UNIVERSITY OF CAPE COAST

SENIOR SECONDARY SCHOOL STUDENTS' AND TEACHERS' PERCEPTION OF THE DIFFICULT ORGANIC CHEMISTRY TOPICS IN THE CENTRAL REGION

BY

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DECLARATION

Candidate's Declaration

I hereby declare that this thesis is the result of my own original research and that no part of it has been presented for another degree in this university or elsewhere.

Candidate's Signature: …………………….. Date:………………………

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Supervisors' Declaration

We hereby declare that the preparation and presentation of the thesis were supervised in accordance with the guidelines on supervision of thesis laid down by the University of Cape Coast.

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ABSTRACT

This study investigated students' and teachers' perceptions of organic chemistry topics in the SSS chemistry syllabus. It compared the perception of students' with that of their teachers' with the hope of ascertaining whether perceptions were correlated.

The survey method was employed, where questionnaires were administered to 300 chemistry students' and their 35 teachers. Students' perception of organic chemistry questionnaire and Teachers' perception of organic chemistry questionnaire with reliability coefficients of 0.94 and 0.87 respectively were administered to the participants. The sample was drawn from 10 senior secondary schools in the Central Region where students had already treated organic chemistry. Stratified random sampling followed by simple random sampling was used to select 300 students (50 percent male and 50 percent female) from the 10 schools.

The study showed that the SSS chemistry students' perceived 14 out of the 31 organic chemistry topics to be relatively difficult to learn. In the case of the chemistry teachers', they perceived all the 31 topics to be relatively easy to teach. It was also found that, significant difference existed between male students' (mean equal to 94.4) and female students' (mean equal to 100.7) perception of the difficulty level of organic chemistry topics.

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DEDICATION

To my dad, Mr. Emmanuel Davis, and my late mother, Rev Mrs. Elizabeth Davis.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE

INTRODUCTION

Background of the study

The relevance of chemistry as a requirement for technological advancement of a nation cannot be looked down upon. The classification of any nation into developed, developing and underdeveloped could be measured accurately by the number of chemists, physicists, engineers, pharmacists, doctors, agriculturalists and science educators the nation could produce. Chemistry is most commonly regarded as the "Central Science" or the "Mother of all Science" owing to its confluence and influence (Ahiakwo, 2000).

Okeke and Ezekannagba (2000) also defined chemistry as a branch of science that deals with composition and changes of matter. Chemistry could therefore be defined as the science that deals with structure and composition of matter. Chemistry at the Senior Secondary School (SSS) level has three components. These are physical, inorganic and organic. Organic compounds permeate our everyday lives as we handle things such as polyesters, toothpastes and plastics. Two important industrial areas, the pharmaceutical (connected mainly the production of medicines) and polymer (which involves with the production of natural products such as proteins and artificial products such as nylon) industries, are organic dominated.

Originally, the term organic chemistry referred to the study of chemical compounds present in living matters, but now it is defined in terms of the study of carbon compounds, which exclude simple ones such as oxides of carbon, carbonates, cyanides and cyanates. There are vast number of synthetic and natural organic compounds due to the uniqueness of carbon; such as catenation (Danitith, 1981), exhibition of tetravalency and its ability to bond with other elements such as nitrogen, halogen, oxygen, and sulphur.

Organic chemistry as a component part of the SSS level chemistry is broad. It has many topics under it; it is only an integral part of the chemistry paper set by West Africa Examinations Council (WAEC) at the Senior Secondary School Certificate Examination (SSSCE) level. There are 2 chemistry papers at the SSS level. The chemistry paper 1 has two sections. In section A, students' are required to answer all the 60 objective questions, which have questions on organic chemistry. In section B, students' are required to answer five out of seven essay questions (which also include questions on organic chemistry). The chemistry paper 2 is a practical paper, which may or may not have questions on organic chemistry. The organic questions in the written section are not compulsory.

Table 1 shows the summary of the number of questions in organic chemistry part of chemistry papers 1 and 2 for three consecutive years. For example, in section A, chemistry paper 1, out of 60 objective questions, there were only 8 questions on organic chemistry (WAEC, 2003). In section B of the same paper, where students were required to answer 5 out of a total of 7 questions, there were 2 questions on organic chemistry (ie. question 5 and question 7). Chemistry paper 2, which was the practical paper, had three alternatives; A, B and C. There were 2 organic questions in alternative B, 1 in alternative C and none in alternative A; students were required to answer questions from only one of the three alternatives.

Table 1

Summary of the number of organic chemistry questions in chemistry papers.

	Number of organic chemistry questions								
	Chemistry Paper 1						Chemistry Paper 2		
	Section A			Section B			Alternative		
Year	Total	Number	%	Total	Number	%	A	B	C
2003	60	8	13.3	7	2(Q5&7)	28.6	0	2	1
2004	60	9	15.0	7	1(Q2)	14.3	1	0	0
2005	60	9	15.0	7	1(Q2)	14.3	1	0	0

According to WAEC (2002), the chief examiners reports for chemistry have branded organic chemistry part of the questions as unpopular to the students and that very few candidates answer questions in that area. The chief examiners reports (WAEC, 2002) specifically stated that “the only organic chemistry question, referring to question 4 of the written section, was the most unpopular and was answered by very few candidates. The question was in four parts and all were poorly answered.” p. (98). This presupposes that, majority of the students do not take an interest in answering questions under organic chemistry. This lack of interest in organic chemistry at the SSS level in part underpinned the current study, which sought to delve into some of the underlying causes for the lack of interest in organic chemistry. It is in this direction that the study sought to find out SSS students' and teachers' perceptions of organic chemistry.

Statement of the Problem

Students' performance in chemistry at the SSS level has been of great concern to most science educators. According to Ampiah (2001), SSSCE chemistry results over the years have been consistently below average. For example, the cumulative pass at grade E in 2003, for all students' in chemistry, was 52.19 percent. About 30% of candidates at that time had quality grades from A – C (WAEC, 2005).

Organic chemistry is usually taught in SSS3 as indicated in the teaching syllabus for chemistry. Students are therefore expected to understand the concepts before the examinations, however, a large number of SSSCE candidates are not able to answer the organic questions in particular, in the final examination of chemistry paper 1, section B. For example, the chief examiner's report (WAEC, 2000), on SSSCE chemistry paper 1, stated that, the very few candidates who attempted the question on organic chemistry could not answer it satisfactorily. Over the years, the chief examiners reports have consistently raised issues of poor performance in organic questions (WAEC, 1995; WAEC, 1996; WAEC, 1997; WAEC, 1998; WAEC, 1999; WAEC, 2001; WAEC, 2001; WAEC, 2003; WAEC, 2004; WAEC, 2005; WAEC, 2006). However organic chemistry is an important component of the study of chemistry for the following reasons:

1. We take in organic compounds in the form of solid foods such as proteins, carbohydrates, fats and oils.
2. We take drinks as coffee and tea that contain caffeine.
3. We use organic compounds such as clothing that are made of cotton, wool, linen, or chemical fibres.
4. Most medicines are organic compounds.
5. Similarly most dyes are organic in nature.

There are many kinds of organic compounds in the real world which chemistry students' must be familiar with that should also arouse their interest in the study of organic chemistry.

The Ghana national aptitude test and examinations committee, concerning students' cumulative passes at grade E in chemistry (WAEC 2005) revealed that, in 2002, 66.7% of female's students' passed at grade E whiles their male's counterparts had 66.1%. In 2003, the story was not different, 53.2% of female's students' passed at grade E whiles their male's counterparts had 51.8% and in 2004, the percentage passes at grade E for female's students' was 73.7% and those of male's students' was 71.0%.

Many studies such as Anamuah-Mensah (1995) as well as Mahaja and Singh (2005) have however suggested that a direct relationship exists between students' performance in chemistry and their perception in chemistry. Even though not many studies have looked at SSS teachers' perception in chemistry in general and organic chemistry in particular, however literature suggests a relationship between teachers' perception in a subject and that of their students' performance (Mahaja & Singh, 2005). It is against this background of poor students' performance in organic chemistry in SSSCE and the continual avoidance of questions on the organic chemistry part of the SSSCE chemistry Paper 1, that this study was undertaken to investigate SSS students' and teachers' perceptions of organic chemistry topics.

The Purpose of the Study

Based upon the problem statement, it would be of interest to find out the organic chemistry topics which are perceived as difficult to understand by students and difficult to teach by teachers; and whether the perception is gender related.

Research Questions

To guide the study, the following research questions were posed:

1. What is SSS chemistry students' perception of the level of difficulty of organic chemistry topics?
2. What is SSS chemistry teachers' perception of how difficult organic chemistry topics are to teach?
3. Which organic chemistry topics do students find the most difficult to understand and what reasons account for the difficulty?
4. Which organic chemistry topics do teachers find the most difficult to teach and what are the reasons for the difficulty?

Hypotheses

The following hypotheses were tested:

1. There is no significant difference between male and female students' perception of the difficulty level of organic chemistry topics.
2. There is no significant difference between boy schools and girl schools perception of the difficulty level of organic chemistry topics.

3. There is no significant difference between male and female students' perception of the difficulty level of organic chemistry topics in the coeducational schools.
4. There is no significant relationship between male and female students' perception of the difficulty level of organic chemistry topics.
5. There is no significant relationship between teachers' and students' perception of the difficulty level of organic chemistry topics.

Significance of the Study

The findings of the study would benefit those, who, in future would pursue further studies on perceptions of students and teachers in organic chemistry at all levels. It would help authors of SSS chemistry books and pamphlets to write chemistry books and pamphlets in a way that would be helpful to chemistry students.

The information, which highlights specific problems encountered in the teaching and learning of organic chemistry at SSS, would inform policy formulation in future. The study would also be useful to the Department of Science and Mathematics Education of University of Cape Coast and University of Education, Winneba, in designing their curriculum for training prospective science teachers to handle the SSS students. It would also be useful to the Ghana Association of Science Teachers (GAST) in educating its members, chemistry teachers in particular, in effective teaching of difficult organic chemistry topics during one of their annual conferences or workshops.

Limitation

The study should have considered all the SSS chemistry teachers and students in Central Region of Ghana. However, due to inadequate funding and time constraint, 10 SSS were selected for the study. Only chemistry teachers and students in SSS3 from the selected schools were used as the sample for the study.

Delimitation

The study was confined to SSS chemistry teachers and students in public schools in the Central Region of Ghana. The scope of the problem was limited to only students' and teachers' perception of organic chemistry. The schools purposively selected were those that had treated or were treating organic chemistry in the third term.

Organisation of Thesis

The rest of the thesis is organised as follows: Chapter Two provides the Literature review of the study which considered teaching and learning of chemistry, perceptions, studies on students' perception, studies on the influence of students' perception on their performance, studies on teachers' perception**,** studies on the relationship between teachers' perception and students' perception as its subheadings. Chapter Three deals with the methodology, which includes the description of sampling and the instrument used for the study. Chapter Four provides the results of the study and Chapter Five gives the summary, findings, conclusions and recommendations of the study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

The review of literature relevant to the topic under discussion has been provided in this chapter. This chapter has been broken down into six subheadings namely; teaching and learning of chemistry; perceptions; studies on students' perception; studies on the influence of students' perception on their performance; studies on teachers' perception; and studies on the relationship between teachers' perception and students' perception. The chapter concludes with a summary.

Teaching and Learning of organic chemistry

Organic chemistry has gained importance in general education in secondary schools and this has had effects on higher education courses. Elsewhere in United Kingdom, students at the University of Glasgow in their first year of study of chemistry, take organic chemistry, which covers the various functional groups and the general physical and chemical properties of organic compounds (Hassan, Hill & Reid, 2004). The organic chemistry is taught mechanistically, seeking to show students why the various groups of organic compounds behave in the way observed. Students are encouraged to ask questions such as, "what class of organic compound is this?" "What kind of reaction can I expect the organic compound to undergo?" "Are there any specific aspects to the reactivity of the compound that I need to bear in mind when deciding on the likely product(s) of the reaction?" One of the major organizational principles of first year organic chemistry is functionality. In high school and the university, organic chemistry textbooks are usually presented by functional groups (Hassan et al, 2004). It is not easy to see how functional groups can be understood although the properties of these groups can be presented in such a way that they make sense.

Experience and practice is needed to enable the student to gain confidence with functionality. Inevitably, organic chemistry can be somewhat like a foreign language for first year students. Students must learn the vocabulary (names, functional groups) and the grammar (reactions, mechanisms) in order ultimately to develop a rudimentary style of composition (mechanistic explanations, evidence of structures). The mechanistic approach is an attempt to present a bewildering array of information in such a way that an underlying structure and rationalization can be perceived and understood.

Early studies on the Scottish syllabus showed that topics like esterification, hydrolysis, condensation, saponification, and carbonyl compounds posed problems to students (Johnstone & Kellett, 1974) while a few years later, the problem of recognising functional groups was explored (Johnstone & Letton, 1982). As a result of this early work, the presentation of organic chemistry at school level was modified in the Scottish system and this was reflected in the new textbooks (Johnstone, Morrison & Reid, 1981). At the same time, ideas were being developed to explain why the problems existed where they existed, in terms of the way the learner handles information (Hassan et al, 2004).

Hassan et al, (2004) focused on the learning of organic chemistry at first year university level. In looking at a first year university organic chemistry, they looked at the experience gained by students at the secondary school level (the Scottish Higher Grade), such as information that they have remembered, but of greater significance is the grasp of the ideas that underpin organic chemistry, these ideas coming from their secondary school experience. At school level in Scotland, laboratory work and taught material are highly integrated. Nonetheless, it is still not always easy to link the molecular understanding to observations.

This point was well made by Johnstone (2000), when he pointed out that understanding chemistry involves working at three levels: the level of the macroscopic (phenomena which are open to the senses); the level of the sub-microscopic (the molecular level); and the level of the symbolic (the use of chemical and algebraic equations to represent or describe a phenomenon). The point that Johnstone (2000) was making is that it is difficult for the new learner to operate easily at all three levels simultaneously. In the learning of organic chemistry, it is however, customary to present the material at the start in symbolic form (symbols and equations) with reactions being interpreted at the molecular and electronic level by means of mechanistic representations. Another weakness of the school presentation lies in the way organic chemistry is laid out (Hassan et al, 2004). The entry point is through hydrocarbons, often related to the oil industry. This moves on into cracking and polymerisation. Quite inadvertently, the emphasis is placed on the carbon skeleton, with pupils having to remember the naming systems for hydrocarbon homologous groups along with basic ideas of isomerism. Later at school, and much more at

university level, the emphasis moves to the idea of functionality in that reactivity is determined largely by functionality. In this, the carbon skeleton becomes much less important apart from, of course, its stereochemical features. Thus, pupils are taught initially to focus on the skeleton and then they have to switch to the functional groups. It is little wonder that, at times, organic chemistry becomes a strange world where the manipulation of the symbols C, H and O develops a confusing algebra all of its own
(Hassan et al, 2004).

Examination performance at school level suggests that students cope fairly well with carbon chains, simple naming and isomerism. However, the move towards organic reactivity and the focus on functionality has less to do with the initial emphasis on carbon skeletons. Another problem may arise because organic reactions seem different from other reactions in that, in many reactions studied, things seem to proceed slowly (compared to many ionic solution reactions already met). While the nature of covalent bonds and bond polarity have been developed, the significance of these ideas in the context of organic reactivity may not always be apparent to students meeting organic reactions for the first time (Hassan et al, 2004). The covalent bond and the ionic bond are introduced early in the syllabus at school. Bond polarity and the polar covalent bond are often taught later, perhaps implying that the polar bond is less common. The idea that bonds can be made to be polarised by external electrophilic or nucleophilic reagents is not really developed much at the school level. At this stage, there is little concept of organic reaction mechanisms in general, including the stereochemical aspects of reaction mechanisms. While there is no specific emphasis on reaction mechanism at school, students should have some understanding of the following key basic concepts related to organic chemistry:

(i) The nature of the covalent bond

(ii) Bond polarity

(iii) Stereochemistry and the importance of molecular shape

(iv) Functionality (Hassan et al, 2004).

In Ghanaian schools and colleges, it appears organic chemistry is usually taught by a didactic approach in which teachers deliver formal lectures to transmit knowledge thereby making students passive learners (Yingjie & Zaiqun, 2003).

There are several theories in teaching and learning of science such as constructivist theory; problem-based learning; contextual learning approaches in science (Dressel & Marcus, 1982; Woods, 1995) among others, which can be useful in the teaching-learning process in the secondary schools.

Constructivism is the dominant paradigm in educational psychology at present. According to this theory, learning is an active process of sense making, which occurs in the mind of the learner as she or he attempts to construct a meaningful representation of new information (Phillips, 1995). As a result, instruction aimed at transmitting (intact) a knowledge structure from the instructor to the student will be ineffective. Instead, learners must build their own structure, or schema, based upon their existing knowledge and understanding (Bodner, 1986). There are many different theories of constructivism (Phillips, 1995), ranging from the individual-centred radical constructivist position of Von Glasersfeld (1993; 1995) to the group-centred social constructivist position (Palincsar, 1998). However, all such theories share as common features the central position of the learner in sense making and in building meaningful knowledge schemata.

Scerri (2003) has pointed out that there are important distinctions between a constructivist theory of learning, adopted for teaching purposes in the education community, and a philosophically constructivist theory of scientific knowledge. The former relates to students' learning process, whilst the latter posits that 'the laws of nature as we know them are social constructs – essentially laws that scientists have agreed between themselves and do not have any fundamental significance' (Collins, as cited in Scerri 2003; p.469). It is clear that one can believe that the learning process involves knowledge construction whilst simultaneously believing that scientifically accepted laws do have physical significance.

The abilities to manage information and to reason analytically, both deductively and inductively are essential requirements for success in organic chemistry. The students are expected to understand, master and apply the organic chemistry material in problem solving. The instructors believe that if one learns fundamental principles and theories one would be able to make applications as needed. Maruto and Camusso (1996) have assessed the knowledge acquired in an organic chemistry using a multiple-choice exercise. The results were used to research areas that should be reinforced in order to improve the quality of the teaching-learning process.

Bradley, Ulrich, Maitland and Jones (2002) have described the importance of cooperative learning in the organic chemistry in which the lecture component diminishes in the first semester and essentially vanishes in the second. Carpenter and McMillan (2003) have also described the incorporation of a cooperative learning technique in organic chemistry. The knowledge space theory has been used for tracking the development of students' conceptual understanding of organic chemistry in second year (Taagepera & Noori, 2000). This study has shown that the students' knowledge base increases but the cognitive organization of the knowledge is weak and misconceptions persist even after two years of college chemistry. Nash, Liotta and Bravaco (2000) have measured conceptual change in organic chemistry. Their results indicated that significant change in students' knowledge structure occurred during the semester.

Mahajan and Singh (2005) have described the perception of organic chemistry instructors from different universities in the SADC (Southern African Development Community) region on the performance of students in this major topic. They have perceived factors such as conducting tutorials, laboratory sessions and students prior knowledge as contributing to students success in organic chemistry, whereas the presence of anxiety or phobia and time constraint contributed to their underperformance. Their study revealed that, the most popular method of instruction is the lecture method using chalk and board, followed by demonstration method using models.

According to Mahajan and Singh (2005), instructors gave the following reasons for students' underperformance in organic chemistry at the undergraduate level:

1. Poor background of organic chemistry from pre-university level.
2. The students find organic chemistry concepts very complicated.
3. The students did not want to put in effort themselves rather believed in spoon-feeding by their instructors.

4. Time constraints as the students have a heavy load of work.
5. Lack of active study.
6. Students do not practice by writing to learn and understand.
7. Large intake of students that results in crowded lecture halls.
8. The students tend to memorize rather than understand the concepts and therefore failed to apply the concepts in new situations p. (14).

The instructors also gave the following suggestions to improve organic chemistry teaching and learning in the SADC region
(Mahajan & Singh, 2005).

1. The students should be encouraged to write and practice exercises.
2. The organic chemistry should be completed well in time or the time allocated for the organic chemistry should be increased.
3. The frequency of small group tutorial sessions and discussions must be increased.
4. The exploratory approach through experimentation must be used more frequently.
5. The students should be provided with more learning aids.
6. The lecturers must draw a relationship with prior knowledge and current topic as it helps students to understand.
7. The students should be advised on good study methods. For example, they should be encouraged to make notes themselves.
8. The students should be introduced to the idea of problem-based learning rather than rote learning.
9. The students should be asked short questions during lectures p. (15)

Teachers who lack pedagogical content knowledge commonly paraphrase information in learners' textbooks or provide abstract explanations that are not meaningful to their students (Eggen & Kauchak, 2001). Students with negative self-concept have poor academic performance (Ford, 1985). These are likely to result in the student having negative perception about the topic under consideration. This necessitated the current study since one cannot isolate teaching from learning.

Perceptions

Definition of Perception

Perception, according to the Shorter Oxford English Dictionary on historical principles, is

- The intuitive recognition of a moral or aesthetic quality, for example, the truth of a remark.
- The action of the mind by which it refers its sensations to an external object as their cause (Little, 1962, p.1470).

The Webster's encyclopaedia of dictionaries also define perception as

- Cognizance, apprehension, sight, understanding, discernment, obtaining knowledge through the senses (to see, hear, or feel)
  (Allee, 1978, p.487).

Cambridge dictionary of philosophy also define perception as the extraction and use of information about one's environment and one's own body
(Audi, 1999, p.654).

Perception may be defined from physical, psychological and physiological perspectives. But for the purpose of this study, it shall be limited to its scope as postulated by Allport (1996), which is the way we judge or evaluate others. That is the way individuals evaluate people with whom they are familiar in everyday life. Eggen and Kauchak (2001) gave cognitive dimension of perception; they see perception as the process by which people attach meaning to experiences. They explained that after people attend to certain stimuli in their sensory memories, processing continues with perception. Perception is critical because it influences the information that enters working memory. Background knowledge in the form of schemas affects perception and subsequent learning. Research findings have corroborated this claim that background knowledge resulting from experience strongly influence perception (Glover, Ronning & Bruning, 1990). Baron and Byrne (1997) called it "social perception" which is the process through which we attempt to understand other persons.

The term "apperception" can also be used for the term under study. Apperception is an extremely useful word in pedagogy, and offers a convenient name for a process to which every teacher must frequently refer. It means the act of taking a thing into the mind (Adediwura & Tayo, 2007). The relatedness of this view of perception to the present study is further explained, that every impression that comes in from without, be it a sentence, which we hear, an object or vision, no sooner enters our consciousness than it is drafted off in some determinate directions or others, making connection with other materials already there and finally producing what we call our reaction. From this it is clear that perception is the reaction elicited when an impression is perceived from without after making connection with other materials in the consciousness (memory). From this point of view, one can deduce that, perception cannot be done in vacuum; it depends on some background information that would trigger a reaction. This is consistent with the views of researchers (Allport, 1996; Glover et al, 1990) and the overall research problem of this study.

Thus, perception in humans describes the process whereby sensory stimulation is translated into organized experience. That experience, or percept, is the joint product of the stimulation and of the process itself. Relations found between various types of stimulation (e.g., light waves and sound waves) and their associated percepts suggest inferences that can be made about the properties of the perceptual process.

Theory of Perceptions

The sense-datum theory holds that when a person has a sensory experience, there is something of which they are aware (Crane, 2005).What the subject is aware of is the object of experience. The object of experience is that which is given to the senses, or the sense-datum: The standard version of the theory takes the argument from illusion to show that a sense-datum, whatever else it may be, cannot be an ordinary physical object. The early sense-datum theorists like Moore (as cited in Crane, 2005) considered sense-data to be mind independent, but non-physical objects. Later theories treat sense-data as mind-dependent entities.

The conception of perception which most sense-data theories propose is as a relation to a non-physical object. This relation is the relation of “being given” or “sensing”. The relational conception of perception is sometimes called an “act-object” conception, since it posits a distinction between the mental “act” of sensing, and the object which is sensed. It is straightforward to show how this theory deals with the arguments from illusion and hallucination. The sense-datum theory treats all phenomenal properties which determine the phenomenal character of an experience as properties of the immediate object of experience. So, when in the case of an illusion, an external object appears to have a property which it does not have in reality, the theory says that some other object, a sense-datum, really does have this property. A similar move is made in the case of hallucination. Perceptions and subjectively indistinguishable hallucinations share their phenomenal character. This means that they share their phenomenal properties: the properties which determine what it is like to have an experience of this character. Based on the phenomenal principle, the conclusion is drawn that these properties must be instantiated in an object of the same kind: a sense-datum. So the sense-datum theory retains the claim, that experiences depend on their objects; but it denies that these objects are the ordinary, mind-independent objects we normally take ourselves to be experiencing.

The sense-datum theory need not deny that we are presented with objects *as* if they were ordinary, public, mind-independent objects. But it will insist that this is an error. The things we take ourselves to be aware of are actually sense-data, although this may only be apparent on philosophical reflection. This is an important point, since it shows that the sense-datum theories are not simply refuted as Harman (as cited in Crane, 2005) seems to argue, by pointing to the phenomenological fact that the objects of experience seem to be the ordinary things around us. A consistent sense-data theorist can accept this fact, but insist that the objects of experience are really sense-data.

The sense-datum theory can say, however, that we are indirectly aware of ordinary objects: that is, aware of them by being aware of sense-data. A sense-datum theorist will term this as an indirect realist or representative realist, or as someone who holds a representative theory of perception. A theorist who denies that we are aware of mind-independent objects at all, directly or indirectly, but only of sense-data, is known as a phenomenalist or an idealist about perception.

The difference between indirect realism and idealism is not over any specific thesis about perception. The difference between them is over the metaphysical issue of whether there are any mind-independent material objects at all. Idealists, in general, hold that all objects and properties are mental or mind-dependent. There are many forms of idealism, and many arguments for these different forms, but what is important in this context is that idealists and indirect realists can agree about the nature of perception considered in itself, but will normally disagree on grounds independent of the philosophy of perception about whether the mind-dependent sense-data are all there is. Thus Foster (2000) argues for his idealism first by arguing for sense-data as the immediate or direct objects of perceptual experience, and then arguing that idealism gives a better explanation of the reality underlying this appearance, and of our knowledge of it. Hence, idealism and indirect realism are grouped together here as “the sense-datum theory” since they agree about the fundamental issue in the philosophy of perception.

Studies on Students’ Perceptions

Studies by Abdullahi and Aninyie (1983), Akinmade and Adisa (1984), have shown that certain topics were perceived to be difficult by students in Nigeria and their perception of the topics showed a reasonable correlation with their performance in their examinations. Also findings by

Anamuah-Mensah (1995) have indicated that students' perceptions of the topics in the syllabus strongly reflected their actual performance on those topics as indicated by the grades obtained at the GCE 'O' level examinations.

A number of studies have been done on students' understanding of chemical concepts they learn in school. The studies showed that students perceive certain chemical concepts such as redox reactions, electrochemistry, solubility and electrolysis as difficult (Ampiah, 2001). A lot of studies have also been done on students, perceptions of topics in SSS chemistry syllabus. Draphor (1994), in her studies about SSS students' perceptions of chemistry topics revealed that, almost all the topics in chemistry were found to be difficult. Wood (1994) also studied students' and teachers' perceptions of SSS chemistry topics and found out that, students had difficulty in learning organic chemistry generally.

Shaibu and Olarewaja (2007) studied the perception of difficult biology concepts among senior secondary school students and teachers. Their purpose was to: identify biology concepts or topics that SSS students and teachers perceive to be difficult; find out if there is a significant difference between the teachers and the students perception; a significant relationship between the teachers length of teaching experience and their perception of the identified difficult concepts or topics, as well as make suggestions that are potentially viable for improving the teaching and learning of biology.

The results of their study showed that: the students and their teachers respectively found about 40% and 50% of the selected concepts or topics to be difficult; the perception of both students and their teachers of the difficulty level of biology concepts or topics was basically the same; there was no statistically significant difference between students and their teachers perception, neither was there any significant relationship between the teachers years of teaching experience and their perception of biology concepts or topics difficulty.

They opined that, the proportion of concepts found or perceived to be difficult is large enough to contribute significantly to students' poor performance that have been observed and reported consistently in the outcome of public examination results such as the SSSCE. Their findings regarding the relative perception of the students and the teachers of difficult biology concepts and the relationship between the teachers' years of teaching experience and perception of difficult biology concepts tend to agree with the reported findings of other scholars, such as Akinmade (1987), Olarewaju (1995), and Umeh (2002).

They however, differ from that of Shaibu (1988) who found a statistically significant difference between students' and their teachers' perception of difficult chemistry concepts. Shaibu and Olarewaja (2007) found out that, the performance in the SSSCE has been very poor in science. Akinmade (1987) for example, reported that on the average 76.8 percent of the students' that sat the SSSCE failed in science. This problem of underperformance is not different among the counterparts of Ghanaian students in Science and particularly in chemistry.

Adamolekun (as cited in Shaibu & Olarewaja, 2007) identified some factors, which she considered to affect students' achievement in science. One of the factors was the content and scope of the syllabus. She opined that the syllabus was often difficult to handle and sometimes overloaded with topics that both teachers and students find difficult to handle as well. She further asserted that an important source of students' underachievement in science has been their misconception of some basic concepts. Balogun (1985) also observed that one of the causes of students' poor performance in science is related to their general perception that science was an easy subject.

Tajudeen (2005), in his study on students' perception of difficult topics in chemistry curriculum in Nigerian secondary schools found that students perceived 13 topics out of 20 major topics in the secondary school chemistry curriculum as difficult topics of which organic chemistry was part . Findings, from his study revealed that chemistry students perceived more than half (65%) of the senior secondary chemistry topics as difficult to learn. Perhaps the low performance of chemistry students at the SSSCE level may not be surprising since they found most of the topic in the curriculum difficult to comprehend (Tajudeen, 2005).

The study also revealed that gender differences of the students had no influence on perception of difficult topics in chemistry curriculum, while school nature influenced perception of chemistry topics (Tajudeen, 2005).

Koul and Fisher (2004) studied students' perceptions of science classroom learning environment and teacher-student interaction in Jammu. The main aim of their study was to investigate how perception of learning environment and teacher-student interaction in science classroom varies with student's cultural background. For the purpose of the study, cultural background was determined by asking students what language they and their parents normally spoke at home.

Jammu city is understood to be a melting pot of various cultures, because of the migration from neighbouring provinces into the city due to the various political reasons of the past five to six decades. It was amazing to know that students covered in this study, who underwent the same core curriculum at school, came from 13 different cultural subgroups. The languages spoken at home, a clear indication of their cultural backgrounds, were Hindi, Kashmiri, Dogri, Punjabi, Balti, Pahari, English, Badarwahi, Muzfarabadi, Punchy, Telgu, Urdu and Kistwari. However, only four of these groups contained sufficient numbers for the analyses. These are Hindi, Kashmiri, Dogri and Punjabi, which constituted 98% of the sample.

The results from their study indicated that there were differences in the student's perceptions of their learning environment and teacher-student interactions that are associated with students' cultural background (the indicator variable taken as language spoken at home). For both the instruments namely the WIHIC (what is happening in classrooms) and the QTI (questionnaire on teachers interaction), the Kashmiri group of students had more positive perception of their classroom environment and teacher interactions than other three groups in the study. The result of their study demonstrated that students in Jammu come from a range of different cultural backgrounds and this influenced how the students perceive their learning environments (Koul & Fisher, 2004).

Harrison, Fisher, and Henderson (1997) also studied students' perceptions of practical tasks in senior biology, chemistry and physics classes. Their aim of this study was to investigate whether there were differences in the perceptions of senior high school biology, chemistry and physics students of their actual science laboratory learning environments, the practical tasks undertaken in these three subject areas and to make comparisons between the content of the laboratory activities and the learning environment perceptions.

They employed the Science Laboratory Environment Inventory (SLEI) instrument which uses two tabular checklists, the Laboratory Structure and Task Inventory and the Laboratory Task Analysis to analyze laboratory activities. The Laboratory Structure and Task Inventory analyses laboratory activities from four perspectives such as, activity planning and design; student performance behaviors; student analysis and interpretation of results; and, student application of laboratory findings. These four perspectives elucidated the manipulative, social and thinking behaviors that characterized scientific investigations. The Laboratory Task Analysis then looked at laboratory activities from the perspectives of structure (high-low cognitive level, open-ended, prescriptive), relation to text (i.e., timing) and mode of participation (i.e., individual, group, and whole-class).

The SLEI assesses student cohesiveness (extent to which students know, help and are supportive of one another), open-endedness (extent to which the laboratory activities emphasize an open-ended, divergent approach to experimentation), integration (extent to which the laboratory activities are integrated with non-laboratory and theory classes), rule clarity (extent to which behavior in the laboratory is guided by formal rules), and material environment (extent to which the laboratory equipment and materials are adequate).

Harrison, Fisher, and Henderson (1997) also found in their study which sought to investigate students' perceptions of practical tasks in senior biology, chemistry and physics classes, using the Science Laboratory Environment Inventory (SLEI) method, that chemistry investigations were perceived to have a higher degree of rule clarity than either biology or physics. The much greater detail provided in chemistry activities than in biology or physics seemed to adequately explain this finding. Chemistry is highly prescriptive for safety reasons and students seemed to reflect this in their SLEI responses.

Studies on the Influence of Students' Perception on their Performance

According to Johnstone, Morrison and Sharp (1971), it is possible to obtain a list of topics that students have difficulty with, either through the students' performance on test designed to cover the content areas or through the perceptions of students. The first approach has been found to be very difficult, since it involves the writing of sufficient test items, which seek an in-depth coverage to reflect all the topics in a given syllabus. The second approach seeks to obtain students' perceived reactions to the topics in a given syllabus as an indication of how difficult the topics are, since there appears to be a good agreement between students' perception and their performance (Anamuah-Mensah, 1995). When the students have good attitude towards the subject taught by even a trained teacher in a well equipped laboratory with textbooks available (Johnstone et al, 1971) they can perform.

Read, George, Masters and King (2004a, 2004b) have done studies on students' perception and performance in chemistry examinations. They accordingly said, the first year chemistry topics at the University of Sydney combine both general or inorganic chemistry (hereafter 'inorganic') and organic chemistry, and their study presented examination performance data for eight such major topics. The data suggested that assessment results could be used to identify the existence of learning barriers by a purely statistical method, and that the nature of such barriers could then be investigated qualitatively; such a method could readily be applied to investigate topics in other subject domains. Whilst explanation in organic chemistry has been discussed in the literature (Goodwin, 2003), as has students' development of organic predictive skills (Treagust, Chittleborough & Mamiala, 2004), the belief amongst chemists that some students simply do not 'get' organic chemistry remains based on anecdotal evidence. Their study presented empirical data consistent with this belief, and offered a speculative interpretation of the nature of learning barriers faced by students learning organic chemistry (Read et al, 2004a, 2004b).

Organic chemistry is considered difficult from students' point of view and their performance in this area is relatively low (Mahajan & Singh, 2005). Mahajan and Singh (2005) reported the results of the survey carried out with organic chemistry instructors in the SADC region to determine what factors they perceive are influential to students' performance in organic chemistry, the preferred instructional methodology and their suggestions on how to improve the teaching and learning. Their findings indicated that tutorial and laboratory sessions were the most important factors that greatly improve the performance in organic chemistry. Other factors that improved their understanding in organic chemistry were active learning methods, use of demonstration models, lecture outlines, concept maps and diagrams, among others. The most preferred method of instruction was the lecture method using chalk and board followed by demonstration method using models. The instructors felt that, lack of time; prior knowledge and insufficient writing and practice are responsible for the poor performance in the organic chemistry. The instructors suggested an increasing tutorial sessions, advising good studying patterns in organic chemistry and insisted on writing assignments regularly.

Dunne and Rennie (1994) sought to examine Fijian students' attitudes and perceptions about science, science-related careers and the career advice they received. Using a one sixth representative sample of Form *5* students, the survey has contributed some of the first information available in Fiji about these variables. Perhaps contrary to the findings in many other countries, the results of this study suggest that females do not regard science less positively than males and do not have different patterns of attribution of their performance in science. Further, and again perhaps contrary to what might be expected in a country whose politics are strongly related to ethnic issues, ethnicity is not a significant correlate of these attitudes. Science is perceived positively by these students, and those preferring a science-related career were significantly more positive in their attitudes than those preferring other careers.

Dunne and Rennie (1994) have reported that both male and female, and both ethnic Fijian and Indo-Fijian, students consider science to be difficult compared to other school subjects and second to English in usefulness of getting a job. The similarity between males and females in their attitudes and perceptions about science suggests that these attitudes cannot account for the different rates of participation of males and females in the science-related workforce and in higher education in Fiji. Part of a more likely explanation is associated with the strong sex-stereotyping of science-related careers found among the students, stereotyping which is, not surprisingly, consistent with the composition of the workforce in Fiji.

Although females are less stereotyped than males in their views, only 10% of them are likely to choose a science-related occupation which is not associated with service to health, compared to about 30% of males. Importantly, the material and economic realities in developing countries limit the availability of certain careers. If there are few science-related careers available, this may directly impede the level of aspiration for such careers. Most students, particularly ethnic Fijians, were reasonably confident about obtaining their preferred job choice. Males, particularly ethnic Fijian males, were more likely to prefer and expect to get a masculine job than females were likely to prefer and expect to get a job they perceived to be feminine.

The finding that parents and teachers are the people who give most advice about careers is consistent with Eccles' (1989) view that they are the main socializers in developing students' views about science and mathematics. Males more than females, and Indo-Fijians more than ethnic Fijians, are likely to receive specific, job-related information rather than general advice to work hard. The emphasis on "working hard," both in the nature of career advice and students' attribution of their performance to effort, was an interesting finding (Dunne & Rennie 1994). It may be a reflection of the uncertainty in the aftermath of the military coups which resulted in increased unemployment and government strategies to restrain wages (Narsey, 1988). The issue of "working hard" may be a reflection of labor market possibilities, where there is pressure for families to produce rather than consume, especially in a subsistence farming economy like Fiji's. The farmers are ethnic, rather than Indo-Fijians, so it is not surprising that advice to work hard was given more often to ethnic Fijian students, particularly as some reported being requested by their parents to return something to their village. The finding that the fixed variables of gender and ethnicity have no consistent relationship with students' perceptions and attitudes about science suggests that schools potentially can have a major role in the formation of students' attitudes.

Data about public examination results are not recorded by sex in Fiji, so it is not possible to link performance on examinations with career selection. However, it is reported that males and females have similar pass rates but females are less likely to continue with further education (Bolabola, 1989). It seems most likely that differences in participation in science are determined by socioeconomic and cultural factors, not innate ones, just as they seem to be elsewhere.

Bolabola, (1989) has described the strong gender and cultural stereotyping of the workforce in Fiji. Even if redrafting of the Government's Development Plan opened up the possibility of increased participation by women in a variety of nontraditional occupations, the social, cultural, and economic barriers are still significant. Examples include the strongly held views by students of the stereotyping of the domestic and nursing sphere as female which, because it is consistent with the reality in Fiji, will take time to change. Similarly, the cultural demands on women, such as those which limit the range of careers considered suitable for Indo-Fijian women, the pressure to marry (Lateef, as cited in Dunne & Rennie, 1994) and the pressure on ethnic Fijian women to continue working on the farm (Bolabola, 1989) provide barriers to their involvement in other careers. Further, in a country where monetary resources are limited and there are economic and political pressures, the fees to be paid for higher education are unlikely to be distributed equally among sons and daughters. All of these factors act against the rapid expansion of women into the workforce, even if that is what is desired by Fijian women themselves, irrespective of their ethnicity.

The outcomes of an essentially quantitative survey such as this are important in an area where there is little documented information about the variables of interest.

Dunne and Rennie (1994) concluded that the study gathered a wider information base by using a number of open-ended questions rather than a simple check-the-box approach, than may otherwise have been possible. The next step was to use a more focused qualitative study with a small, carefully chosen sample of students and their families to examine ways in which the social and cultural barriers to females' participation in science operate and can be challenged in the Fijian context.

Studies on Teachers' Perception

Studies on teachers' perception in science are not new. Eun-Ju and Young-Ja (2007) have looked at the Survey of Chemistry Teachers' Perceptions and Teaching Style on Chemistry I Course. The purpose of their study was to find out chemistry teachers' perceptions on the aims and characteristics of the chemistry I course from the seventh national curriculum by means of investigating how frequently particular learning contents were selected and what the teachers' teaching styles were in order to find out how effectively teachers were working with the seventh national curriculum in teaching. For their study, data was collected by means of questionnaires, which was answered by 44 chemistry teachers in 40 different high schools. Results from their study indicated that chemistry teachers perceived the aim of the course was to promote democratic citizens with the knowledge of chemistry. And the most appropriate way of teaching chemistry I course was inquiry-centered teaching such as experiment-practice and inquiry-discussion. However, these perceptions did not reflect when they actually taught students in the classroom. Instead, most of the class was concepts learning and there were a lot of differences in selecting learning contents among chemistry teachers. Although chemistry I course was considered a good subject to make students have interest and curiosity in chemistry; it was not appropriate to make students understand the concepts of chemistry. They concluded that learning contents in chemistry I course needed improvement and since the goal of seventh national curriculum of chemistry I course was to emphasize inquiry teaching, inquiry based teaching should be practiced in the class.

Adesoji and Arowosegbe (2004) also looked at the isolation of factors in teachers' perception of senior secondary chemistry practical in Nigeria. The purpose of their study was to isolate the factors in teachers' perception of senior secondary practical aspect of the chemistry curriculum. Their study revealed that teachers perceived the content of chemistry curriculum as over-loaded and lack of laboratory facilities and equipment for teaching chemistry practical; this hindered teachers from using inquiry method for teaching chemistry. Teachers' perceived time allotted for teaching chemistry as inadequate and made them rush over many topics without practical activities with the view to finish the syllabus. This had adverse effect on students' understanding of chemistry as it enables students to perceive chemistry as difficult and as an abstract subject. Also, teachers perceived lack of chemistry laboratory as a major factor hindering acquisition of necessary skills through practical work. Teacher's competency and teaching experience also hindered effective learning of skills in senior secondary chemistry practicals.

Gado, Verma and Simonis (2004) studied Middle Grade Teachers' Perceptions of their Chemistry Teaching Efficacy: Findings of a One year long Professional Development Program. They found out those teachers who experienced learning about chemistry concepts through the Conceptual Chemistry Professional Development program became more knowledgeable not only in chemistry concepts but became more confident about their abilities to put their experiences into practice in their classes. Also teachers provided with the opportunity to attend graduate level professional growth opportunities such as the Conceptual Chemistry Professional Development program may be one way to facilitate teachers' understandings of Chemistry concepts and teaching skills that could have a significant impact on teaching outcomes.

Snow (2002) conducted a study to examine the perceptions held by senior secondary school teachers about their use of classroom space. Six participants (Georgia teachers with National Board certification) were interviewed and asked to describe their teaching experiences related to: orientation issues (the individual's perception of space); operation issues (intentions and attempts to shape and use the environment); and evaluation issues (judgments made about the environment). The findings of her study indicated three major themes concerning teachers' perceptions of classroom space: (1) the adequacy of the amount and arrangement of space for teachers' need, (2) the physical condition of the classroom in relation to teacher performance and morale, and (3) the effects of the classroom's physical condition on student behavior. The amount or arrangement of space was inadequate for the teachers' needs, particularly in the areas of student mobility and storage. However, teachers found numerous ways to modify and shape their setting to make it support their instructional program. Newer facilities and smaller class sizes contributed to teachers' sense of well-being and effectiveness while poor maintenance and overcrowding were associated with feelings of frustration. Teachers believed that the physical environment sent positive or negative messages. Students in trailers and older, poorly maintained buildings seemed to be more destructive and less appreciative of their facility than students in newer schools. Based on teachers' perception in her study, seven classroom design recommendations were identified.

1.) Construct adequate storage to house materials for instructional programs, particularly in laboratory sciences. 2.) Plan for flexible arrangements of people, furnishings, and equipment by limiting built-ins and immobile fixtures. 3.) Locate all technology resources together and away from windows. 4.) Provide classroom space in secondary schools that will support instructional programs and accommodate student mobility. 5.) Construct additional space for computer workstations located in classrooms. 6.) Build separate workspaces for teachers to use for planning and conferencing with parents, students, and colleagues. 7.) Create professional classroom environments that include computers with Internet access and telephones with outside lines.

Adeyanju (2003) studied Teachers' Perception of the effects and use of learning aids in teaching in Winneba basic and secondary schools. The purpose of his study was to find out the level of agreement or disagreement to a fourteen-item questionnaire on the relevance, the quality and types of teaching aids that teachers used in teaching their lessons. Teachers specifically were asked to indicate the types of teaching materials they would eventually want to use in their teaching. Results showed that 6 teachers would like to use projectors to teach their lessons. Thirty-four other teachers would prefer to use non-projected materials to teach their lessons. Nineteen teachers would prefer to use other methods, the rest numbering 21 would prefer to use locally made (self made) charts and other visual materials. He accordingly found that the positive effect of teaching with various learning aids were approved as acceptable to over ninety percent of the teachers in that: teachers claimed that learners understand better what they teach using visual aids; the teachers also improvised for the teaching aids when needed, and that they used teaching aids to explain the various concepts that required explanation. Adeyanju (2003) further stated that since teachers go to the extent of borrowing teaching aids from Ghana Education Service and from some of the schools that have them, and since teachers claim that they do not need further training on how to prepare and use teaching aids to teach their lessons, the inference that can be made from the analysed observations is that teachers use some teaching aids to teach their lessons.

Conclusion drawn from his survey was that teachers, whether those on training or those that have qualified, perceive the use of learning aids in teaching as advantageous to the teachers and to the students. Their use reduces the talk and chalk method of teaching.

Wood (1994), also found in his study on SSS students' and their teachers' perceptions of chemistry topics that, teachers' had difficulty teaching organic chemistry.

Ones attitude is the result of one's perception. For example, two people with different perceptions look at the same thing and thus think about it differently, and end up with different attitudes. Both think they are right.

According to Adediwura and Tayo (2007), attitude could be defined as a consistent tendency to react in a particular way often positively or negatively toward any matter. Attitude possesses both cognitive and emotional components. Attitudes are important to educational psychology because they strongly influence social thought, the way an individual thinks about and process social information (Fazio & Roskes, 1994). According to Eggen and Kauchak (2001), positive teachers' attitudes are fundamental to effective teaching. The teacher must work his students into such a state of interest in what the teacher is going to teach him that every other object of attention is banished from his mind. The teacher should also fill the students with devouring curiosity to know what the next steps in connection with the topic are.

Eggen and Kauchak (2001) identified a number of teachers' attitudes that will facilitate a caring and supportive classroom environment. They are: enthusiasm, caring, being firm, democratic practices to promote students responsibility, use of time for lesson effectively, free interaction with students and providing motivation for them. Many researchers, psychologists and educators alike, have identified some of the variables that have effects on students' academic performances. Academic performance is an individual's inherent potentials in terms of intelligence combined with other sociological factors. Ojerinde (1981) identified personality factors such as anxiety, achievement, motivation and level of interest as factors that affect academic performance. The consistence of these claims was asserted by Ford (1985), which claimed that student with high self-efficacy received higher grades than those with low self-efficacy and that student with negative self-concept have poor academic performance.

Teacher variables are also noted to have effect on students' academic performances. These includes, teachers' knowledge of subject matter, teaching skills, attitude in the classroom, teachers qualification and teaching experience. Ehindero and Ajibade (2000) asserted that, "students, who are curious stakeholders in educational enterprise, have long suspected and speculated that some of their teachers (lecturers in the university) lack the necessary professional (not academic) qualification (that is, skills, techniques, strategies, temperament and others) required to communicate concepts, ideas principles and so on, in a way that would facilitate effective learning" (p. 4). They also believed that these deficiencies contribute significantly to the growing rate of failure and subsequent drop out of students in tertiary institutions. Similarly, the same significant growth rate of failure and subsequent drop out of students in the Nigeria higher institutions did occur in Nigerian secondary schools (Adediwura & Tayo 2007). The growing failure rate could essentially be noticed in the yearly decline in students' performance in the Senior Secondary School Certificate Examination. This thus, is making many students to abandon schooling at the end of senior secondary school years. Adediwura and Tayo (2007) therefore investigated whether teachers in the secondary schools possessed the necessary professional qualification (such as skills, techniques, temperament etc.) that is required to communicate concepts, ideas, principles etc. in ways that would facilitate effective learning in Nigerian secondary schools.

Studies on achievement in science, in general for example
(Soyibo, 1985; Eke, 1986; & Ato, 1986) have all attributed failure or underachievement, on the part of students to such factors as teachers' qualifications, experience, interest and resourcefulness of teachers and socio-cultural factors. The teacher is a very important factor in curriculum implementation. His or her knowledge levels and teaching practices are very crucial and important in determining students' performance. The teachers' knowledge of the subject matter greatly affects the students' comprehension of science, chemistry inclusive (Oyeneyin & Balogun, 1982). The teacher often determines the topics to be learnt, the order in which the topics and the concepts are to be learnt the nature of assignments and the times to be allotted to teaching. Teachers are the final brokers when it comes to educational policy (James, 2000).

Shwartz, Ben-Zvi, and Hofstein (2005) also conducted a study on the importance of involving high-school chemistry teachers in the process of defining the operational meaning of 'chemical literacy'. Their aim was to find out, if the workshop helped 'teachers; as learners' to construct their own meaning of the term science literacy and as practitioners in their classroom' to obtain a clear understanding of the new teaching goals. They employed theory-based methods, such as 'teachers' beliefs and practice' and 'a study group strategy'.

The development of the definition of science literacy provided the teachers with an opportunity to reflect on fundamental issues regarding chemistry teaching. Considering the fact that teachers' beliefs, views and perceptions have a great influence on their practice, the success of this workshop would lead to the helpful change in the educational system, the more likelihood of success in educational reform, and finally the increased possibility of promoting students learning in regard to science literacy.

According to Shwartz et al (2005), the process during which the teachers constructed their understanding of the goals of teaching chemistry in high school was observed and diagnosed in light of constructivism. This result showed pedagogical suggestion as to using 'a study group' as a teaching strategy. 'Study group' offered learners the opportunity to get together to solve problems. Learners could inquire and asked questions that matter to them, over time, in a cooperative and supportive environment. Actually, the researchers provided a wide variety of activities to help the teachers develop the meaning of science literacy and link their understanding to pedagogical aspects in their practices. Lectures on various issues were conducted, contrasting opinions were delivered and the goals for teaching science in high school in general, chemistry in particular, were discussed. Furthermore, the teachers conducted qualitative mini-studies to establish a broad, external framework to support the needs of 'chemical literacy' for the public and to detect the impact and contribution of learning chemistry on students. This procedure implied what in-service could do for teachers' professional developments (Shwartz et al, 2005).

The teachers debated on whether to teach basic chemistry for all 10th graders in high school or not, and what contents they should teach in the basic chemistry at high school. At the beginning of the workshop, some of teachers insisted that the goal for teaching the basic chemistry was actually a preparatory one to help students who would take applied chemistry and eventually matriculation examination. However, over the workshop they developed the meaning of chemical literacy in the context of teaching science, and changed their perception on the goal of teaching basic chemistry for all 10th graders taking the course.

The chemistry teachers then reached a general understanding that 'chemistry explains phenomena in terms of the microscopic structure of matter.' They defined a chemically literate person as a graduate of the basic chemistry course (that is, 10th grader). They also reconsidered the general ideas as a core chemical content that was needed for 'chemical literacy' and finally, they broadened their perceptions of chemical literacy so that the context, skills, and affective aspects as well as conceptual knowledge were part of 'chemical literacy'.

They analyzed the content of the basic chemistry course and concluded that it offered a relatively narrow understanding of 'what chemistry is all about' by focusing on mainly the structure and properties of matter. As a result, they recommended that the basic chemistry should introduce a wide range of chemical ideas, such as chemical reactions involving energy changes. They also recommended that 'an appreciation of the chemical language was needed, but the domination of specific terms is not.' This was suggested in order to minimize the preparatory character of the basic course, and to reduce the difficulties for non-science-oriented students to learn chemical symbols and chemical language.

Shwartz et al (2005) broadly defined science literacy as having scientific attitudes and scientific reasoning skills. A scientifically literate citizen should be able to evaluate the quality of scientific information on the basis of its source and the methods used to generate it. Scientific literacy also implies the capacity to pose and evaluate arguments based on evidence and to apply conclusions from such arguments appropriately. In this perspective, the pedagogical strategies for promoting scientific reasoning skills, namely higher level thinking skills and critical thinking skills should be emphasized in science education. However, it is not easy as it sounds to promote this kind of science literacy because the teaching practice for promoting it requires science teachers to have deep understanding of pedagogy as well as discipline. What is more, there are practical barriers for a change to promote science literacy for the public in teaching science at high school. In this sense, the study conducted by Shwartz et al (2005), offered a valuable opportunity to reflect on the teaching of chemistry in high school classroom.

'The chemistry in context' was particularly, considered deeply by the teachers. They learned that the second dimension of 'chemical literacy' was the ability to see the relevance and usability of chemistry in everyday life. Students should be able to use understanding of chemistry in decision-making, and in participating in a social debate regarding chemistry-related issues. A chemically literate student should understand the relation between innovations in chemistry and other applications such as medicine, agriculture, and environmental engineering. Thus, they came to introduce context-based approach in the chemistry curriculum, but it was out of their ability to change them. However, according to the article some of the teachers were participating in the syllabus committee to offer their opinions as a result of this workshop.

Additionally, many other pedagogical suggestions were made during the workshop. For example, the teachers came up with the idea that using newspaper articles for guided reading in the basic chemistry classroom should be helpful to promote their critical thinking skills. The teachers analyzed the ‘chemical literacy’ components represented in an article, composed questions for students, and discussed the way ‘critical reading’ could be developed during such an activity. Also, the teachers came up with the ideas that to help students understand the nature of science, it should be taught throughout the whole process of teaching chemistry; and the goal in laboratory work was to encourage our students to ask inquiry questions.

With regard to the analysis of practical barriers to a future change of practice, many chemistry teachers wanted students to think of chemistry as the elitist discipline so that they had highly achieving students in their classrooms and they were recognized as competent teachers. The teachers in the workshop eventually changed their perceptions on the goals of teaching the basic chemistry in high school and decided to implement their new understanding of chemical literacy in their institutions.

Science literacy has two important roles in science education. One is in deciding what content science courses should include. The other is in suggesting pedagogy that helps students develop thinking skills and scientific attitudes. In this information age, we should take more responsibility for developing the ability of our students to think rationally and critically about chemistry-related issues, especially those who do not intend to take any more chemistry in the future. Although we science teachers have a variety of perceptions toward science literacy, it is obvious that attainment of science literacy for all students is the main goal of the current reform in science teaching (Shwartz et al, 2005).

Studies on the Relationship between Teachers' and Students' Perception

Results of studies on the relationship between students' and teachers' perception in science have been equivocal. Literature has indicated that evaluation of perceived difficulties of participants in a given area of study makes use of test and non- test methods. The test may be

1. Multiple choice test items (objectives)
2. Short answer test items (subjective)
3. Use of internal and external examination outcomes.

The non-test methods include

1. Observations
2. Interviews
3. Questionnaires

The non-test method was used by Leece (1976) to obtain students' and teachers' perception of the level of difficulty of all the 19 curriculum topics of an "A" level Nuffield chemistry. The respondents had to indicate the difficulty of each of the topics on a 4-point Likert scale. [The responses ranged from "much harder than average" to "much easier than average"]. An approximate facility index was calculated for each topic resulting in high positive rank correlation between teachers' and students' perception of the topics. This was contrary to the general expectation of negative correlation between teachers' and students' perceived chemistry topics. Students' interest in amount of substance was lowest but highest in atomic structure and carbon chemistry. Topics in physical chemistry listed as difficult included equilibrium and free energy, and equilibrium involving redox and acid base systems as well as gaseous and ionic systems, energy changes and bonding. Amount of substance and periodicity were among the easiest. These difficult topics require a wide range of mathematical skills and knowledge of many basic chemical concepts including molarity of solutions, mole concept, and ionic equation and balancing of chemical equations.

Furniss (1977) used a combination of tests non-test method to investigate difficulties encountered in chemistry. Two sets of students were involved in the study – sixth formers and first year chemistry undergraduates. Both groups took two sets of tests. The sixth formers had a test before the final examination and another test a month after the final examination. A section of the paper inquired about topics they had found difficult, easy or enjoyable while their teachers' problems and attitudes towards the 'A' level chemistry were also investigated.

The undergraduates had one test before and the other after the year ended. Only their perception of organic chemistry was tested. The perceptions of teachers and students in the sixth form group were at variance. Thus while students indicated that carbon chemistry, energy changes and bonding were difficult to learn, teachers indicated that these were easy to teach. Two other areas which students had difficulty with were reaction rates, equilibrium and free energy. The teachers also regarded periodicity and atomic structure as easy to teach. In organic chemistry, functional groups, structure, isomerism and nomenclature were found to pose difficulties. This study recommended the necessity to relegate certain topics from the sixth form chemistry with the caution that the harm that may be done by material that is incorrectly learnt and misunderstood is difficult to right and hinder subsequent learning. Besides, some of the teachers involved in the survey admitted their lack of knowledge in certain aspects of chemistry. A much simplified non-test method, which does not even relate to topics in science was used by Dunne and Rennie (1994) to obtain students' perceived difficulty in science as part of a broader survey on gender, ethnicity and science. The statements;

"Science is too difficult for me"

"I find science easy to understand" had to be completed with responses ranging from "very difficult" to "very easy".

The simplicity of the study on perception gives evidence that when afforded the opportunity, students' readily provide their perceptions of a given topic. In Ghana the non-test method has been used by Apafo (as cited in Wood, 1994) to explore the perceived difficulties of students with the 'O' level chemistry. Anamuah-Mensah (as cited in Wood, 1994) used the same method to investigate teachers' reactions to the 'A' level chemistry syllabus. Both studies were necessitated in part by the relatively low achievements by students in the final examinations. In both studies, the instruments used consisted in part, of the topics in the respective syllabuses to which the respondents reacted. The 'O' level group made up of both remedial and lower six form students had to indicate which topics were easy or difficult to grasp, never grasped or not taught. The study revealed that, students had difficulty with almost all the topics. Solubility. electrolysis, redox reactions, energy changes, metals and non-metals were found to be among the most difficult to grasp by students. Organic chemistry was not listed. Since the respondents were not given the chance to indicate possible sources of some of their difficulties; they were limited in attributing their difficulties to either the nature of the topics or the intellectual developmental level of the students. The teachers had to indicate which topics were taught with ease or difficulty and which were not taught and reasons for any difficulties. The result showed that teachers had difficulty with orbital nature of atoms, benzene and its aromatic systems and they did not teach many topics in the application section as they spent too much time on principles. The reasons given by less than 20% of the sample for finding a topic difficult included the following;

1. Too many topics in the syllabus
2. Teaching period being too short
3. Being comfortable with certain aspects of the topics
4. The abstract nature of some topics
5. Lack of reference books.

In this study, the non-test method based on respondents' reaction to the topics of the syllabus was adopted. Its advantage over the test method is its time and cost effectiveness. Its limitation is that, it cannot unlike the test method, isolate either the causes or the exact problems causing a respondents difficulty on specific topics.

Shaibu and Olarewaja (2007) for instance in their study which sought to find the perception of difficult biology concepts among senior secondary school students' and teachers' found that there was no significant relationship between the students' and the teachers' perception of the difficult biology concepts. However earlier study by Shaibu (1988) on the relationship between teachers and students perception on chemistry found out that there was a statistically significant difference between their perceptions. Shaibu and Olarewaja (2007) therefore suggested that:

"The question of whether or not significant differences exist between the perception of students' and their teachers regarding the conceptual difficulty levels of various school subjects need further investigation and clarification in the continued search to improve the quality of teaching and learning of science generally and biology specifically" p. (131)

According to Adediwura and Tayo (2007), students' perception of teachers' knowledge of subject matter, attitudes to work and teaching skills is absolutely dependent on the fact that they have been taught by the teachers under evaluation and are familiar with them. They therefore, have minds already pre-occupied with memories and reactions that inventory for data collection would measure. Perception may be energized by both the present and past experience, individual attitude at a particular moment, the physical state of the sense organ, the interest of the person, the level of attention, and the interpretation given to the perception.

Eggen and Kauchak (2001) highlighted three headings under which a study on teachers' knowledge of subject matter can be done. These are namely: knowledge of content, pedagogical content knowledge and general pedagogical knowledge. It is a statement of fact that nobody can teach what he does not understand. It has been established that there is high correlation between what teachers know and what they teach (Wilson cited in Adediwura

& Tayo, 2007). Thus, the ability to teach effectively depends on the teachers' knowledge, and knowledge occurs in a variety of forms. Teacher effectiveness is impeded if the teacher is unfamiliar with the body of knowledge taught and when teachers' effectiveness is subject specific. The implication of this for teachers is that they must thoroughly understand the content of what they teach. The teacher whose understanding of topic is thorough use clearer language, their discourse is more connected, and they provide better explanation than those whose background is weaker. The way the students perceive the teachers in terms of their (teachers) knowledge of content of subject matter may significantly affect the students' academic performance (Adediwura & Tayo, 2007). Pedagogical content knowledge depends on an understanding of a particular topic and how to explain it in a way that it will make sense to the students. Pedagogical content knowledge implies, an understanding of ways of representing the subject matter that make it comprehensive to others and an understanding of what makes the learning of specific topics easy or difficult. Eggen and Kauchak (2001) declared that where pedagogical content knowledge is lacking, teachers commonly paraphrase information in learners' textbooks or provide abstract explanations that are not meaningful to their students. From evidences available in literature, it is clear teachers' knowledge of subject matter is highly essential for effective teaching. Ehindero (1990) confirmed that a teachers' teaching is influenced by the level of his pedagogical knowledge, as different from his subject matter knowledge. It is to be noted that pedagogical knowledge is not exactly the same thing as knowledge of subject matter. They nevertheless are, intimately linked, because teachers' mastery and use of them in the classroom would indicate the depth of their knowledge of subject matter.

Lang, Wong and Fraser (2005) investigated the chemistry laboratory classroom environment, teacher–student interactions and student attitudes towards chemistry among 497 gifted and non-gifted secondary-school students in Singapore. The data were collected using the 35-item Chemistry Laboratory Environment Inventory (CLEI), the 48-item Questionnaire on Teacher Interaction (QTI) and the 30-item Questionnaire on Chemistry-Related Attitudes (QOCRA).

Results supported the validity and reliability of the CLEI and QTI for the sample. Stream (gifted versus non-gifted) and gender differences were found in actual and preferred chemistry laboratory classroom environments and teacher–student interactions. Their study was to, validate the Chemistry Laboratory Environment Inventory (CLEI) and Questionnaire on Teacher Interaction (QTI) among Grade 10 students in Singapore; investigate stream (gifted versus non-gifted) and gender differences in classroom environment perceptions on

(a) the actual and preferred forms of the CLEI,

(b) the actual form of the QTI.

and investigate associations between student attitudes to chemistry and students' perceptions on

(a) the CLEI,

(b) the QTI.

As this was the first study conducted in Singapore's gifted chemistry classrooms, the findings of the study could provide useful information for the teaching of the gifted and about the psychosocial aspects of the chemistry laboratory learning environment for the gifted (Lang et al, 2005). Based on the students' perceptions, the findings related to the chemistry laboratory learning environment and to teacher–student interactions are particularly useful to the administrators, teachers and other stakeholders. Lang et al (2005) found out from the teachers' perspective that the findings could help chemistry teachers to reflect on the various aspects of the chemistry laboratory, their interactions with students and their teaching approaches in the environment. For the students, the findings also provided a better understanding of the students' perceptions on their existing and ideal chemistry laboratory classroom learning environment and the teacher–student interactions that could help the gifted, as well as the non-gifted, to learn better in the future. They also found out that associations between student attitudes and open-endedness suggested that it could be desirable for educators to consider creating a more open-ended learning environment for the teaching and learning of chemistry in secondary schools. A further implication would be that we might redesign our chemistry curriculum by customizing instruction to meet the learning needs of learners, incorporating more lively and practical approaches and infusing scientific inquiry, creative and critical thinking skills into both the theoretical and the laboratory work (Lang et al, 2005).

According to Lang et al (2005) open-endedness and material environment were significant predictors of gifted students' attitudes to chemistry. Open-endedness could be beneficial in establishing a unique and an enjoyable learning environment for the gifted. The first practical implication of this finding is that teachers might attempt to adopt more open-ended approaches in their teaching and improve the quality of the material environment in the chemistry laboratory in order to meet the learning needs of gifted students. The findings based on using the CLEI showed a preference by the gifted for a more open-ended and a better-equipped laboratory class. These findings suggest that teachers might adopt a more creative teaching and learning approach in the gifted classroom as a necessary move. The teachers concerned ideally would establish an intellectually-stimulating environment and design an appropriate chemistry curriculum for the gifted. Students could be asked to and expected to be thinking critically and creatively across all curriculum areas. Also, teachers might use a variety of resources and materials to create divergent learning tasks or situations. Because the findings also showed that the open-endedness dimension was positively correlated with students' chemistry-related attitudes, the use of such divergent approaches to teach the gifted is likely to help them thrive (Quah & Teo, 1994).

The findings with the QTI showed that we need to be more aware of dynamic teacher–student interactions taking place in the classroom with an understanding of the dynamics of the communication process, we can learn to manage the learning environment more effectively. This study also showed that the interpersonal behaviour of teachers had an impact on the students' attitudes towards chemistry.

This study like those reviewed in the literature (Ampiah, 2001; Wood, 1994; Shaibu 1988; Shaibu and Olarewaja, 2007) also made use of non-test method to evaluate the perceptions of students and teachers on difficult topics in organic chemistry section of the chemistry syllabus. In this study the questionnaire survey was used to collect data from a cross section of teachers and students. The details of the methodology are presented in the next chapter (Chapter Three).

CHAPTER THREE

METHODOLOGY

Introduction

In this chapter, the research design, population, sample, sampling procedure and instruments that were used to collect data are discussed. The chapter also provides information on how the reliability and validity of the instruments were determined, the procedure for the collection of data and the method used for the analysis of data.

Research Design

This study used the descriptive survey design to determine SSS chemistry students’ and teachers’ perception of the level of difficulty of organic chemistry topics. A survey attempts to collect data from members of a population in order to determine the current status of the population with respect to one or more variables (Gay, 1992). The purpose of the survey design was to identify organic chemistry topics which are perceived as difficult to understand by students and difficult to teach by teachers; and whether the perception gender related.

The design involved both SSS chemistry students’ and teachers’ groups from ten senior secondary schools in the Central Region of Ghana.

This design has an advantage of producing good amount of responses from a whole range of people (Best and Khan, 1995).

Survey includes studies that use questionnaires or standard interviews for data collection with the intent of generalizing from a sample to a population (Babbie, 1990). The survey questionnaire designed included both closed-ended and an open-ended questions. This was administered to both SSS chemistry students in their final year and SSS chemistry teachers.

This study however sought to elicit information from SSS chemistry students and their teachers about their perception of organic chemistry topics. The independent variables were gender, type of respondents and type of schools, whilst the level of perception for the students and teachers group was the dependent variable. The rationale for the choice, for a descriptive survey design (only questionnaire) was because it is economical and turnover in data collection is rapid (Fowler, 1988).

Population

The study targeted SSS3 students offering chemistry and their chemistry teachers in both public and private secondary schools in Central Region. There were 49 SSS in Central Region in 2004/2005 academic year. Eighteen out of the 49 SSS offered courses in chemistry, physics and biology. Of these schools, three were boys’ schools, three were girls’ schools and 12 were coeducational. The Central Region was chosen for study due to proximity and researcher’s familiarity with the area. There were about 2,400 SSS3 chemistry student and 50 chemistry teachers in all the 18 Senior Secondary Schools in the Central Region in 2004/2005 academic year.

Sample

The schools comprised of three boys' schools, three girls' schools and four co-educational schools. Thirty third year SSS students were selected from each of the 10 schools to make the total number of students in the sample 300 out of about 1600. This is because the average number of students' in a class was about 40. The table of random numbers was used to select the sample. All chemistry teachers of the schools selected formed part of the sample. In all 35 chemistry teachers and 300 students of SS3 in 10 selected SSS were purposively selected as sample for the study. This is because, at the time of the data collection, only 10 schools (made of three boys' schools, three girls' schools and four co-educational) had treated organic chemistry.

Sampling Procedure

All the 18 SSS were visited to determine whether or not they had treated organic chemistry. At the time of the visit, 6 schools were still treating organic chemistry; one school had elected not to teach it at all. The ten out of the eleven SSS that had already treated organic chemistry were therefore selected as sample for the study. This is because one of the schools was used for pilot testing of the instruments. The simple random sampling technique was used to select a class from each of the selected schools having more than one science class. All the chemistry teachers in the selected SSS also formed part of the sample of the study.

Thirty chemistry students were sampled from each selected SSS single sex school using the table of random numbers. In the four co-educational institutions stratified random sampling procedure was used to select students. Each of the two sexes formed a stratum from which the table of random numbers was used to select the required number of students (ie.15 boys and 15 girls). This procedure made it possible for both female and male students to be fairly represented. This gave all students of the selected SSS an equal chance of being included in the sample. The sample was made up of chemistry students of which, 150 were males and 150 females. Ninety out of the 150 males were from boys' schools whilst the remaining 60 were from the mixed schools. Similarly ninety out of the 150 females were from girls' schools whilst the remaining 60 were from the mixed schools. The average age of the students was about 18 years with standard deviation of 0.9 years. There were 35 chemistry teachers involved in the study. This was made up of 10 teachers (constituting 28.6% of them) from only girls' schools, 13 teachers (37.1%) from only boys' schools and the remaining 12 teachers (34.3%) from coeducational schools. The average age of the teachers was about 37 years with the standard deviation of about 0.9 years. Their average teaching experience was about ten years with standard deviation of 0.8 years.

Instruments

The questionnaire was the main instrument used for this study. Questionnaire was chosen because it is effective in securing information from the respondents (Macmillan, 1996). The questionnaire could be completed at the respondent's own convenience. Moreover, it offers assurance of anonymity. According to Wallen and Fraenkel, (1991), designing one's own instrument is time consuming, and do not recommend for those without a considerable amount of time, energy and money to invest in the endeavor. Choosing an instrument that has already been developed takes far less time than it does to develop a new instrument to measure the same thing, therefore, selecting an already developed instrument when appropriate, is preferred. Such instruments are usually developed by experts who possess the necessary skills (Wallen & Fraenkel, 1991).

Based on that, the structure of the instruments were adapted from previous studies in the area of perceptions (Ampiah, 2001; Wood, 1994) and modified to suit the present study.

Students' Perception of Organic Chemistry Topics Instrument

The students' perception of organic chemistry questionnaire (SPOQ) was used in a survey to secure information from the SSS3 students on their perception of organic chemistry topics. The SPOQ (Appendix A) was based on the WAEC SSS elective chemistry syllabus and it included both closed-ended and open-ended questions.

The SSS students' instrument had 35 items. Items 1 and 2 were used to gather background information on age and gender. Items 3 – 33 which covered all the topics under organic chemistry. To respond to the items, the respondent was required to indicate his or her perception of understanding of each of the listed topics on a five (5) point likert scale. Thus, 5 was assigned if the respondent had a positive perception toward the topic, that is, if the respondent found the topic very easy to understand; 4 was assigned to topics found easy to understand; 3 corresponded to topics understood only after a considerable effort; 2 also corresponded to topics found difficult to understand and 1 was assigned to topics not taught. Items 34 – 35 solicited free responses on one (1) difficult topic and reasons for the difficulty.

The validity is concerned with the extent to which an instrument measures what it is intended to measure (Ebel & Fresbie, 1995). Supervisors and postgraduate colleagues in the area of science education went through the items to determine if the items measure the intended content area (face validity) and whether they cover the whole content area (content validity). The comments and suggestions from the experts were helpful in the modification of items in the questionnaire. Furthermore, the factors that contribute to low validity such as unclear directions, and ambiguities in language were eliminated.

The reliability of a measuring instrument is the degree to which that instrument consistently measures whatever it measures (Gay, 1992).

The SPOQ was trial tested in the third term in one of the schools (unknown to other schools) that had treated organic chemistry. The SPOQ was trial tested using 40 chemistry students. Their responses was analysed to test for the reliability of the SPOQ. This was found to be high enough to make the SPOQ items reliable.

The selection of the school used for the pilot testing was based on the table of random numbers. The selection of chemistry students was by simple random sampling. The reliability coefficient of the SPOQ was determined using the Cronbach's alpha. The value of the reliability coefficient was found to be 0.94. This is a measure that assesses the internal consistency of an instrument. The internal consistency tells of how consistent items measure the same dimension of an attribute.

Teachers' Perception of Organic Chemistry Topics Instrument

The teachers' perception of organic chemistry questionnaire (TPOQ) was used in a survey to secure information from the SSS chemistry teachers on their perception of organic chemistry topics. The TPOQ (Appendix B) was based on the WAEC SSS elective chemistry syllabus. The TPOQ included both closed-ended and open-ended questions.

Teachers' instrument had a total of 37 items. The first four items asked for background information on gender, age range, academic qualification and teaching experience. Items 5 – 35 covered all the topics under organic chemistry. To respond to the items, the respondent was required to indicate his or her perception of teaching of each of the listed topics on a three (3) point likert scale. Thus, 3 was assigned if the respondent had a positive perception toward the topic, that is, if the respondent found the topic very easy to teach; 2 also corresponded to topics found difficult to teach and 1 was assigned to topics not taught. Items 36 – 37 solicited free responses on topics which in teachers' opinion, students have difficulty with and reasons that accounted for the difficulty.

Expert judgment of senior members in the field of science education was sought on the content and face validities of the instrument (Wallen & Fraenkel, 1991). The comments and suggestions from the experts were used in restructuring the items. To ensure the validity of the instrument, the factors that contribute to low validity such as unclear directions, and ambiguities in language were eliminated. The TPOQ was also trial tested in the third term in the same school where the SPOQ was also trial tested. The TPOQ was trial tested using six 6 chemistry teachers. Their responses was analysed to test for the reliability of the TPOQ. This was found to be high enough to make the TPOQ items reliable.

The reliability coefficient of the TPOQ was determined using the Cronbach's alpha. The value of the reliability coefficient was found to be 0.87.

Data Collection Procedure

The heads of the selected SSS were visited and permission sought to undertake the study. Their various heads of institutions notified the heads of chemistry departments in the selected schools. A meeting with the head of chemistry department of each of the selected SSS was held to arrange the time that would be convenient for the questionnaire to be administered. The selection of respondents was done a day prior to the administration of the instrument. The purpose and relevance of the study were explained to all the respondents involved in the study immediately after the selection of those respondents.

The instruments were hand-delivered to each of the schools involved in the study on the day of administration of the instrument. The administration of TPOQ was done in the staff common room. In all cases the teachers were asked to read carefully through the instructions and the items before responding. Each item had three levels of the Likert scale. The instruction required teachers to tick only one of the three levels to reflect their perceptions of the topic as either easy or difficult to teach. The TPOQ was administered during normal school hours.

The administration of the SPOQ was done immediately after the teachers had completed theirs. This took place in their respective classes for each school. In all cases the respondents were asked to read through the instructions and the items very carefully before responding by ticking one of the five levels of the Likert scale to reflect their perceptions of the topic; that is the degree of their understanding of the topic. The SPOQ was also administered during normal school hours. It took three weeks to administer the TPOQ and SPOQ.

Data Analysis

The data was analysed using the research questions as guide. This was then organised and coded with various numbers assigned to each distinctive variable such as age, gender among others for students and also gender, age range, academic qualification among others with respect to teachers. Inputs were made of the coded data using the Statistical Package for the Social Sciences (SPSS) computer software for analyses, with the data appropriately and completely coded. Data was analysed in terms of percentages, means, standard deviation, t-test and Pearson's correlation.

The t-test is the main statistic that was used to test the first hypothesis. The t-test is deemed appropriate since it is used to determine whether a significant difference existed between the two groups being compared. Here male students' and female students' perceptions of the level of difficulty of organic chemistry topics were compared for all the ten schools. Boy schools and girl schools perceptions of the level of difficulty of organic chemistry topics was also compared. Finally male and female students' perceptions of the level of difficulty of organic chemistry topics was compared; for all the four coeducational schools and within each of the mixed schools.

The Pearson's correlation was used to test the fourth and fifth hypothesis. This was used to determine whether there existed any correlation between the teachers' perception and the students' perception of difficult organic chemistry topics. The Pearson's correlation was also used to find out if there was a relationship between male and female students' perception on the difficult organic chemistry topics. A correlation coefficient of $-1<r<0$ implied the two groups being compared are inversely related. A correlation coefficient of $0<r<1$ also implied a direct relationship existed between the two groups being compared. A correlation coefficient of zero ($r=0$) implied no relationship existed between the two groups being compared.

In addition to that, frequency count (percentages) was also used to discuss students' and teachers' perception of organic chemistry topics, as well as the open ended questions in both SPOQ and TPOQ. The details of the data analysis are presented in the next chapter (Chapter four).

CHAPTER FOUR

RESULTS AND DISCUSSION

Introduction

In this chapter, the results of the study and the discussions of the findings are presented. The analysis and discussion of the results are based on the research questions and hypotheses.

SSS Chemistry Students' Perception of the level of Difficulty of Organic Chemistry Topics

Research Question one sought to find out SSS chemistry students' perception of the level of difficulty of organic chemistry topics in the SSS chemistry syllabus. In order to address this research question, students were asked to indicate their responses to the items on a questionnaire SPOQ.

It must be noted that, in scoring students' responses on the Likert scale items, "not taught" was scored 1 point, which is the minimum on the scale; "difficult to understand", was also scored 2 points; "understood only after considerable effort" 3 points; then followed by "easy to understand" 4 points; and "very easy to understand" was scored 5 points, which is the maximum on the scale.

The total score for the SSS chemistry students' responses to the difficulty level of organic chemistry topics was computed using SPSS. The expected minimum total score was 31 and maximum total score expected was 155. The result yielded a minimum total score of 37 and a maximum total score of 151 with a total mean score of 97.5. This shows that the SSS chemistry students' perception of the level of difficulty of organic chemistry topics was generally, slightly positive. This is an indication that the SSS chemistry students generally understood organic chemistry topics after considerable effort. When the number of organic chemistry topics divides the mean total score, the result is the overall mean that is about 3.2.

It seems from the result that SSS chemistry students' perception of organic chemistry has seen slight improvement. Previous findings from literature indicated a negative students' perception of organic chemistry. This result is at variance with the findings of Wood (1994) and Draphor (1994), who studied Senior Secondary School Students' perception of chemistry topics and indicated that chemistry students had difficulty with organic chemistry in general.

Table 2 indicates that only 6 out of the 31 topics in organic chemistry were easy for students to understand ($\overline{X} > 3.4$). These 6 topics are all part of the introductory topics. Teachers probably had ample time to effectively teach the students. Even though the topic "separation and purification" happens to be one of the introductory topics in organic chemistry, students did not find it easy to understand. Nonetheless, they understood it after considerable effort. This may be due to the fact that talk and chalk method of instruction was not much and possibly it was all about copying of notes issued by the teachers with probably inadequate explanation. This is evidenced in item two (2) of the teacher factor (Appendix C). Twenty-four of the organic chemistry topics were understood after considerable effort ($2.5 < \overline{X} < 3.5$). Fats and oils as esters, sources, physical and chemical properties of fats and oils, polymers and polymerization, each recorded a mean of 2.6, which was the least in this category whilst the topics, “sources and properties of alkenes”; sources and uses of alkynes; physical properties of alkanols also recorded a mean of 3.4 each, which was the highest in this category. This presupposes that, majority of the students probably tried to understand most of these topics by either reading on their own or solicited help through other chemistry teachers or colleagues who are very good in class. Difunctional nature of amino acids was the only topic SSS chemistry students found difficult to understand. The mean score was 2.1.

Table 2 again shows that more than 20% of the students, indicated that 5 topics, namely; classification and nomenclature; determination of empirical and molecular formulae; homologous series; sources and properties of alkanes; uses of alkanes were very easy to understand. In addition more than 42% of the students indicated the 5 topics already mentioned were easy to understand. Only 1% of the students indicated that difunctional nature of amino acids was very easy to understand.

Four topics, namely, difunctional nature of amino acids (DNA); chemical properties of benzene (CPB); structure and physical properties of benzene (SPPB); laboratory detection of alkenes (LDA) were found to be difficult by more than 20% of the students.

This is in agreement with the findings of Ampiah (2001) who studied Students’ perception of topics in Senior Secondary School Chemistry Syllabus and indicated that the topics, such as benzene, amino acids among

Table 2

Responses of Students' Perception of the Difficulty level of Organic Chemistry Topics in SSS Chemistry Syllabus (N=300)

No	Topics	VEU (%)	EU (%)	UCE (%)	DU (%)	NT (%)	$\overline{X}$	SD
1	Classification and nomenclature	24.7	45.7	22.7	6.3	0.7	3.9	0.9
2	Separation and purification	10.0	31.0	32.0	12.7	14.3	3.1	1.2
3	Determination of empirical and molecular formulae	33.3	42.7	16.7	6.7	0.7	4.0	0.9
4	Homologous series	23.7	45.0	23.3	7.3	0.7	3.8	0.9
5	Isomerism	16.7	42.7	31.0	9.0	0.7	3.7	0.9
6	Sources and properties of alkanes	20.3	44.3	26.3	8.0	1.0	3.8	0.9
7	Uses of alkanes	23.7	49.3	21.0	3.7	2.3	3.9	0.9
8	Petroleum	9.3	29.0	37.0	9.7	15.0	3.1	1.2
9	Sources and properties of alkenes	11.7	38.7	36.0	10.0	3.7	3.4	1.0
10	Laboratory detection of alkenes	7.0	28.0	32.3	20.3	12.3	3.0	1.1
11	Sources and uses of alkynes	11.0	36.7	36.3	8.7	7.3	3.4	1.0
12	Structure and physical properties of benzene	6.3	21.3	37.7	22.3	12.3	2.9	1.1
13	Chemical properties of benzene	4.0	22.3	37.3	22.7	13.7	2.8	1.1

Table 2 continued

No	Topics	VEU (%)	EU (%)	UCE (%)	DU (%)	NT (%)	$\overline{X}$	SD
14	Sources, nomenclature and structure of alkanols	12.7	32.0	34.7	13.7	7.0	3.3	1.1
15	Classification of alkanols	12.7	32.7	35.7	12.3	6.7	3.3	1.1
16	Physical properties of alkanols	11.3	41.0	29.0	11.0	7.7	3.4	1.1
17	Chemical properties of alkanols	10.0	34.3	30.3	14.0	11.3	3.2	1.1
18	Laboratory test for alkanols	10.7	29.7	27.3	16.7	15.7	3.0	1.2
19	Sources, nomenclature and structure of alkanoic acids	11.3	31.7	28.7	16.7	11.7	3.1	1.2
20	Physical properties of alkanoic acids	7.7	35.3	35.0	10.0	12.0	3.2	1.1
21	Chemical properties of alkanoic acids	8.0	28.0	31.3	18.0	14.7	3.0	1.2
22	Laboratory test for alkanoic acids	9.3	28.3	27.7	15.3	19.3	2.9	1.3
23	Uses and properties of alkanoic acids	11.7	34.7	26.3	12.7	14.7	3.2	1.2
24	Sources, nomenclature and structure of esters	9.0	29.0	27.7	17.3	17.0	3.0	1.2
25	Physical properties of esters	8.3	27.7	30.7	14.7	18.7	2.9	1.2
26	Chemical properties of esters	5.3	23.0	36.7	15.7	19.3	2.8	1.2
27	Fats and oils as esters	4.7	19.7	36.3	13.0	26.3	2.6	1.2

Table 2 continued

No	Topics	VEU (%)	EU (%)	UCE (%)	DU (%)	NT (%)	$\overline{X}$	SD
28	Sources, physical and chemical properties of fats and oils	3.7	22.0	32.3	13.0	29.0	2.6	1.2
29	Soapy and soapless detergents	7.0	29.0	25.0	8.0	31.0	2.7	1.4
30	Difunctional nature of amino acids	1.0	11.3	21.0	25.7	41.0	2.1	1.1
31	Polymers and polymerization	7.0	17.3	33.0	18.0	24.7	2.6	1.2

Note: VEU-very easy to understand; EU-easy to understand; UCE-understood only after considerable effort; DU-difficult to understand; NT-not taught; $\overline{X}$ -mean; SD-standard deviation.

others were difficult for chemistry students to understand. Factors such as large class size, teaching and learning materials, lack of equipment for practical lessons may have contributed to these difficulties on the part of students. Most of the instructions lack the student-teacher interaction, which help the students to critically examine and articulate their thoughts in order to be independent. Basically, notes were dictated to students without ample explanation.

The four organic chemistry topics mentioned as difficult by students have been presented in bar chart as shown in Figure 1. This Figure compares male and female students' perception with respect to these four difficult

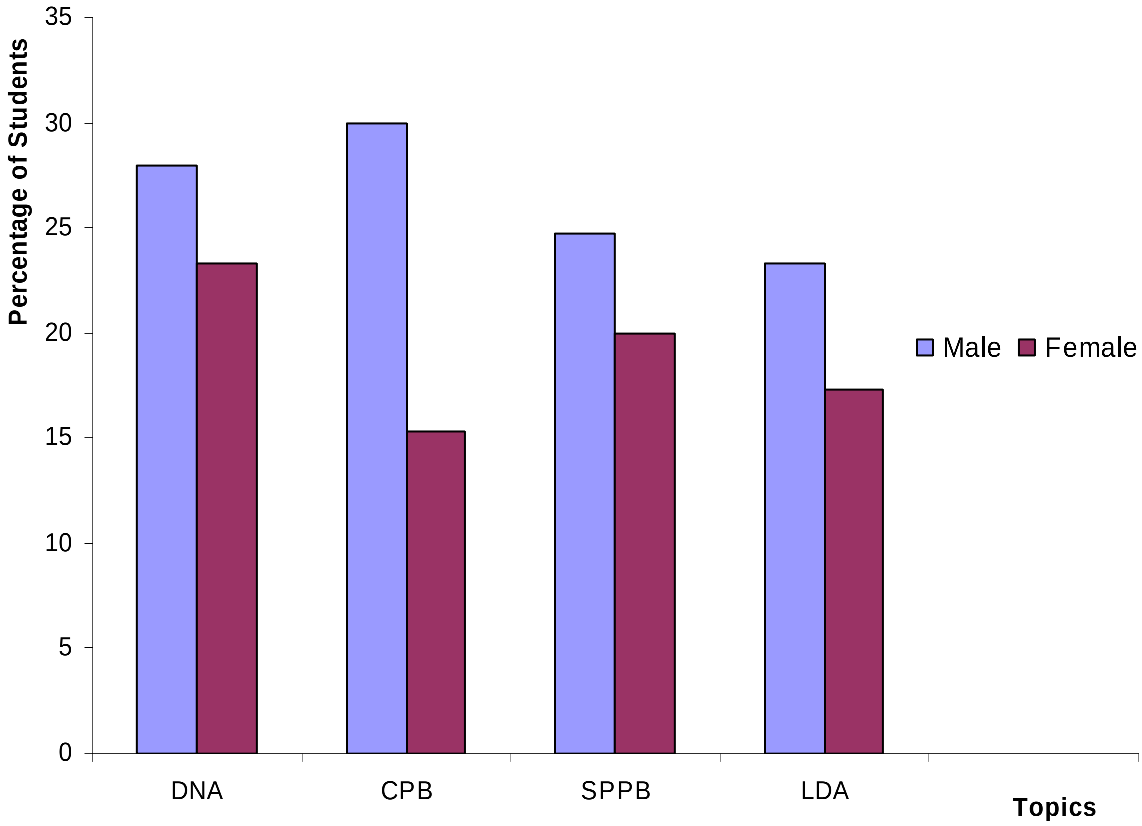

Figure 1: Topics students find difficult by gender

organic chemistry topics.

In each of the four topics, a higher proportion of male students found them difficult to understand compared to their female counterparts. In the case of chemical properties of benzene (CPB), the proportion of males who found the topic difficult was twice that of females.

Five topics, namely; difunctional nature of amino acids (41%), soapy and soapless detergents (31%), sources, physical and chemical properties of fats and oils (29%), fats and oils as esters (26.3%), and polymers and polymerization (24.7%) were not taught according to the students. Normally, organic chemistry is taught in the first term of the final year. Therefore, it is likely that most teachers skip the topics or just give notes on the topics to the students.

Figure 2 shows the topics that were not taught, according to the majority of students, in each of the schools. Majority of students in school I mentioned two topics (DNA and FOE) as not taught.

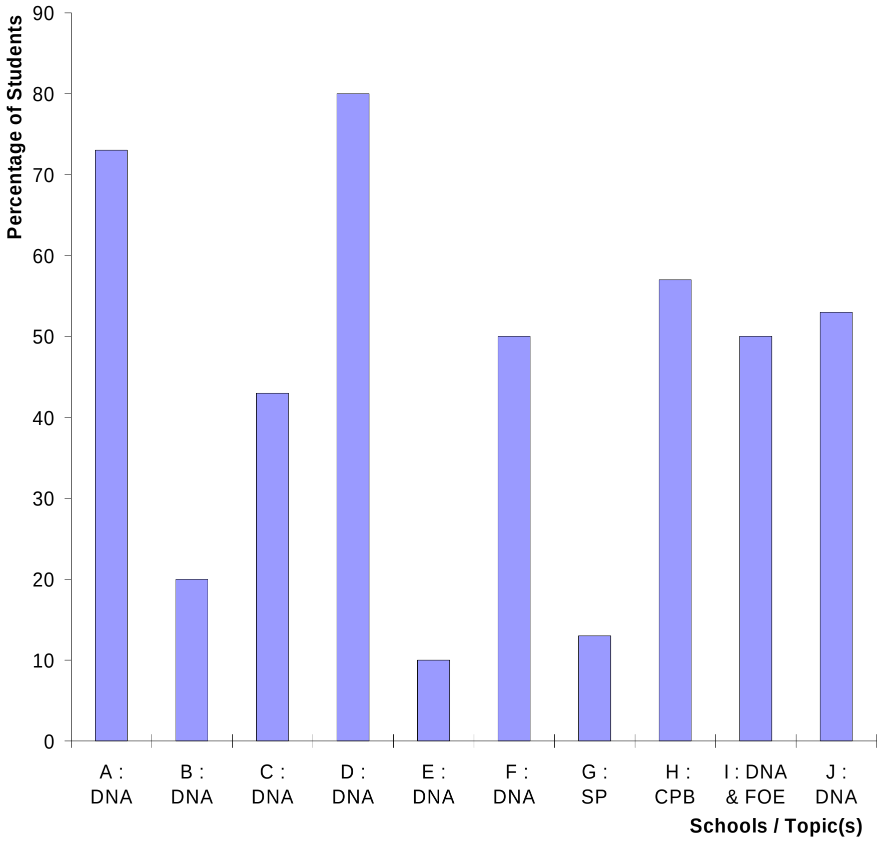

Figure 2: Topics not taught by school

Students in 8 out of the 10 selected SSS, mentioned difunctional nature of amino acids (DNA) as not taught. More than fifty percent of students in schools A and D indicated that difunctional nature of amino acids was not taught. This could mean that, schools A and D actually did not cover the topic difunctional nature of amino acids but the few students who had covered it, probably did so as a result of extra help elsewhere (extra tuition). Also, less than fifty percent of students in schools B and E indicated that difunctional nature of amino acids was not taught. This could also mean that, either the majority of the students in schools B and E had covered the topic by way of extra classes elsewhere or the topic was treated in class in the absence of the few students who indicated that the topic was not taught. School I mentioned fats and oils as esters (FOE) in addition to difunctional nature of amino acids as not taught, while in schools G and H students mentioned chemical properties of benzene (CPB), and separation and purification (SP) respectively as not taught.

Figure 3 shows the bar chart for two different schools A and D with considerable proportion of students that mentioned five organic chemistry topics as not taught. Apart from the topic polymers and polymerization (P&P) which recorded equal proportions of students from schools A and D; the rest of the topics, fats and oils as esters (FOE), sources, physical and chemical properties of fats and oils (SPCF), soapy and soapless detergents (SSD), and difunctional nature of amino acids (DNA) saw school D recording higher percentages than school A. Schools A and D had similar perception in polymers and polymerization.

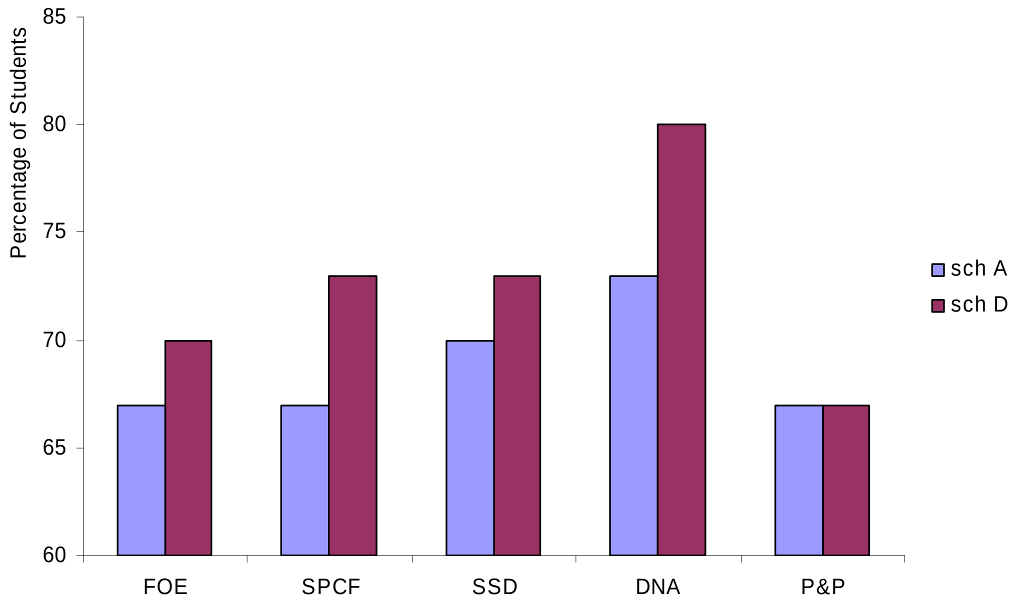

Figure 3: Topics not taught between school A and school D

SSS Male and Female Chemistry Students' Perception of the Level of Difficulty of Organic Chemistry Topics

The first research hypothesis sought to find out whether a significant difference existed between male and female chemistry students' perception of the level of difficulty of organic chemistry topics. In order to address this, male and female students were asked to provide their perceptions of the level of difficulty of organic chemistry topics in the questionnaire (SPOQ). An independent-samples t test was conducted to evaluate the hypothesis that no significant difference existed between the perceptions of male and female students about the difficulty level of organic chemistry topics. The results are presented in Table 3.

The test was significant, $t(298) = -2.62$, $p = 0.01$ indicating there was a significant difference between male ($\overline{X} = 94.4$, SD = 21.9) and female ($\overline{X} = 100.7$, SD = 19.8) students' perception of the difficulty level of organic chemistry topics.

Table 3

Difference between Male and Female Students' Perception of the Difficulty Level of Organic Chemistry Topics (N=300)

Groups Compared	$\overline{X}$	SD	df	t	P
Males	94.4	21.9	298	-2.62	0.01
Females	100.7	19.8			

Female students therefore found organic chemistry topics less difficult to understand than male students.

Figure 4 shows a box plot of male and female students' perception of organic chemistry topics. The male students had a wide range of mean ($37 < \overline{X} < 150$) than the female students ($50 < \overline{X} < 145$). Female students had a higher median ($\overline{X} > 100$) than the male students ($\overline{X} > 97$). The shaded box in Figure 4 shows that less than 50 percent of the male students are above the median score ($\overline{X} > 97$) and over 50 percent of the male students are below the median. This is an indication that fewer male students found organic chemistry topics easier to understand. In the case of female students, the shaded region shows that about 50 percent of female students were above the median ($\overline{X} > 100$) and the same percentage were below the median. Also, the interquartile range for males was higher than for females indicating that a wider variation in the way male students perceived the difficulty level of organic chemistry topics compared to how females did. One can tell from Figure 4 that more female students ($\overline{X} > 100$) found organic chemistry topics less difficult than the male students ($\overline{X} > 97$).

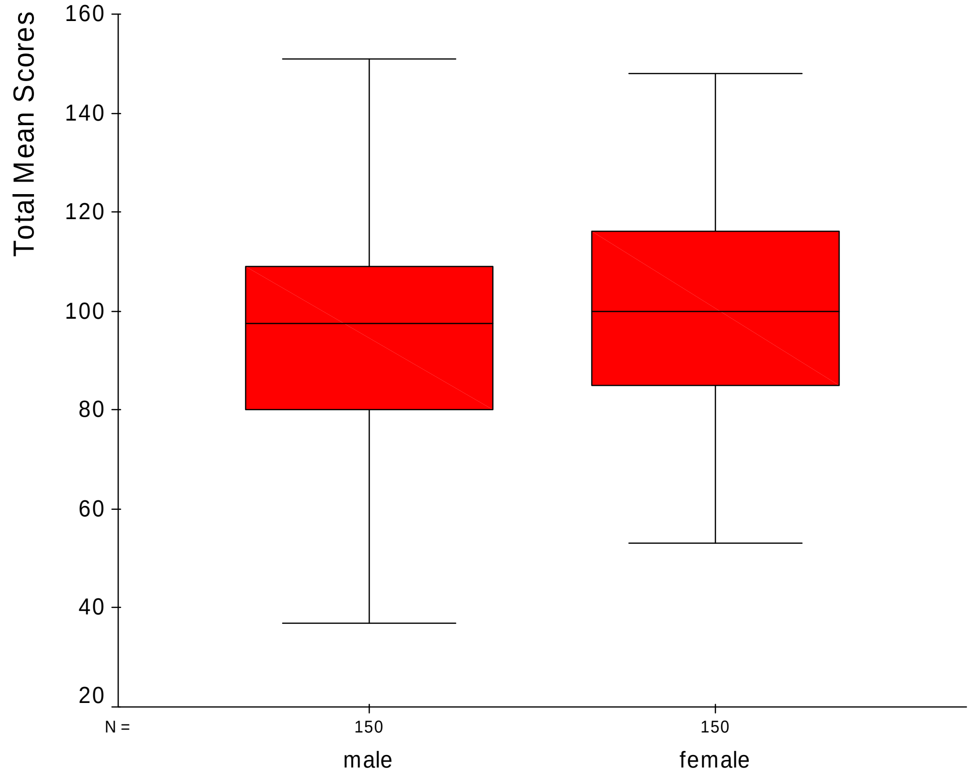

Figure 4: Male and female students' perception of organic chemistry topics

Table 4 also shows an independent-sample t test between male and female schools (Research hypothesis two). The test was significant, t (178) = -2.99, p = 0.003. This means a significant difference existed between the students' perception of organic chemistry topics difficulty in male schools and female schools. Female schools therefore found organic chemistry topics less difficult to understand than the male schools (Appendix E).

Figure 5 shows students' perception of organic chemistry topics in single sex schools. The mean of male schools ranged between $35 < \overline{X} < 135$ and that of female schools is $50 < \overline{X} < 150$. The ranges of values for both male and female schools are homogeneous.

Table 4

Difference between Students' Perception of the Difficulty Level of Organic Chemistry Topics in Male Schools and Female Schools Only (N=180)

Groups Compared	$\overline{X}$	SD	df	t	P
Male Schools	92.7	22.1	178	-2.99	0.003
Female Schools	102.3	20.8			

Here also, the female schools had higher median ($\overline{X} > 100$) than the male schools ($\overline{X} > 97$). The shaded portion in figure 5 shows that fewer students in the male schools are above the median. The very majority of them were below the median. This means very few students in the male schools found organic chemistry topics easy to understand. In the case of students in female schools, slightly more than 50 percent are above the median, an indication that majority of them found organic chemistry topics easy to understand.

One can tell from the box plot in Figure 5 that, students in the female schools found organic chemistry topics less difficult to understand than their colleague students in the male schools.

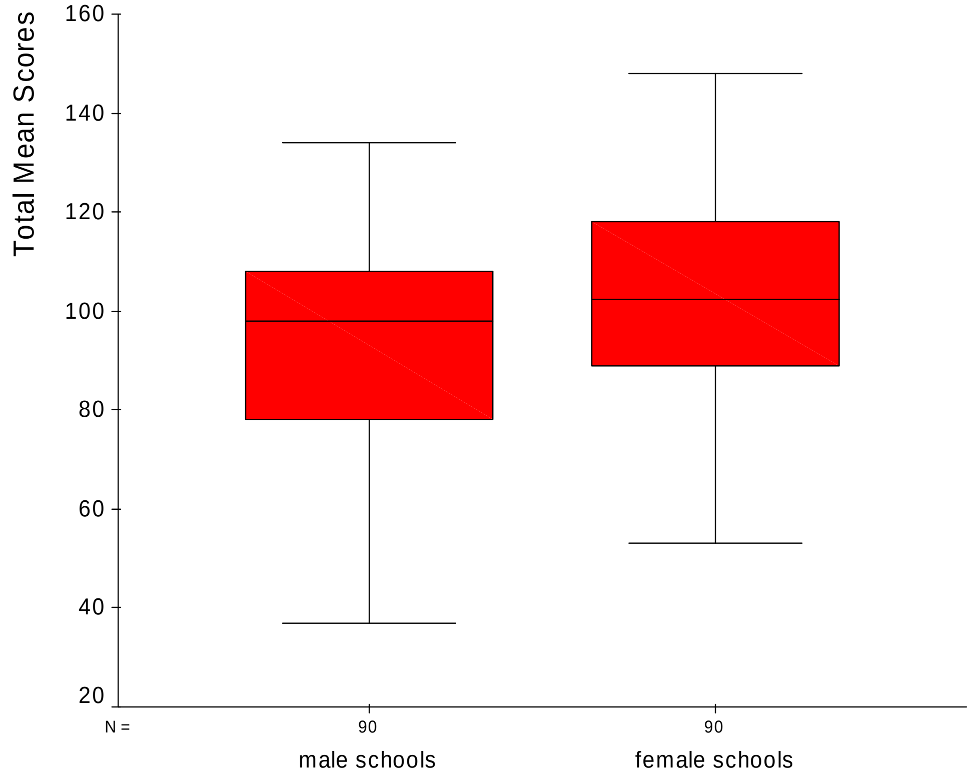

Figure 5: Students' perception of organic chemistry topics in single sex schools

An independent-samples t-test was also conducted to evaluate the hypothesis that no significant difference existed between the perceptions of male and female students of the difficulty level of organic chemistry topics in the mixed schools as shown in Table 5 (Research hypothesis three). The results presented in Table 5 indicate that no significant difference existed between male and female students' perception of the difficulty level of organic chemistry within the same schools. The null hypothesis was upheld in only mixed school. This implied that both male and female students' perception of difficult organic chemistry topics were basically the same in the mixed schools.

Figure 6 shows the students' perception of organic chemistry topics in mixed schools. The school I had a wide range of mean between $45 < \overline{X} < 140$

Table 5

Difference between Male and Female Students' Perception of the Difficulty Level of Organic Chemistry Topics in the Mixed Schools

School	Groups Compared	$\overline{X}$	SD	df	t	P
G	Male	102.73	18.8	28	-0.57	0.58
	Female	106.13	13.7			
H	Male	105.80	18.3	28	0.84	0.41
	Female	101.40	8.6			
I	Male	93.87	25.5	28	-0.17	0.87
	Female	95.40	25.1			
J	Male	84.93	17.9	28	-0.77	0.45
	Female	90.00	18.0			

followed by school J with mean ranging between $55 < \overline{X} < 120$. The ranges of mean values for schools I and J are homogeneous.

School G has a wider range of mean $(78 < \overline{X} < 130)$ than school H $(85 < \overline{X} < 120)$. The ranges of values for the schools G and H are not homogeneous. This is because schools G and H recorded extreme cases where three of the students from these schools had perception greater than the maximum; (One of the students from school G had $\overline{X} > 130$ and the other two from school H recorded $\overline{X} > 120)$ and one student from school H had perception below the minimum ($\overline{X} > 85$). The interquartile range for school I was highest, followed by school J then school G and lastly school H. This means there was a wider variation in the way students in school I perceived

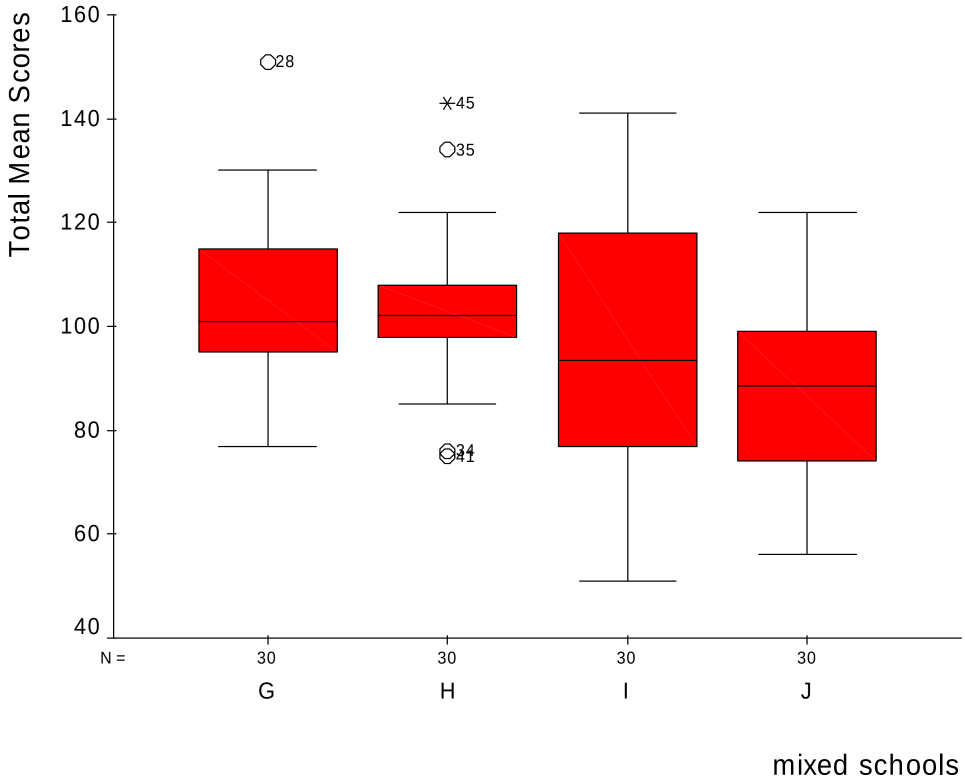

Figure 6: Students' perception of organic chemistry topics in mixed schools

the difficulty level of organic chemistry topics compared to how the students in other schools did.

The shaded region in school G indicated that majority of the students were above the median ($\overline{X} > 100$) and very few students were below the median ($\overline{X} > 100$). This shows that most of the students in this school understood the organic chemistry topics without much difficulty. Similarly, the shaded box in school H indicated that majority of the students were above the median ($\overline{X} > 103$) with a few of the students below it. This also means most of the students in the school found organic chemistry topics less difficult to understand. The shaded box in school I also recorded a median of $\overline{X} > 90$ with the majority of the students above it and a few of the students below the median. This also tells that majority of the students in this school found organic chemistry topics easy to understand. The shaded portion in school J shows that only a few students were above the median ($\overline{X} > 88$). This indicates that less than 50 percent of the students in this school found organic chemistry topics easy to understand.

Table 6 shows an independent-sample t test between male and female students' in all the four coeducational institutions. The test was not significant, t (118) = -0.39, p = 0.7. This indicates no difference between male and female students' perception of the difficulty level of organic chemistry topics in all the four coeducational institutions.

Table 6

Difference between Male and Female Students' Perception of the Difficulty Level of Organic Chemistry Topics in all the four Mixed Schools (N=120)

School	Groups Compared	$\overline{X}$	SD	df	t	P
Mixed	Male	96.8	21.5	118	-0.39	0.70
	Female	98.2	18.1			

Figure 7 also shows the box plot of male and female students' perception of organic chemistry topics in the mixed schools.

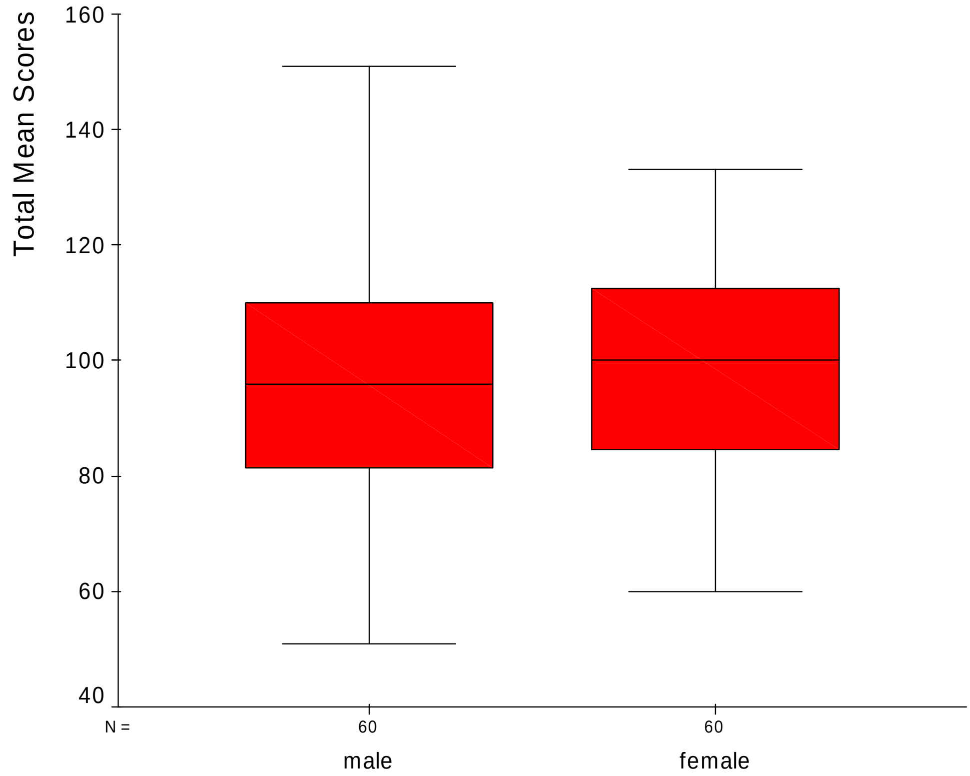

Figure 7: Male and female students' perception of organic chemistry topics in mixed schools.

The range of values ($45 < \overline{X} < 155$) of male students is wider than the values ($58 < \overline{X} < 130$) of female students. The ranges of values of both male and the female students in mixed schools are homogeneous. The shaded portion of the male students' category indicated that, equal number of male students was above and below the median ($\overline{X} > 95$). This shows that, about half of the male students in the mixed schools found organic chemistry topics easy to understand. Similarly the shaded region of female students category indicated that less than half of the female students were above the median ($\overline{X} > 100$) and more than half of them were below the median. This shows that less than half of the female students in the mixed schools found organic chemistry topics easier to understand. The box plot also shows that the median

($\overline{X} > 100$) of female students is greater than the median ($\overline{X} > 95$) of male students in the mixed schools. Also, the interquartile range for females was lower than for males indicating a relatively narrower variation in the way female students from mixed schools perceived the difficulty level of organic chemistry topics compared to how male students from mixed schools did.

Table 7 presents the summary of the mean scores of male and female students' perception of difficult organic chemistry topics. It must be noted that in scoring students' responses on the likert scale items, "not taught" scored 1 point, which happens to be the minimum on the scale. If the response was; "difficult to understand", 2 points was awarded. A response, "understood after considerable effort" also attracted 3 points, then followed by the response; "easy to understand" which also scored 4 points and finally, a response of; "very easy to understand" scored 5 points, which is the maximum on the scale. The results of both the male and female students' perceptions have been presented in Table 7. The results show that male students' overall mean score of 3.0 out of 5 points indicated that male chemistry students understood organic chemistry after considerable effort ($2.4 < \overline{X} < 3.5$). The male students found six topics namely, classification and nomenclature, determination of empirical and molecular formulae, homologous series, isomerism, sources and properties of alkanes, and uses of alkanes; as "easy to understand" ($3.4 < \overline{X} < 4.5$). The female students overall mean of 3.3 was also an indication that female chemistry students understood organic chemistry topics after considerable effort; even though their overall mean score of 3.3 was higher than that of their male counterparts, which was 3.0.

Table 7

Summary of the Mean Scores of Male and Female Students' Perception of Difficult Organic Chemistry Topics

No	Topics	Mean scores of male students' (N = 150)	Mean scores of female students' (N = 150)
1	Classification and nomenclature	3.9	3.9
2	Separation and purification	3.0	3.2
3	Determination of empirical and molecular formulae	4.0	4.0
4	Homologous series	3.9	3.8
5	Isomerism	3.6	3.7
6	Sources and properties of alkanes	3.7	3.8
7	Uses of alkanes	3.8	3.9
8	Pertroleum	3.0	3.2
9	Sources and properties of alkenes	3.4	3.5
10	Laboratory detection of alkenes	2.9	3.0
11	Sources and uses of alkynes	3.3	3.5
12	Structure and physical properties of benzene	2.8	3.0
13	Chemical properties of benzene	2.7	3.0
14	Sources, nomenclature and structure of alkanols	3.2	3.4
15	Classification of alkanols	3.2	3.5
16	Physical properties of alkanols	3.2	3.6

Table 7 continued

No	Topics	Mean scores of male students' (N = 150)	Mean scores of female students' (N = 150)
17	Chemical properties of alkanols	3.0	3.3
18	Laboratory test for alkanols	2.9	3.2
19	Sources, nomenclature and structure of alkanoic acids	3.0	3.3
20	Physical properties of alkanoic acids	3.0	3.3
21	Chemical properties of alkanoic acids	2.8	3.1
22	Laboratory test for alkanoic acids	2.8	3.1
23	Uses and properties of alkanoic acids	2.9	3.4
24	Sources, nomenclature and structure of esters	2.8	3.1
25	Physical properties of esters	2.7	3.1
26	Chemical properties of esters	2.6	3.0
27	Fats and oils as esters	2.5	2.7
28	Sources, physical and chemical properties of fats and oils	2.5	2.7
29	Soapy and soapless detergents	2.7	2.8
30	Difunctional nature of amino acids	2.1	2.0
31	Polymers and polymerization	2.7	2.6
	Overall mean score	3.0	3.3

Maximum score = 5

Except for two topics, namely, sources and properties of alkenes; and physical properties of alkanols, which the male students perceived as "understood after considerable effort" and the female students perceived as "easy to understand", both male and female students' perception of difficult topics under organic chemistry were the same for all the other topics.

This is an indication that females found organic chemistry topics less difficult to understand than their male's counterparts. There is a statistically significant difference between male students' and female students' perception of difficult organic chemistry topics.

Anamuah- Mensah (1999), delivered a paper at the national education forum on the theme; towards sustaining an effective national education system, when he stated that; "it is said that the institution of the science and technology clinic for girls (STME clinics) in 1987 coupled with the training workshops on gender sensitivity for teachers' has increased girls' motivation to study science". p (18).

It is therefore not surprising that, in all these years of girls being encouraged to pursue science, it seems their perception of science and chemistry in particular have been significantly influenced positively. For example, the 26th meeting of the Ghana national aptitude test and examinations committee, concerning students' cumulative passes at grade E in chemistry (WAEC 2005) attest to that effect. In 2002, 66.7% of female's students' passed at grade E whiles their male's counterparts had 66.1%. In 2003, the story was not different, 53.2% of female's students' passed at grade E whiles their male's counterparts had 51.8% and in 2004, the percentage passes at grade E for female's students' was 73.7% and those of male's students' was 71.0%.

Ampiah (2001) found a statistically significant difference between male students' perception and their female counterpart, when he studied students' perception of topics in senior secondary school chemistry syllabus. He found out that male students had better perception of SSS chemistry topics than their female counterpart. This further show that the female chemistry students seem to have probably erased from their memory, the notion that chemistry is a difficult subject.

The Pearson correlation was conducted to evaluate the claim that, no relationship existed between male students' and female students' perception of the level of difficulty of organic chemistry topics (Research hypothesis four). The correlation was significant at the 0.01 level. The correlation coefficient of 0.15 implied an extremely low positive correlation existed between male and female students' perception of difficult organic chemistry topics. This means where male students found topic difficult or easy to understand female students also did.

SSS Chemistry Teachers' Perception of the Level of Difficulty of Organic Chemistry Topics

Research Question two sought to find out SSS chemistry teachers' perception of the level of difficulty of organic chemistry topics in the SSS chemistry syllabus. In order to address this research question, teachers were asked to indicate their responses to the items on the questionnaire TPOQ (Appendix B).

The total score for the SSS chemistry teachers' responses of the difficulty level of organic chemistry topics was computed using SPSS. The expected minimum total score was 31 and maximum total score expected was 93. The result yielded a minimum total score of 65 and a maximum total score of 93, which was equal to the expected maximum total score, with a total mean score of 84.7. This shows SSS chemistry teachers' perception of the level of difficulty of organic chemistry topics was generally highly positive. This is an indication that SSS chemistry teachers generally found organic chemistry topics easy to understand. When the number of organic chemistry topics divides the mean total score, the result is the overall mean, which is about 2.7.

Table 8 indicates that 28 out of the 31 topics in organic chemistry were easy for teachers to teach ($\overline{X} > 2.4$). Structure and physical properties of benzene, and chemical properties of benzene and esters, each recorded a mean of 2.5, which was the least in this category whilst the topics, homologous series, sources, properties and uses of alkanes also recorded a mean of 3.0 each, which was the highest in this category. This presupposes that, most of the teachers might be able to effectively instruct to such an extent that most of the students might also, to a large extent, understand what he or she is being instructed on.

Difunctional nature of amino acids; sources, physical and chemical properties of fats and oils; polymers and polymerization were found to be difficult to teach by the teachers ($1.4 < \overline{X} < 2.5$). Table 8 again shows that more than 90% of the teachers, indicated that 8 topics, namely; classification and nomenclature (C&N); homologous series (H&S); sources and properties of alkanes (SPA); uses of alkanes (UOA); sources, nomenclature and structure of alkanols (SNSA); classification of alkanols (COA); laboratory test for alkanols (LTA); sources, nomenclature and structure of alkanoic acids (SNSAA) were easy to teach and these have been presented on a bar chart as shown in Figure 8 where all the teachers found homologous series and uses of alkanes easy to teach.

Table 8

Responses of Teachers' Perception of the Difficulty level of Organic Chemistry Topics in SSS Chemistry Syllabus (N=35)

No	Topic	ET (%)	DT (%)	NT (%)	$\overline{X}$	SD
1	Classification and nomenclature	94.3	5.7	0.0	2.9	0.2
2	Separation and purification	74.3	14.3	11.4	2.6	0.7
3	Determination of empirical and molecular formulae	82.9	14.3	2.9	2.8	0.5
4	Homologous series	100.0	0.0	0.0	3.0	0.0
5	Isomerism	80.0	17.1	2.9	2.8	0.5
6	Sources and properties of alkanes	97.1	2.9	0.0	3.0	0.2
7	Uses of alkanes	100.0	0.0	0.0	3.0	0.0
8	Pertroleum	88.6	5.7	5.7	2.8	0.5
9	Sources and properties of alkenes	85.7	8.6	5.7	2.8	0.5
10	Laboratory detection of alkenes	74.3	11.4	14.3	2.6	0.7
11	Sources and uses of alkynes	88.6	8.6	2.9	2.9	0.4

Table 8 continued

No	Topic	ET (%)	DT (%)	NT (%)	$\overline{X}$	SD
12	Structure and physical properties of benzene	60.0	31.4	8.6	2.5	0.7
13	Chemical properties of benzene	57.1	34.3	8.6	2.5	0.7
14	Sources, nomenclature and structure of alkanols	91.4	2.9	5.7	2.9	0.5
15	Classification of alkanols	94.3	5.7	0.0	2.9	0.2
16	Physical properties of alkanols	88.6	11.4	0.0	2.9	0.3
17	Chemical properties of alkanols	88.6	8.6	2.9	2.9	0.4
18	Laboratory test for alkanols	91.4	5.7	2.9	2.9	0.4
19	Sources, nomenclature and structure of alkanoic acids	94.3	5.7	0.0	2.9	0.2
20	Physical properties of alkanoic acids	82.9	14.3	2.9	2.8	0.5
21	Chemical properties of alkanoic acids	80.0	14.3	5.7	2.7	0.6
22	Laboratory test for alkanoic acids	82.9	5.7	11.4	2.7	0.7
23	Uses and properties of alkanoic acids	80.0	14.3	5.7	2.7	0.6
24	Sources, nomenclature and structure of esters	74.3	17.1	8.6	2.7	0.6
25	Physical properties of esters	74.3	17.1	8.6	2.7	0.6
26	Chemical properties of esters	65.7	20.0	14.3	2.5	0.7

Table 8 continued

No	Topic	ET (%)	DT (%)	NT (%)	$\overline{X}$	SD
27	Fats and oils as esters	74.3	11.4	14.3	2.6	0.7
28	Sources, physical and chemical properties of fats and oils	62.9	11.4	25.7	2.4	0.9
29	Soapy and soapless detergents	74.3	8.6	17.1	2.6	0.8
30	Difunctional nature of amino acids	54.3	22.9	22.9	2.3	0.8
31	Polymers and polymerization	57.1	25.7	17.1	2.4	0.8

Note: ET- easy to teach; DT – difficult to teach; NT – not taught; $\overline{X}$ - mean; SD-standard deviation.

Two topics, namely; structure and physical properties of benzene; and chemical properties of benzene were found to be difficult to teach by more than 30% of teachers. This may be due to lack of enough materials for illustrating and teaching benzene. Most chemistry textbooks present the structure of benzene in two dimensions, which makes it extremely difficult for most readers to understand its concepts. It is therefore necessary that models or teaching aids are made available for teachers to effectively teach the student to understand. This is evidenced in items 7 and 8 of the textbook (Appendix D).

Two topics, namely; sources, physical and chemical properties of fats and oils (25.7%), and difunctional nature of amino acids (22.9%) were not taught. The figures in parentheses are proportions of teachers who indicated topics as not taught. This may be as a result of the extensive nature of the organic chemistry syllabus and the late stage at which these topics in the last section of the chemistry syllabus are taught. The students are often tired and not motivated to learn when they are taught. Some teachers do not cover the topics in the last section of the syllabus probably due to attitude exhibited by some students.

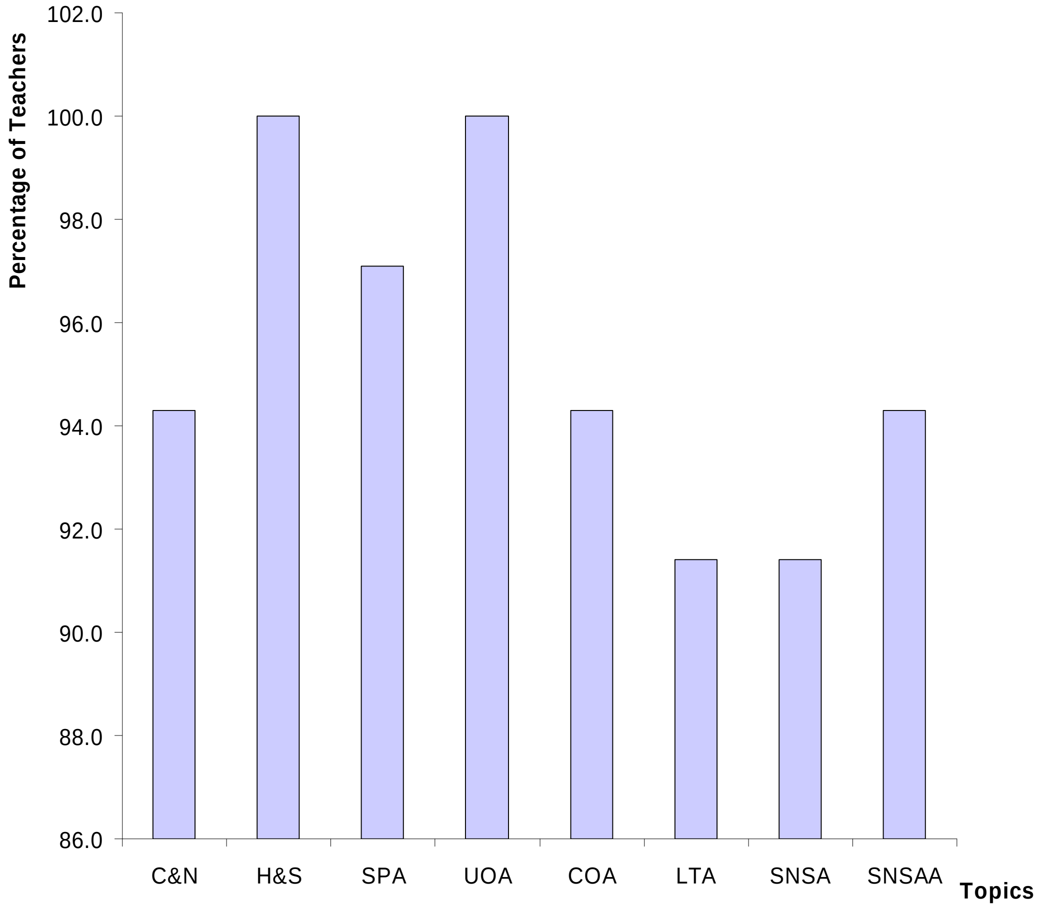

Figure 8: Topics teachers find easy to teach

Comparison of Students' Perception and Teachers' Perception of Difficult Organic Chemistry Topics

Table 9 shows that while students understood difficult organic chemistry topics under considerable effort (overall mean=3.2), teachers found them easy to teach (overall mean=2.7). Difunctional nature of amino acids which students perceived as difficult ($1.4 < \overline{X} < 2.5$) to understand was also difficult for teachers to teach ($1.4 < \overline{X} < 2.5$). The teachers found two topics, namely, sources, physical and chemical properties of fats and oils; polymers and polymerization difficult to teach ($1.4 < \overline{X} < 2.5$). The students indicated that the same topics were understood after considerable effort ($2.4 < \overline{X} < 3.5$). Both teachers and students were in agreement about the difficulty in teaching and understanding the topic respectively for 28 of the topics.

In many schools, laboratory detection of alkenes, tests for alkanols and alkanoic acids, like most practical topics are taught theoretically. It is therefore not surprising that SSS chemistry students had difficulty understanding these topics. The lack of practical activities is usually due to lack of basic chemicals and other facilities in the laboratory. Also, large class sizes make it difficult for teachers to organize effective practical lessons. In the case of large class sizes, teachers could demonstrate the laboratory test to students if materials necessary to do so are available.

The fifth hypothesis sought to find out whether a significant relationship existed between SSS chemistry teachers' and students' perception of the level of difficulty of organic chemistry topics. In order to address this students and teachers were asked to provide their perceptions of the level of difficulty of organic chemistry topics of the items in the questionnaire SPOQ and TPOQ (Appendices A & B).

Table 9

Mean Distribution of Students' and Teachers' Perception of Difficult Organic Chemistry Topics

No	Topics	$\overline{X}$ (students)	$\overline{X}$ (teachers)
1	Classification and nomenclature	3.9	2.9
2	Separation and purification	3.1	2.6
3	Determination of empirical and molecular formulae	4.0	2.8
4	Homologous series	3.8	3.0
5	Isomerism	3.7	2.8
6	Sources and properties of alkanes	3.8	3.0
7	Uses of alkanes	3.9	3.0
8	Petroleum	3.1	2.8
9	Sources and properties of alkenes	3.4	2.8
10	Laboratory detection of alkenes	3.0	2.6
11	Sources and uses of alkynes	3.4	2.9
12	Structure and physical properties of benzene	2.9	2.5
13	Chemical properties of benzene	2.8	2.5
14	Sources, nomenclature and structure of alkanols	3.3	2.9
15	Classification of alkanols	3.3	2.9
16	Physical properties of alkanols	3.4	2.9
17	Chemical properties of alkanols	3.2	2.9

Table 9 continued

No	Topics	$\overline{X}$ (students)	$\overline{X}$ (teachers)
18	Laboratory test for alkanols	3.0	2.9
19	Sources, nomenclature and structure of alkanoic acids	3.1	2.9
20	Physical properties of alkanoic acids	3.2	2.8
21	Chemical properties of alkanoic acids	3.0	2.7
22	Laboratory test for alkanoic acids	2.9	2.7
23	Uses and properties of alkanoic acids	3.2	2.7
24	Sources, nomenclature and structure of esters	3.0	2.7
25	Physical properties of esters	2.9	2.7
26	Chemical properties of esters	2.8	2.5
27	Fats and oils as esters	2.6	2.6
28	Sources, physical and chemical properties of fats and oils	2.6	2.4
29	Soapy and soapless detergents	2.7	2.6
30	Difunctional nature of amino acids	2.1	2.3
31	Polymers and polymerization	2.6	2.4
	Overall mean score	3.2	2.7

The Pearson correlation was conducted to evaluate the hypothesis that, no relationship existed between SSS chemistry students' perception and teachers' perception of the level of difficulty of organic chemistry topics. The correlation was significant at the 0.01 level. The correlation coefficient was 0.19. This implied an extremely low positive correlation existed between SSS chemistry students' perception and teachers' perception of the level of difficulty of organic chemistry topics.

Figure 9 shows the scatter plot of the correlation between teachers' perception and students' perception of organic chemistry topics. The scatter plot shows almost no correlation between teachers' and students' perception of organic chemistry topics. This is an indication that, there is a gap between teachers' and students' perception of organic chemistry topics. This implies teachers would see eye to eye with student who find a particular topic, which is easy to teach, difficult to understand. Teachers would find it difficult to come to the level of the students and even use very simple language that will help the student to understand a difficult topic. The null hypothesis was therefore upheld because there is almost no correlation between teacher' and students' perception of organic chemistry topics. The figure 9 also shows that the teachers' perception has no influence on the students' perception.

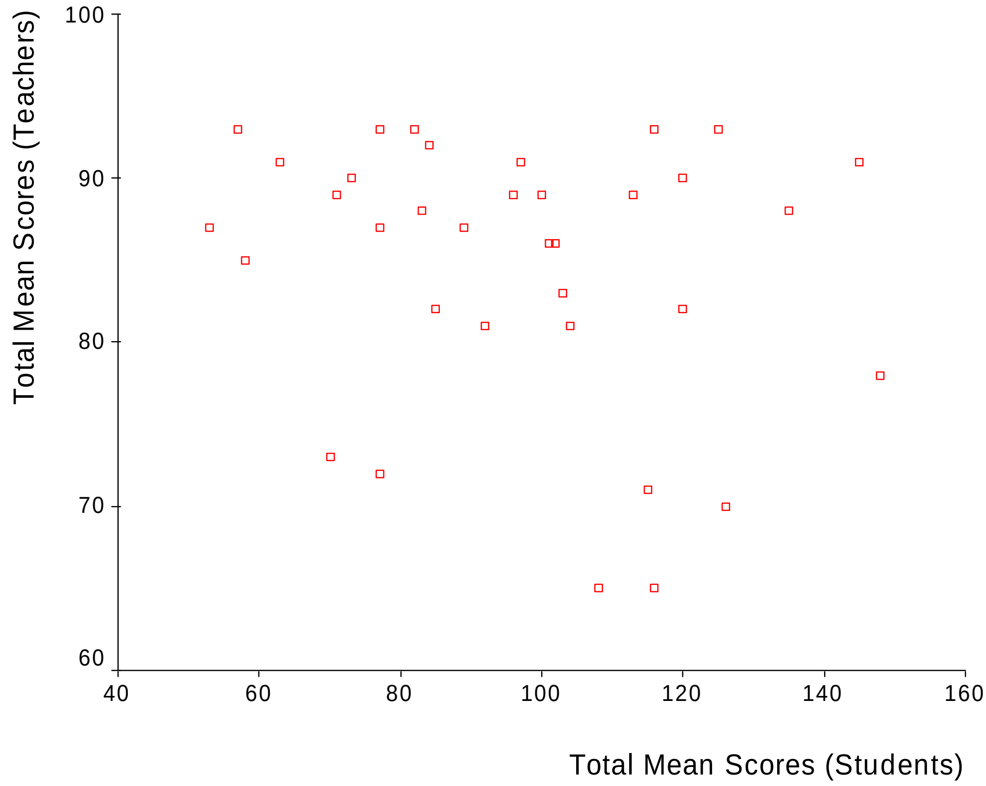

Figure 9: Correlation between teachers' and students' perception of organic chemistry topics

SSS Chemistry Students' Response to Perceived Difficult Organic Chemistry Topics

Research Question three sought to find out organic chemistry topics that were perceived as difficult to understand and reasons given by students. In order to answer the research question, students were asked to mention one topic they found most difficult to understand in organic chemistry and briefly explain why they found it difficult to understand. The students' responses are presented in Table 10. Twenty-four percent of the respondents failed to indicate any topic they found difficult to understand. Of the 228 respondents, quite a proportion (17.1%) had difficulty with aromatic hydrocarbons. Students gave diverse reasons, such as, the Kekule's structure of benzene was not well understood, could not differentiate between the old and new structures of benzene, too many conditions, reagents and equations among others, for the difficulty in understanding the chemistry of aromatic hydrocarbons. The reasons mentioned are evidenced in items 18, 20 and 25 under learning difficulty (Appendix C).

Table 10

Students' Response in respect of Difficult Organic Chemistry Topics (N=228)

No	Topic	N	%
1	Aromatic Hydrocarbons	39	17.1
2	Laboratory test	25	11.0
3	Synthesis	21	9.2
4	Esters	19	8.3
5	Isomerism	19	8.3
6	Alkanoic acids	18	7.9
7	Saturated and unsaturated hydrocarbons	17	7.5
8	Difunctional nature of amino acids	16	7.1
9	General comments	15	6.6
10	Alkanols	13	5.7
11	Classification and nomenclature	9	3.9
12	Petroleum	6	2.6
13	Separation and purification	6	2.6
14	Determination of empirical and molecular formulae	5	2.2

The way most of the students answered item 34 (Appendix A), it was advisable to combine topics that were in the same category. Note that aromatic hydrocarbons comprised of structure and physical properties of benzene and chemical properties of benzene. Laboratory test also comprised of laboratory detection of alkenes; laboratory test for alkanols and laboratory test for alkanoic acids. Synthesis comprises soapy and soapless detergents; polymers and polymerization: Esters entail sources, nomenclature and structure of esters, physical properties of esters, chemical properties of esters, fats and oils as esters, sources, physical and chemical properties of fats and oils: Alkanoic acids are made of sources, nomenclature and structure of alkanoic acids; physical properties of alkanoic acids; chemical properties of alkanoic acids; uses and properties of alkanoic acids: Alkanols comprise of sources, nomenclature and structure of alkanols; classification of alkanols; physical properties of alkanols; chemical properties of alkanols: Saturated and unsaturated hydrocarbons comprise of sources and properties of alkanes, uses of alkanes, sources and properties of alkenes, sources and uses of alkynes:

The first four topics mentioned in Table 2 as difficult, included difunctional nature of amino acids; structure, physical and chemical properties of benzene (aromatic hydrocarbons) and laboratory detection of alkenes in that order, yet students indicated aromatic hydrocarbons as most difficult. One would have expected students to choose difunctional nature of amino acids as the most difficult topic since it reflected in Table 2. Here each of the students had the opportunity to indicate his or her perception on all the thirty-one topics in organic chemistry, which was not the case in Table 10, where each student had to mention only one topic he or she found most difficult to understand.

This is because the proportion of those who indicated a topic as difficult (Table 2) in each case was higher than the corresponding proportion who indicated a topic as most difficult (Table 10).

A student perception of a topic being difficult does not necessarily mean, that topic is the most difficult. For example, in Table 1, seven point three percent (7.3%) of students indicated homologous series as difficult but none of the students mentioned it as most difficult topic. Students in Table 2 also perceived all the topics, mentioned by the students as most difficult, in Table 10, as difficult.

The analysis of students' explanation to their choice of the most difficult organic chemistry topic discussed in Table 10 shows that their reasons could be grouped into the following subheadings as shown in
Table 11.

The results in Table 11 show that teacher factor, students' perception and learning difficulty were the three major sources of students' difficulties in learning organic chemistry. Typical responses by students' under each of the subheadings have been presented in Appendix C. Some of the reasons student gave with respect to teacher factor indicated that some SSS chemistry teachers might have to vary their methods of teaching or instruction and gain mastery over the content. They may have to be punctual and use the time for lesson effectively. In this way, the students' perception of organic chemistry topics as complex would change for better and learning of organic chemistry might not be a problem.

Most laboratories at SSS levels are still poorly equipped with needed chemicals and equipment, thus making it impossible for practical work to be

Table 11

Students' Views about Sources of Difficulties (N=231)

No	Sources of Students' Difficulties	N	%
1	Teacher Factor	76	32.9
2	Students' Perception	67	29.0
3	Learning Difficulty	62	26.8
4	Textbooks	11	4.8
5	Students' Attitude	8	3.5
6	Others	4	1.7
7	No comments	3	1.3

carried out (Anamuah-Mensah, 1999). The establishment of science resource centres equipped with computers, computer assisted learning packages and other science teaching materials, which are not normally found in school science laboratories, provided a partial solution to the lack of adequately equipped laboratories. The science resource centre also served the practical needs of the students from other schools as well as the host school. Lack of maintenance has denied most students of this opportunity since most of the science resource centres are not functional.

SSS Chemistry Teachers' Response to Students' Perceived Difficulty with Organic Chemistry Topics

Research Question four sought to find out organic chemistry topics that were perceived by teachers as difficult for students to understand and reasons given by teachers. In order to answer the research question, teachers were asked to mention some of the topics students had much difficulty with in organic chemistry and briefly explain why they found it difficult. The results of teachers' responses are presented in Table 12. None of the respondents selected separation and purification, and petroleum as difficult for the students. Yet students talked about the fact that method used in teaching separation and purification was confusing, moreover this was taught without any practical demonstration. In the case of petroleum, the students' said, the stages involved are complex and also notes were provided without adequate explanation. This may be due to the fact that teachers had only three opportunities to mention students' most difficult topics and the two topics not mentioned by teachers that could be difficult for students but definitely not the most difficult.

Quite a proportion of the teachers (25.4%) claimed the topic, aromatic hydrocarbons was most difficult for students. The teachers gave diverse reasons such as, the topic being complex, abstract and students' poor background in chemistry from the basic schools, for the difficulty in understanding the chemistry of aromatic hydrocarbons. This is evidenced in items three (3) and five (5) under teachers perception and item ten (10) under textbooks (Appendix D). This is a confirmation of what the students mentioned as their most difficult organic chemistry topics, an indication that teachers probably know their students very well.

The analysis of the teachers' explanation to their choice of the most difficult organic chemistry topic discussed in table 12 shows that their reasons could be grouped into the following subheadings shown in table 13.

Table 12

Teachers' Response to Topics Students found Difficult in Organic Chemistry

No	Topic	N	%
1	Aromatic Hydrocarbons	16	25.4
2	Synthesis	10	15.9
3	Difunctional nature of amino acids	8	12.7
4	Saturated and unsaturated hydrocarbons	8	12.7
5	Esters	7	11.1
6	Isomerism	4	6.3
7	Alkanoic acids	3	4.7
8	Classification and nomenclature	2	3.2
9	Laboratory test	2	3.2
10	Determination of empirical and molecular formulae	1	1.6
11	Homologous series	1	1.6
12	Alkanols	1	1.6
	Total	63	100

The results in Table 13 show that, learning difficulty, textbooks and teachers' perception were the three main sources of students' difficulties in organic chemistry topics. Typical responses by teachers' under each of the subheadings have been presented in Appendix D.

Table 13

Teachers' Views about Students Sources of Difficulties

Sources of Students' Difficulties	Number of Students'	Percentage
Learning Difficulty	14	35.0
Textbooks	14	35.0
Teachers' Perception	12	30.0
Total	40	100.0

Some of the reasons teachers gave with respect to teachers' perception about students most difficult topics in organic chemistry, such as topics being too abstract with lack of practical evidence (items one (1) and two (2)) and lack of teaching aids and reference materials, evidenced in item one under textbooks (Appendix D) indicated that some teachers might have problems teaching certain topics in organic chemistry.

Anamuah-Mensah (1999) seems to address some of the reasons such as lack of reference materials. He said that one issue, which has not received much attention, is the lack of reference resources for the science teacher and chemistry teacher in particular. Teachers' therefore depend on only the recommended text for teaching. The science textbook is the source of the teachers' lecture notes, examination questions and laboratory experience of the students. Very few teachers consult other books and multimedia materials such as science video clips and slides for teaching. Science teachers need resource books from which they can get ideas on say industries, or traditional games and toys that are enriched with scientific concepts. It is possible that once teachers perceived organic chemistry as complex, confusing and abstract, the students' are likely to have similar, if not the same perceptions. One cannot isolate teaching from learning. They both go together. If the students had difficulty in learning organic chemistry, it is equally likely that the teachers might as well experience some difficulty in their instructions.

According to Anamuah- Mensah, as cited in Wood, (1994),

> "the perception of a topic as difficult to teach may have to do with the time involved in gathering and preparing materials for teaching, adequate time to teach the prepared lessons, the ingenuity to simplify abstract concepts without loss of authenticity, the use of language appropriate for the level of the students, maintaining interest through relevance of topic and assisting students to build up complex mental models as well as relating new material to students previous knowledge". p. (22)

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

This concluding chapter presents the key findings, conclusion and recommendations with respect to the SSS chemistry students' and teachers' perception of organic chemistry topics, with some suggestions made for future study.

Summary

The problem that prompted this study was the consistent report by the Chief Examiner (WAEC), of poor performance in the organic chemistry section of the SSCE chemistry paper1 by SSS chemistry students. Anamuah-Mensah (1995) has suggested that, a direct relationship existed between students' performance in chemistry and their perception in chemistry. Mahaja and Singh (2005) however suggested a direct relationship between teachers' perception in a subject, particularly in chemistry and their students' performance. One can conveniently assert on this basis that, there is a direct relationship between teachers' perception in chemistry and students' perception in chemistry.

This study was therefore designed to investigate students' and teachers' perception of difficult organic chemistry topics. It also investigated whether there was a significant difference between male students' and female students' perception of difficult organic chemistry topics. This comparison between male and female students' perception was also done between male schools and female schools, and within mixed schools (Appendix E).

The study further investigated whether there was any relationship between male chemistry students' perception of difficult organic chemistry topics and that of their female counterpart. This comparison was also done between the SSS chemistry students and their teachers. The study specifically sought to find answers to the four research questions and two hypotheses.

The study was carried out in the Central Region of Ghana using the survey method. Three hundred final year SSS students and their chemistry teachers (35 of them) were purposively selected. Questionnaires (SPOQ and TPOQ) were administered and responded to by these 300 SSS final year chemistry students' and their chemistry teachers'.

The data collected was analyzed using quantitative approach. The quantitative approach included the use of percentages and descriptive statistics, such as the mean and the standard deviations. T-test statistic was used to find out whether there was any significant difference between male and female students' perceptions of difficult organic chemistry topics. However, the Pearson's correlation was used to find out whether there was a relationship between students' and teachers' perception in difficult organic chemistry topics. Frequency count was used to identify students' most difficult topic in organic chemistry and sources of difficulty.

Key Findings

1. Generally the SSS chemistry students' perception of the level of difficulty of organic chemistry topics was slightly positive ($\overline{X} < 97.5$). The students generally perceived organic chemistry topics as

"understood after considerable effort". Students perceived 19.3% of the organic chemistry topics as "easy to understand"; 77.4% topics as "understood after considerable effort"; and 3.3% topics as "difficult to understand". The male students perceived 19.4% of the organic chemistry topics as "easy to understand" whiles the female students also perceived 32.3% of the organic chemistry topics as "easy to understand". The male students similarly perceived 77.4% of the topics whiles the females also perceived 64.5% of the topics as "understood after considerable effort". Both of the however perceived 3.2% of the organic chemistry topics as "difficult to understand".

2. Generally the SSS chemistry teachers' perception of the level of difficulty of organic chemistry topics was highly positive ($\overline{X} < 84.7$). The teachers generally perceived organic chemistry topics as "easy to teach". Teachers perceived 90.3% of the organic chemistry topics as "easy to teach"; and 9.7% topics as "difficult to teach".
3. Students found aromatic hydrocarbons as the most difficult topic to understand. Teacher factor, students' perception and learning difficulty were the three main factors which accounted for students' difficulty in organic chemistry. It came out strongly that organic chemistry topics are complicated and there was lack of reference materials for studies.
4. Teachers mentioned aromatic hydrocarbons as the most difficult to teach. Textbooks, learning difficulty of students and teachers' perception were the three main factors which accounted for students' difficulty in organic chemistry. It also came out strongly that organic

chemistry topics are complicated and there was lack of models or teaching aids.

5. Generally, the study found a statistically significant difference between male and female students' perception of the difficulty level of organic chemistry topics ($p=0.01<0.05$). Similarly, between the male and female schools, it was significant ($p=0.003<0.05$). The difference was in favour of females in both cases. Among the mixed schools, the test was not significant ($p=0.7>0.05$).
6. There is a low positive correlation between the male and female students' perception of the difficulty level of organic chemistry topics ($r=0.15$).
7. There is an extremely low positive correlation (almost absence of correlation) between the SSS chemistry students' and teachers' perception of the difficulty level of organic chemistry topics ($r=0.19$).

Conclusion

It can be concluded from the results of this study that SSS chemistry students find organic chemistry topics difficult to understand. If a topic is understood after considerable, effort then it is difficult. Hence, it is not surprising that SSS chemistry students either avoid answering questions or do not answer questions under organic chemistry satisfactorily in the SSSCE chemistry paper1. Teachers generally find organic chemistry topics easy to teach. One thing which stood out was the fact that both students and teachers mentioned aromatic hydrocarbons as the most difficult topics with the reason being lack of teaching and learning materials. This depicted some degree of relationship between them.

Chemistry teachers should find very good methods and approaches to reduce the wide gap between them and their students since it came out that there was almost no correlation between them.

Recommendations

The following suggestions are made to address the problem:

1. Textbook writers should adopt approaches (such as the use of simple language, pictures in 3-dimension relevant to the topic being treated among others) which will enable chemistry students have better perception of difficult organic chemistry topics.
2. The Departments of Science and Mathematics Education of the Universities of Cape Coast and Winneba should train prospective science teachers, particularly chemistry teachers to effectively handle organic chemistry topics at the SSS level, so as to improve students' perception. For example, how to teach aromatic hydrocarbons, since both students' and teachers' mentioned it as most difficult topic in organic chemistry.
3. The Ghana Association of Science Teachers (GAST) should in one of the annual conferences or workshops, educate its members, chemistry teachers in particular, on the current trends of teaching the difficult organic chemistry topics to help chemistry students have better perception.

Suggestions for Future Research

The following suggestions are made for future research in this area of study:

The low positive correlation coefficient r=0.19 which indicated a slightly positive relationship between teachers and students calls for further studies on the relationship between teachers' perception and students' perception of difficult topics in organic chemistry. It may be extended to cover other difficult topics in chemistry. This unlike the present study will lay bare whether a significant relationship exists or not between the teachers and students. Moreover, the use of the two different scales may have limited the study.

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APPENDICES

Appendix A

STUDENTS' PERCEPTION OF ORGANIC CHEMISTRY QUESTIONNAIRE (SPOQ)

A study is being conducted on the perception of SSS 3 chemistry students and chemistry teachers on organic chemistry topics.

This questionnaire forms part of the study. There is no right or wrong response. Your opinion about each topic is very important.

PERCEPTIONS ABOUT ORGANIC CHEMISTRY TOPICS

Tick **(✓)** the appropriate column corresponding to your opinion about the topic.

Please be sure to respond to all the items. If you change your mind about your response to an item just cross it out and tick **(✓)** another. You are assured of the confidentiality of your opinion. Thank you.

BIO DATA

1. GENDER (TICK): MALE ☐ FEMALE ☐

2. AGE (Write in the box): ☐

Note: VEU-very easy to understand; EU-easy to understand; UCE-understood only after considerable effort; DU-difficult to understand; NT-not taught;

No	Topics	VEU	EU	UCE	DU	NT
3	Classification and nomenclature					
4	Separation and purification					
5	Determination of empirical and molecular formula					
6	Homologous series					
7	Isomerism					
8	Sources and properties of alkane					
9	Uses of alkanes					
10	Petroleum					
11	Sources and properties of alkenes					
12	Laboratory detection of alkenes					
13	Sources and uses of alkynes					
14	Structure and physical properties of benzene					
15	Chemical properties of benzene					
16	Sources, nomenclature and structure of alkanols					
17	Classification of alkanols					
18	Physical properties of alkanols					
19	Chemical properties of alkanols					

No	Topics	VEU	EU	UCE	DU	NT
20	Laboratory test for alkanols					
21	Sources, nomenclature and structure of alkanoic acids					
22	Physical properties of alkanoic acids					
23	Chemical properties of alkanoic acid					
24	Laboratory test for alkanoic acids					
25	Uses and properties of alkanoic acid					
26	Sources, nomenclature and structure of esters					
27	Physical properties of esters					
28	Chemical properties of esters					
29	Fats and oils as esters					
30	Sources, physical and chemical properties of fats and oils					
31	Soapy and soapless detergents					
32	Difunctional nature of amino acids					
33	Polymers and polymerization					

34. Indicate the topic you find most difficult to understand in organic chemistry.

Topic:……………………………………………………………………………

35. For the difficult topic indicated above briefly explain why you find it difficult to understand.

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Appendix B

TEACHERS' PERCEPTION OF ORGANIC CHEMISTRY QUESTIONNAIRE (TPOQ)

A study is being conducted on the perception of SSS 3 chemistry students and chemistry teachers on organic chemistry.

This questionnaire forms part of the study. There is no right or wrong response. Your opinion about each topic is very important.

PERCEPTIONS ABOUT ORGANIC CHEMISTRY TOPICS

Tick **(✓)** the appropriate column corresponding to your opinion about the topic.

Please be sure to respond to all the items. If you change your mind about your response to an item just cross it out and tick **(✓)** another. You are assured of the confidentiality of your opinion. Thank you.

BIODATA

1. GENDER (TICK): MALE ☐ FEMALE ☐
2. AGE (TICK): 23-34 yrs ☐
   35-44 yrs ☐
   45-60 yrs ☐
3. ACADEMIC QUALIFICATION (TICK): ☐ DIPLOMATE ☐ DEGREE
4. NUMBER OF YEARS IN TEACHING (Write in the box): ☐

Note: EU-easy to understand; DU-difficult to understand;

NT-not taught;

No	Topics	EU	DU	NT
5	Classification and nomenclature			
6	Separation and purification			
7	Determination of empirical and molecular formula			
8	Homologous series			
9	Isomerism			
10	Sources and properties of alkane			
11	Uses of alkanes			
12	Petroleum			
13	Sources and properties of alkenes			
14	Laboratory detection of alkenes			
15	Sources and uses of alkynes			
16	Structure and physical properties of benzene			
17	Chemical properties of benzene			
18	Sources, nomenclature and structure of alkanols			
19	Classification of alkanols			
20	Physical properties of alkanols			
21	Chemical properties of alkanols			
22	Laboratory test for alkanols			
23	Sources, nomenclature and structure of alkanoic acids			
24	Physical properties of alkanoic acids			
25	Chemical properties of alkanoic acid			
26	Laboratory test for alkanoic acids			
27	Uses and properties of alkanoic acid			
28	Sources, nomenclature and structure of esters			

No	Topics	EU	DU	NT
29	Physical properties of esters			
30	Chemical properties of esters			
31	Fats and oils as esters			
32	Sources, physical and chemical properties of fats and oils			
33	Soapy and soapless detergents			
34	Difunctional nature of amino acids			
35	Polymers and polymerization			

36. Which topics under organic chemistry do students' have much difficulty with?

i………………………………………………………………………………

ii………………………………………………………………………………

iii……………………………………………………………………………

37. Give a brief reason for the difficulty.

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Appendix C

Reasons For Students' Difficulty in Respect of their Choice of the most Difficult Organic Chemistry Topic.

Learning difficulty:

Typical responses on students' learning difficulty are as follows:

1. Too many chemical reactions to memorize or understand (classification and nomenclature).
2. Some of the names are not friendly but complex (classification and nomenclature).
3. Difficult to learn (separation and purification).
4. It was not well understood (determination of empirical and molecular formulae).
5. Manipulating carbon and other atoms to arrive at desired structure beats me (isomerism).
6. Not able to differentiate between functional groups, stero and iso compounds (isomerism).
7. Different forms make it difficult to learn by its complexity (isomerism).
8. It entails very much (isomerism).
9. Not easy to understand (isomerism).
10. How to develop structures from a given compound and nomenclature (isomerism).
11. Change in shape of molecules (isomerism).
12. Not easy to understand when I read (petroleum).

13. Difficult to memorize the boiling points of some compounds (petroleum).
14. Not easy to understand let alone memorizing (saturated and unsaturated hydrocarbons).
15. Too many equations and chemical formulae (saturated and unsaturated hydrocarbons).
16. Do not get the understanding when I read (laboratory test).
17. I do not understand ketone formation (saturated and unsaturated hydrocarbons).
18. The Kekule concept is not well understood (aromatic hydrocarbons).
19. Joining the various structures and the statements that accompany them beat my mind (aromatic hydrocarbons).
20. Cannot differentiate between the old and new structures and naming system (aromatic hydrocarbons).
21. Did not understand the nomenclature (aromatic hydrocarbons).
22. Because the structure of benzene is not certain, it is believed to be inbetween the two structures of Kekule and this makes it difficult to understand its physical properties (aromatic hydrocarbons).
23. Not easy to learn (aromatic hydrocarbons).
24. Do not understand concept very well (aromatic hydrocarbons).
25. Involves too many conditions, reagents and equations (aromatic hydrocarbons).
26. I find it difficult to classify alkanols into primary, secondary and tertially alkanols (alkanols).

27. I cannot tell how many carbons are attached to the hydroxyl carbon (alkanols).
28. Lack the basics (alkanols).
29. The chemical equations of the alkanols and unsaturated hydrocarbons involve conditions, which is not easy to keep in mind (alkanols).
30. Too many conditions and chemical reactions involved calls for chew and pour (alkanols).
31. Too many reagents (laboratory test).
32. Difficult to understand (laboratory test).
33. Not clear (alkanoic acids).
34. Could not understand how all the reactions occurred (alkanoic acids).
35. How reactions take place and the products formed (alkanoic acids).
36. Too many chemical equations (laboratory test).
37. Too many reagents and conditions (laboratory test).
38. Naming is not clear (esters).
39. How to write chemical formulae after reaction with other substances (esters).
40. Did not catch up from the start (esters).
41. Did not understand, the first time the teacher taught; three different teachers had to teach (esters).
42. Difficult to differentiate between the formula for fats and oils (esters).
43. I learn and always forget (difunctional nature of amino acids).
44. Not easy to grasp at a go, involves complex chains (difunctional nature of amino acids).
45. Did not understand (difunctional nature of amino acids).

46. Deals with so many organic compounds joined together up to infinity; hence more imagery is needed to understand the concept (synthesis).
47. Reaction equations are difficult to understand (synthesis).
48. Difficult to understand (synthesis).
49. Do not understand when I learn or even when I am taught (synthesis).
50. Very difficult to understand the structural formula (synthesis).
51. It involves a lot of conditions, reagents and chemical equations you would have to learn.
52. It was not clear to me.
53. Making difference clear is the problem because it talks about closely related things.
54. Do not understand the polarity aspect (alkanoic acids).
55. It is not easy to memorize; serious and in-depth learning must be done before even a few can stick to memory (saturated and unsaturated hydrocarbons).
56. I do not know when to use pent-2-ene and 1,2-dichloro compounds; I am confused with when the commas, dashes are suppose to be and the order of the names (classification and nomenclature).
57. It is difficult to understand how the O-H bond of alkyl group reacts in aqueous solution to bring about the acidic and basic properties of the organic molecules (alkanoic acids).
58. It is very broad and difficult to understand some of the ways in which alkanols are produced (alkanols).
59. Not easily understood (aromatic hydrocarbons).

60. Could not understand after putting in so much effort personally (aromatic hydrocarbons).
61. Difficult to memorize (aromatic hydrocarbons).
62. Naming and structural formula (saturated and unsaturated hydrocarbons).

Teacher factor

Typical responses about the factors inherent in the teacher are as follows:

1. Teacher failed to develop my interest (classification and nomenclature).
2. Just copied lots of notes without proper explanation from teacher (separation and purification).
3. Taught without practicals (separation and purification).
4. No effective teaching was done; not enough information about topic was given to help students (determination of empirical and molecular formulae).
5. Teacher did not teach to my understanding (isomerism).
6. Teacher did not take his time to teach; did not bother to explain further when students requested for an explanation (isomerism).
7. Not taught properly (isomerism).
8. Only copied notes; teacher did not explain further (isomerism).
9. Did not follow what the teacher taught (isomerism).
10. Not taught (isomerism).
11. Teacher could not express himself well (isomerism).
12. I was not taught (saturated and unsaturated hydrocarbons).

13. Theoretically taught instead of practicals (saturated and unsaturated hydrocarbons).
14. Not treated (saturated and unsaturated hydrocarbons).
15. Too much notes copied (petroleum).
16. Note provided by teacher without explanation (petroleum).
17. Teacher was too fast (laboratory test).
18. Teaching was based on imagination of most teachers (laboratory test).
19. Because most of them were learnt in class and we did not have any practical work on it (saturated and unsaturated hydrocarbons).
20. Teacher never taught to my understanding (aromatic hydrocarbons).
21. Resonance and Kekule structure not well explained (aromatic hydrocarbons).
22. Teacher taught without giving notes (aromatic hydrocarbons).
23. Not taught (aromatic hydrocarbons)
24. Teacher never taught to my understanding (alkanols).
25. Lack of teachers (alkanols).
26. Not done in laboratory practically but theoretically taught; made understanding difficult (laboratory test).
27. Teacher did illustrate to us but was still not clear (laboratory test).
28. Not explained to the best of understanding (laboratory test).
29. Not taught practically (laboratory test).
30. No practical lessons (laboratory test).
31. Teacher did not have time to explain everything to me (alkanoic acids).
32. Teacher did not explain topic very well; he thinks some of the class understand so all of us understand (alkanoic acids).

33. No practical tests were taken (laboratory test).
34. Lack of practicals (laboratory test)
35. Teacher did not teach to our understanding; no practical lesson was done (esters).
36. Not taught into details (esters)
37. Not taught at all (esters).
38. Teacher sometimes refused to answer questions asked by students (esters).
39. Taught theoretically instead of practically making it difficult (esters).
40. Teacher does not address students’ questions satisfactorily; students cannot figure out the structures pictorially; teacher beats about the bush in answering students’ questions (esters).
41. Not taught properly (synthesis).
42. Not taught in class at all (synthesis)
43. It was not taught in class (difunctional nature of amino acids).
44. Explanation given not clear (difunctional nature of amino acids).
45. Teacher’s explanation not clear (difunctional nature of amino acids).
46. Not taught properly and lack of textbooks (difunctional nature of amino acids).
47. I have not been taught at all; needs considerable effort to understand (synthesis).
48. Not taught (synthesis).
49. Introduced to us but not treated into details (synthesis).
50. Everything seemed advanced; sometimes no explanation from teacher (synthesis).

51. Teacher rushed through the topic (synthesis).
52. Insufficient practical lessons (synthesis).
53. Poor explanation by teacher and the structure involved (synthesis).
54. Sometimes the explanation is not vivid; encouragement to study is not there.
55. Teacher simply cannot express himself; he taught as though we already knew the topic.
56. Teacher was absent most of the time; very little time was spent in teaching organic chemistry.
57. Teacher goes too fast; topic is generally complex
58. Teacher needs to vary his skills in teaching; class complains a lot.
59. Teacher taught as though we already understood and rushed through.
60. There was the need for some visual aids to help picture more clearly (aromatic hydrocarbons).
61. It's just taught but not put into practice, so that at least we do not chew the notes (laboratory test).
62. Teachers think we should be able to do some research work in order to understand; he only scratched the surface (esters).
63. No practical lesson done; some of us learn faster when practical examples are used (classification and nomenclature).
64. Teacher's explanation did not go down well with students (alkanols).
65. Teacher does not go over when students do not understand; he rushed through all topics under organic chemistry (aromatic hydrocarbons).
66. Teacher did not teach to my understanding; never bothered when asked to go over (aromatic hydrocarbons).

67. Not well taught; taught very late; teacher rushed through them (esters).
68. An only note was given without sufficient explanation (alkanoic acids).
69. Explanation was not clear (alkanols).
70. Not taught (laboratory test).
71. Poor illustration by teacher; mainly talking (lecturing): Did not give every little detail right from scratch (aromatic hydrocarbons).
72. Taught in a rush (saturated and unsaturated hydrocarbon).
73. Never taught at all (aromatic hydrocarbons).
74. Not demonstrated (laboratory test).
75. Lack teachers and insufficient books (alkanoic acids).
76. Teacher did not make it easy to understand; when asked to go over he refused (classification and nomenclature).

Students' Perception in Organic Chemistry

Typical responses about their opinion in organic chemistry are as follows:

1. Methods used in for example chromatography are very confusing (separation and purification).
2. It is complicated (separation and purification)
3. It is confusing identifying whether a compound contains single or double bonds (determination of empirical and molecular formulae)
4. The questions are sometimes confusing especially when percentages of some gases are not provided (determination of empirical and molecular formulae).
5. Tricky (isomerism).
6. It is very broad; not interesting; much attention is needed (isomerism).
7. Use of numbers, commas etc make naming difficult (isomerism).

8. Naming and formation of structure is confusing (isomerism).
9. Stages involved are complicated; understanding was not clear (petroleum).
10. Very complicated names and structure (petroleum).
11. I became confused as to what substance to use to detect the hydrocarbon (laboratory test).
12. The different theories were confusing; I find it difficult to explain the different theories (aromatic hydrocarbons).
13. Very confusing and complicated (aromatic hydrocarbons).
14. Confusing and complex (aromatic hydrocarbons).
15. Complicated (aromatic hydrocarbons).
16. Complicated (aromatic hydrocarbons).
17. Very complicated (aromatic hydrocarbons).
18. Very complicated (aromatic hydrocarbons).
19. Confusing (alkanols).
20. Naming and structure very confusing (alkanoic acids).
21. Too many conditions and reagents; very confusing (laboratory test).
22. It is very confusing; needs time to assimilate (esters).
23. Very confusing and complex (esters).
24. General formula for triglyceride is complicated (esters).
25. Complex structures (esters).
26. They are confusing; spent a lot of time solving questions and reading before understanding (difunctional nature of amino acids).
27. Complex (difunctional nature of amino acids).
28. Confusing (difunctional nature of amino acids).

29. Confusing (difunctional nature of amino acids).
30. Too complex (difunctional nature of amino acids).
31. Very involving and need time to assimilate (difunctional nature of amino acids).
32. Too complex (difunctional nature of amino acids).
33. Very complex; took 3hours to study just a page of my notes; we were given only notes without tutorials (synthesis).
34. Too long and complex reactions and equations (synthesis).
35. Complex functional groups (synthesis).
36. Too complex (synthesis).
37. Processes and chemical equations involved too long and confusing (synthesis).
38. It seems complicated to learn.
39. Very complicated.
40. Too broad and volatile.
41. Everything chemical about chemistry causes misery.
42. Very involving; too many chemical reactions, equations and reagents.
43. It is very confusing (alkanoic acids).
44. It is very confusing (aromatic hydrocarbon).
45. Complicated and confusing; it takes a great effort to learn the whole process and reactions (saturated and unsaturated hydrocarbon).
46. Too many reagents used and the test are some how complex (saturated and unsaturated hydrocarbon).

47. They jam up in the mind after studies, unless you revise every day; if you ignore for about a week every thing seem new when you open the notes again (laboratory test).
48. They are a lot with so many different conditions and reagents (synthesis).
49. Equations too huge; they are a lot too (synthesis).
50. Very complicated; one needs to take an extra look before understanding (alkanols).
51. Always confused about naming of these acids (alkanoic acids).
52. Involves a lot and very confusing; it must be taught and not lectured on (aromatic hydrocarbon).
53. Reactions and test very confusing; also involves too many conditions and reagents (laboratory test).
54. Much is needed from you and structure is complex (alkanoic acids).
55. Chemical properties very confusing; methods of preparation difficult (alkanoic acids).
56. Sometimes boring (laboratory test).
57. Appears boring (alkanoic acids).
58. Too many reactions making learning a bit boring (saturated and unsaturated hydrocarbon).
59. Too many conditions and reagents (laboratory test).
60. Structure and properties complex (aromatic hydrocarbon).
61. Complex mechanisms involved (aromatic hydrocarbon).
62. Bulky and complex (aromatic hydrocarbon).
63. Complicated (laboratory test).

64. Too many conditions and reagents (saturated and unsaturated hydrocarbons).
65. Many and complicated (saturated and unsaturated hydrocarbons).
66. Very complicated (saturated and unsaturated hydrocarbons).
67. Complex and confusing (classification and nomenclature).

Textbooks

Some of the typical responses on curriculum are as follows:

1. I simply cannot make any meaning from what is explained in the various textbooks around (separation and purification)
2. My first time in chemistry (determination of empirical and molecular formulae).
3. Lack of relevant textbooks (isomerism).
4. Inadequate materials for studies (aromatic hydrocarbon).
5. Not familiar (aromatic hydrocarbon).
6. Chemical equations and formulae not clear and familiar (alkanols).
7. Should have been taught earlier to give us the opportunity to try our hands on several experiments (alkanoic acids).
8. Lack of relevant books and chemicals (alkanoic acids).
9. Lack of textbooks in the library and bookshops (esters).
10. Because I was new to it, I found the technicalities included too complicated (classification and nomenclature).
11. Lack of textbooks (classification and nomenclature).

Student’s Attitude

Typical responses about factors inherent in students’ attitude are as follows:

1. Just don’t understand (laboratory test).

2. I don’t like it; did not avail myself to learn it well (aromatic hydrocarbon).
3. I just don’t understand (aromatic hydrocarbon).
4. Just difficult (aromatic hydrocarbon).
5. Just don’t understand (alkanols).
6. I was not in class during lesson (difunctional nature of amino acids).
7. Absent when taught (difunctional nature of amino acids).
8. Difficult (saturated and unsaturated hydrocarbons).

Others

Typical responses in respect of other comments are as follows:

1. Actual structure still not found (aromatic hydrocarbons).
2. Different from all other compounds in organic chemistry (aromatic hydrocarbons).
3. Application of rules with exceptions and needs serious thinking (esters).
4. Encouragement needed is not given but rather condemnation.

Appendix D

Reasons Teachers' gave in Respect of Organic Chemistry Topics Students' have much difficulty with.

Learning difficulty:

Typical responses with regard to learning difficulty are as follows:

1. Students' have difficulty in visualizing how atoms take part in a chemical reaction and how Sp^2- Sp^2 sigma and pi bonds are formed in benzene (aromatic hydrocarbons; saturated and unsaturated hydrocarbons).
2. The unusual behaviour of benzene (aromatic hydrocarbons).
3. Students' find it difficult to produce chemical properties of organic compounds taught due to the volume of subject area vis a vis time frame to finish (esters).
4. Students' do not appreciate the various reactions that these groups undergo (alkanols; alkanoic acids).
5. This is due to varied calculation steps sometimes involved in arriving at the formula (determination of empirical and molecular formulae).
6. Students do not clearly grasp mixing of different orbitals to obtain equivalent orbitals (saturated and unsaturated hydrocarbons).
7. The reactions these compounds undergo; writing of correct formulae of esters (saturated and unsaturated hydrocarbon; esters).
8. Students find it difficult to understand formation of hybrid orbital and molecular orbital structure of benzene (aromatic hydrocarbons; difunctional nature of amino acids).

9. Inability to relate theory with the reality (laboratory test; aromatic hydrocarbons; synthesis).
10. Students could not understand delocalization of pi electrons (aromatic hydrocarbons).
11. Not conversant with structures (classification and nomenclature).
12. Inability of students to observe pattern (aromatic hydrocarbons; saturated and unsaturated hydrocarbons; isomerism).
13. They confuse the structure of fats and oils with alkanols; they seem not to appreciate the fact that it is a different functional group (esters).
14. The chemical properties of benzene are difficult to remember (aromatic hydrocarbons).

Teachers' perception in organic chemistry

Typical responses about teachers' opinion about students' difficulty in organic chemistry are as follows:

1. Too abstract (isomerism).
2. Lack of practical evidence makes it look more abstract (esters; alkanoic acids; aromatic hydrocarbons).
3. Seems a little too complex for students' to understand (aromatic hydrocarbons; difunctional nature of amino acids).
4. Topic is abstract (isomerism).
5. Topic is abstract (aromatic hydrocarbons; synthesis).
6. Structures and names of simple amino acids do not follow any definite pattern like alkanes, alkenes and alkynes (difunctional nature of amino acids).
7. Some how abstract (saturated and unsaturated hydrocarbons)

8. Giving the IUPAC and common names of a compound confuse them (esters).
9. Complex (aromatic hydrocarbons; difunctional nature of amino acids).
10. Most concepts are too abstract (aromatic hydrocarbons; saturated and unsaturated hydrocarbons).
11. The two functional groups of amino acids confuse the students (difunctional nature of amino acids).
12. Complex (synthesis).

Textbooks

Typical responses on curriculum are as follows:

1. Lack of teaching aids makes teaching and learning difficult (esters; aromatic hydrocarbons; synthesis).
2. Lack of practicals may be a factor (laboratory test).
3. Lack of necessary apparatus and required chemicals (homologous series).
4. Models needed (saturated and unsaturated hydrocarbons).
5. Lack of models (isomerism).
6. Lack of teaching aids (aromatic hydrocarbon; synthesis).
7. There are not enough materials for illustrating and teaching these (aromatic hydrocarbons; synthesis; difunctional nature of amino acids).
8. No models or teaching aids (synthesis; difunctional nature of amino acids; esters; alkanoic acids).
9. They are lately taught (esters; synthesis).
10. Basic chemistry in Junior Secondary Schools is not enough (aromatic hydrocarbons; saturated and unsaturated hydrocarbons).

11. Lack of chemistry foundation after Junior Secondary School (difunctional nature of amino acids).
12. Weak knowledge in science after Junior Secondary School (synthesis).
13. Weak standard of scientific knowledge after Junior Secondary School (classification and nomenclature).
14. As a result of the extensive nature of organic chemistry syllabus and the late stage at which polymers are taught, students are often tired when they are taught (synthesis).

Appendix E

Table 14

Distribution of Students by Types of Schools and Gender

School	Type of school	Gender		Number of respondents from each school
		Male	Female	
A	Girls	0	30	30
B	Girls	0	30	30
C	Girls	0	30	30
D	Boys	30	0	30
E	Boys	30	0	30
F	Boys	30	0	30
G	Mixed	15	15	30
H	Mixed	15	15	30
I	Mixed	15	15	30
J	Mixed	15	15	30
	Total	150	150	300