https://doi.org/10.1016/j.ijedro.2022.100188

Bakaç, M., Taşoğlu, A. K., & Akbay, T. (2011). The effect of computer-assisted instruction with simulation in science and physics activities on the success of students: Electric current. *European Journal of Physics and Chemistry Education, 3*, 34–42.

Bakri, F., Permana, H., Wulandari, S., & Muliyati, D. (2020). Student worksheet with AR videos: Physics learning media in laboratory for senior high school students. *Journal of Technology and Science Education, 10*(2), 231–243. https://doi.org/10.3926/jotse.891

Barmby, P., & Defty, N. (2006). Secondary school pupils' perceptions of physics. *Research in Science & Technological Education, 24*(2), 199–215. https://doi.org/10.1080/02635140600811585

Civelek, T., Uçar, E., Üstünel, H., & Aydın, M. K. (2014). Effects of a haptic augmented simulation on K-12 students' achievement and their attitudes towards physics.

Eurasia Journal of Mathematics, Science and Technology Education, 10(6), 565–574. https://doi.org/10.12973/eurasia.2014.1122a

de Barros Vidor, C., Danielsson, A., Rezende, F., & Ostermann, F. (2020). What are the problem representations and assumptions about gender underlying research on gender in physics and physics education? A systematic literature review. *Revista Brasileira de Pesquisa em Educação em Ciências, 20*, 1133–1168. https://doi.org/10.28976/1984-2686rbpec2020u113311

de Quadros, A. L., CarvalhoDa-Silva, D., Silva, F. C., Pereira de Andrade, F., Aleme, H. G., Tristão, J. C., Oliveira, S. R., Santos, L. J., & De Freitas-Silva, G. (2011). The knowledge of chemistry in secondary education: Difficulties from the teachers' viewpoint. *Educación Química, 22*(3), 232–239. https://doi.org/10.1016/S0187-893X(18)30139-3

Erinosho, Y. S. (2013). How do students perceive the difficulty of physics in secondary school? An exploratory study in Nigeria. *International Journal of Cross-Disciplinary Subjects in Education, 3*(3), 1510–1515. https://doi.org/10.20533/ijcdse.2042.6364.2013.0212

Guido, R. M. D. (2013). Attitude and motivation towards learning physics. *International Journal of Engineering Research and Technology, 2*(11), 2087–2094.

Haught, P., Nardi, H. A., & Walls, R. T. (2015). Preservice teachers' academic memories of school: A tool for learning. *American Journal of Educational Research, 3*(2), 166–172. https://doi.org/10.12691/education-3-2-9

Hazari, Z., Brewe, E., Goertzen, R. M., & Hodapp, T. (2017). The importance of high school physics teachers for female students' physics identity and persistence. *The Physics Teacher, 55*(2), 96–99. https://doi.org/10.1119/1.4974122

Hochberg, K., Kuhn, J., & Müller, A. (2018). Using smartphones as experimental tools—Effects on interest, curiosity, and learning in physics education. *Journal of Science Education and Technology, 27*(5), 385–403. https://doi.org/10.1007/s10956-018-9731-7

Holmes, N. G., & Lewandowski, H. J. (2020). Investigating the landscape of physics laboratory instruction across North America. *Physical Review Physics Education Research, 16*(2), 020162. https://doi.org/10.1103/PhysRevPhysEducRes.16.020162

Hudson, P., Usak, M., Fančovičová, J., Erdogan, M., & Prokop, P. (2010). Preservice teachers' memories of their secondary science education experiences. *Journal of Science Education and Technology, 19*(6), 546–552. https://doi.org/10.1007/s10956-010-9221-z

Kurniawan, D. A., Astalini, A., & Sari, D. K. (2019). An evaluation analysis of students' attitude towards physics learning at senior high school. *Jurnal Penelitian dan Evaluasi Pendidikan, 23*(1), 26–35. https://doi.org/10.21831/pep.v23i1.20821

Maulidah, S. S., & Prima, E. C. (2018). Using physics education technology as virtual laboratory in learning waves and sounds. *Journal of Science Learning, 1*(3), 116–121. https://doi.org/10.17509/jsl.v1i3.11797

Mami, W. S. (2021). The effect of teachers' attitudes on students' learning of grade-8 students of MSU-Sulu Laboratory High School. *International Journal of Research in Engineering, Science and Management, 4*(9), 59–63.

Miller, K., & Shifflet, R. (2016). How memories of school inform preservice teachers' feared and desired selves as teachers. *Teaching and Teacher Education, 53*, 20–29. https://doi.org/10.1016/j.tate.2015.10.002

Nuñez, R. P., Hernández, C. A., & Gamboa, A. A. (2021). Active learning and knowledge in physics: A reading from classroom work. *Journal of Physics: Conference Series, 1981*(1), 012007. https://doi.org/10.1088/1742-6596/1981/1/012007

Oon, P. T., & Subramaniam, R. (2013). Factors influencing Singapore students' choice of physics as a tertiary field of study: A Rasch analysis. *International Journal of Science Education, 35*(1), 86–118. https://doi.org/10.1080/09500693.2012.718098

Opoku-Ntim, I., Gyampo, O., & Andam, A. B. (2019). Risk assessment of radon in some bottled water on the Ghanaian market. *Environmental Research Communications, 1*(10), 105001. https://doi.org/10.1088/2515-7620/ab4568

Osei-Antwi, D., Essiam, C., & Quayson, C. (2023). Are chemistry topics difficult to learn? The stance of Ghanaian senior high school students. *International Journal of New Trends in Arts, Sports & Science Education, 12*(2), 112–121.

Patil, P., Gaikar, P. S., Kathare, P. V., Gaikwad, G. L., Gaikwad, G. L., Sawant, D. U., et al. (2019). Analysis of psychological approach behind physics subject—Feels difficult. *Think India Journal, 38*, 158–164.

Piaget, J. (1950). *The origins of intelligence in children*. International Universities Press.

Ramaila, S., & Reddy, L. (2018). First year university physics students' perceptions of teaching methods. In J. Engelbrecht (Ed.), *The 62nd Annual Conference of the South African Institute of Physics* (pp. 294–299). https://events.saip.org.za/event/91/attachments/2266/3110/SAIP2017_294-299.pdf

Saleh, S., & Subramaniam, L. (2019). Effects of brain-based teaching method on physics achievement among ordinary school students. *Kasetsart Journal of Social Sciences, 40*, 580–584. https://doi.org/10.1016/j.kjss.2017.12.025

Samsudin, M. A., Jamali, S. M., Zain, A. N. M., & Ebrahim, N. A. (2020). The effect of STEM project-based learning on self-efficacy among high-school physics students. *Journal of Turkish Science Education, 17*, 94–108. https://doi.org/10.36681/tused.2020.15

Shrestha, N. (2021). Factor analysis as a tool for survey analysis. *American Journal of Applied Mathematics and Statistics, 9*(1), 4–11. https://doi.org/10.12691/ajams-9-1-2

Snětinová, M., & Kácovský, P. (2019). Hands-on experiments in the interactive physics laboratory: A study of students' intrinsic motivation. *Journal of Physics: Conference Series, 1287*, 012049. https://doi.org/10.1088/1742-6596/1287/1/012049

Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de Pauw, J., Dehaene, W., Deprez, J., De Cock, M., Hellinckx, L., Knipprath, H., Langie, G., Struyven, K., Van de Velde, D., Van Petegem, P., & Depaepe, F. (2018). Integrated STEM education: A systematic review of instructional practices in secondary education. *European Journal of STEM Education, 3*(1), Article 02. https://doi.org/10.20897/ejsteme/85525

Tomara, M., Tselfes, V., & Gouscos, D. (2017). Instructional strategies to promote conceptual change about force and motion: A review of the literature. *Themes in Science and Technology Education, 10*, 1–16.

Vygotsky, L. S. (1978). *Mind in society: The development of higher psychological processes*. Harvard University Press.

Williams, C., Stanisstreet, M., Spall, K., Boyes, E., & Dickson, D. (2003). Why aren't secondary students interested in physics? *Physics Education, 38*(4), 324–329. https://doi.org/10.1088/0031-9120/38/4/306

World Bank. (2024). *World development report 2024*. https://www.worldbank.org/en/publication/wdr2024