RELATIONSHIP BETWEEN CONCEPTUAL UNDERSTANDING OF QUALITATIVE ANALYSIS AND PEREORMANCE IN VOLUMETRIC ANALYSIS AMONG SECONDARY SCHOOL STUDENTS IN KAFANCHAN, NIGERIA.

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NOVEMBER, 2014.

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NOV EMBER, 2014.

DECLARATION

I declare that the work in this thesis entitled **"Relationship Between Conceptual Understanding of Qualitative Analysis And Performance in Volumetric Analysis among Secondary School Students in Kafanchan, Nigeria "** has been carried out by me in the Department of Science Education. The information derived from the literature has been duely acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or Diploma at any other university.

Jonathan AYUBA	sign	Date

CERTIFICATION

This thesis entitled "RELATIONSHIP BETWEEN CONCEPTUAL UNDERSTANDING OF QUALITIATIVE ANALYSIS AND PERFORMANCE IN VOLUMETRIC ANALYSIS AMONG SECONDARY SCHOOL STUDENTS IN KAFANCHAN, NIGERIA" by Jonathan AYUBA meets the regulations governing the award of the degree of master of science Education of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

Jonathan AYUBA	Sign	Date
Prof. J.S. Mari Chairman Supervisory Committee.	Sign	Date
Dr. S.S. Obeka Member Supervisory Committee.	Sign	Date
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DEDICATION

This thesis is dedicated to God almighty for his grace upon my life throughout the period of my studies.

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ABBREVIATIONS

TUQA-Test of Understanding of Chemistry

TOPS-Test of Practical Skills

SSS-Senior Secondary School

SSCE-Senior Secondary Certificate Exams

WAEC-West Africa Examination Council

WASCE-West Africa School Certificate Exam

NECO-National Examination Council

STME-Sciences Technology and Mathematics Education

VA-Volumetric Analysis

QA-Qualitative Analysis

TUQAM- Test of Understanding of Qualitative Analysis for Males

TOPSM-Test of Practical Skills for Males

TUQAF-Test of Understanding of Qualitative Analysis for Females

TOPSF-Test of Practical Skills for Females

VAM-Volumetric Analysis for Males

QAM-Qualitative Analysis for Males

VAF-Volumetric Analysis for Females

QAF-Qualitative Analysis for Females

Operational Definition Of Terms

Qualitative Analysis: This is an analytical method of analyzing a substance in order to ascertain the nature of its chemical constituents.

Volumetric Analysis: this is quantitative analytical method involving the measurement of volume of solution of unknown concentration which is used to determine the concentration of the analyte.

Test of Understanding of Qualitative Analysis: this is an assessment tool developed by the researcher which was used to measure students' conceptual understanding of qualitative analysis.

Test of Practical Skills: this is an assessment tool developed by the researcher which was used to measure students' skills in practicals.

Conceptual Knowledge: this refers to understanding of meaning of concepts.

Conceptual Instruction: This is teaching activity that impact knowledge on concepts.

ABSTRACT.

This study investigated the relationship between conceptual understanding of inorganic Analysis and performance in volumetric analysis among secondary school students in Kafachan, Nigeria. The sample consisted of a total of 75 students drawn from five secondary schools in Kafanchan zone. The samples were randomly selected using balloting. Two instruments were used for data collection, Test of Understanding of Qualitative Analysis (TUQA) and Test of Practical Skill (TOPS). TUQA was first administered after which TOPS was administered. The Data collected were analysed and the hypotheses stated were tested using pearsons product moment correlation and t-test statistical techniques at 0.05 level of significance. The major findings revealed that significant relationship exist between students' conceptual knowledge of inorganic chemistry qualitative analysis and performance in volumetric analysis. It also revealed that there is no significant difference between students' performance in Qualitative Analysis and volumetric analysis. The study also revealed that there is no significant difference between the performance of male and female students in conceptual understanding of inorganic chemistry qualitative analysis. The researcher recommended that effort should be made to ensure that attention is given to conceptual instruction to enhance meaningful learning of qualitative analysis concepts. Based on this it was concluded that, conceptual knowledge of qualitative analysis relates high with the performance of students in volumetric analysis.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

Science teaching and learning have continually received criticisms from the society as a result of poor performance of Nigerian students in science subjects relative to their counterparts in other countries (Ajayi 2006). This is evident from the report of second international science study in which Nigerian students came last in Primary Science and second to the last in secondary science among the participating countries of the world (Rossier 1990, STAN 1992) cited in (Udoh 2008). A similar underachievement in science is further reported by Shelter Right Initiative where Nigeria trail behind other West African countries in Science subjects for nine consecutive years (Olubusiyi 2003).To support these, WAEC Chief Examiner's report (2009, 2010, 2011, 2012) reported that the performance of students in sciences was not encouraging. According to him, in 2010, the raw mean score was 34 and the standard deviation 17.66, this indicated that the performance was poorer than 2009 with raw mean score of 38 and standard deviation 18.65.Similarly, in 2011, the mean score was 24 and standard deviation 5.54, in 2012, the mean score was 24 and standard deviation 5.51. These show that the performance of students in the sciences has been declining.

Despite the indispensability of science in national development, Nigerian secondary school students' enrolment in science has not been appreciable. This situation coupled with poor formation of science concepts among students (Ezeh,1995) cited in Ibe (2013) poor interest in science (Achimugu, 1995) cited in Kaufman (2010) and overall poor academic achievement of secondary school students in science raised doubt about the efficacy of the existing instructional approaches in science. The current instructional models have been criticised of estrangement and lacking in indigenized approaches (Adesoji and Akpan, 1991) cited in Udoh (2008).

Teachers continue to teach science, particularly chemistry as a body of abstract knowledge with little or no students involvement in the learning process. The results show persistent poor performance in internal and external examinations, lack of interest on the part of the students in science and declining enrolment in science and related courses (Nwosu 2004).

Based on the relevance of chemistry, it is expected that the study of chemistry and performance in public examinations would be on the increase. But indices from examinations such as those organized by West African Examination Council (WAEC) showed both low enrolment and poor performance in chemistry WAEC, 2009, 2010,2011, 2012). Abdullahi (1982) cited in Nbina (2010) attributed the failure in chemistry to lack of qualified science personnel and equipments. Inappropriate medium of instruction (Obemeata 1995) cited in Edu (2006), poor classroom management (Pwob 1993) cited in Achimugu (2012) admission of unqualified students (Igwe 1994) cited in Ezeh (2011) and students perception of difficulty in some chemistry concepts (Bello 1990, Akinsola and Igwe, 1999) cited in Njoko (2007) are other reasons advanced.

A review of literature revealed that there is a fluctuating trend in students' performance in chemistry at secondary school level (Ifeakor 2005). Agusiobo (1998) cited in Okafor (2000) explained that the poor capital investment in terms of provision of science resources contribute to students' low level of academic performance. Commenting on students' achievement in Chemistry, the WAEC Chief examiner's report on Chemistry 1 May/June 2004 noted that, generally candidates performance was poor compared to previous years. The mean for the paper was 20 as against 26 for May/June 2003 WASSCE, while the standard deviation was 9.6 as against 10.34 for May/June 2003 WASSCE. He further stated that this could be attributed to poor exposure of candidates to practical work and inability of candidates to pay good attention to the study of chemistry. To support this, Njoko (2007) stated that, students performance in chemistry has consistently been poor and discouraging. This is attributed to poor teaching methods, lack of adequate practical equipment, mathematical nature of Chemistry concepts and laws. The West African Examination Council (WAEC) chief examiners' report, Nigeria 2005 and 2007 indicated that many candidates fail Chemistry in Senior Secondary School Certificate Examination (SSCE) because of their inability to link the relationship in mole concept such as mole to mole, mole to mass, mole to volume relationships.

Nigerian secondary school students poor performance in practical aspect of Chemistry in the Senior Secondary School Examination contribute to high failure rate of students in Chemistry (Akinleye 1987) cited in Achimugu (2012). West African Examination Council (WAEC) (2006), noted students poor performance in practical Chemistry examination and attributed this to poor exposure of candidates to Practical work.

Chemistry is essentially a practical oriented subject which demands proper exhibition of good study behavior for effective interpretation of existing phenomena (Njelita 2008). Lee and Fraser (2001) cited in Tan, Chia and Treagust (2001) reported that science teachers do not place much value on laboratory activities since they feel this takes time away from teaching to cover the prescribed examination driven curriculum. Akpan (1999) observed that lack of practical activities by chemistry students has resulted in poor communication and observational skills. The absence of these skills gave rise to students' poor performance in chemistry. Ojokuku (2012) stated that, laboratory experiences are so important that examination bodies like WAEC and NECO assessed learners as part of the final year examination in senior secondary. For instance, part of questions in WAEC chemistry 3 practical in 2007 and 2009 were:

- List four pieces of apparatus that would be used in determination of heat of neutralization.
- List three pieces of apparatus required for evaporation of sodium chloride solution to dryness.

A review of past senior secondary certificate chemistry examination question papers shows that there are usually three questions. Question one is usually on quantitative analysis involving acid-base titration and computation of unknown variable using the data generated. Question two is usually qualitative chemical analysis which involves identification of given chemical substances through the analysis of their constituent ions and functional groups. Question three is theory of practical which requires cognitive understanding of basic principles behind chemistry practical activities.

In Nigeria, Senior Secondary School Chemistry students do qualitative analysis practical work to prepare them for the externally administered practical examination. This forms part of the Senior Secondary School Certificate Chemistry examination, ordinary level. In qualitative analysis practical work, students are required to carry out procedures, record their observations and identify the cations and anions present in unknown samples.

Qualitative analysis is a difficult topic for secondary Chemistry students (Tan, Chia and Treagust 2001). In order to do well in qualitative analysis practical work, students should have a conceptual understanding of the underlying reactions (Treagust 1995).To make sense of the procedures, reactions and results in qualitative analysis practical work, students need to apply content knowledge which they have learned in topics such as acids, bases and salts, oxidation and reduction, reactivity of metals and periodicity. However, studies by Achimugu (2012) has revealed that students have difficulties in understanding chemical concepts and reactions that underpin qualitative analysis. Boo (1998) found that students believed the driving force for double decomposition reaction, a reaction involved in the identification of ions in qualitative analysis, was the difference in reactivity between the metallic elements present in the compound involved. Butts and Smith, (1987) in Tan, etal (2001) found that students could not relate the formation of precipitate in a double decomposition reaction to the low solubility of the salt. Similarly, students' lack of understanding of qualitative analysis was the examiners' comments, that in procedure involving the addition of aqueous ammonia to the unknown samples, many students wasted time testing for ammonia gas (WAEC 2009, 2010, 2011, 2012). Thus, there is the need for understanding of the principles underlying qualitative analysis in order to obtain accurate result.

A lot of researches have been conducted on gender issues and performance. .While some of these studies have reported gender disparity in STME achievement in favour of males, (Ajunwa2000) cited in Aina (2012).Other studies however, reported no difference exist (Madu 2004, Ibe 2004).Thus, gender differences in achievement in science seems inconclusive. A careful consideration of the statistics of contribution in STME in Nigeria reveals that participation of women is significantly low (Ibe 2006).To this effect, Nsofor (2001) lamented that this problem has been and is still in existence.

1.1.1 Theoretical Framework

This study is anchored on Ausubel's theory of meaningful learning and standard problem solving theory. Ausubel's theory of meaningful learning asserts that meaningful learning occurs when new knowledge is consciously linked by the learner to existing concepts the learner already knows. Ausubel views knowledge as representing an integrated system, in which ideas are linked together in an orderly fashion. Ausubel (1963) emphasizes that, to learn meaningfully, students must relate new knowledge to what they already know.

Ausubel (1963) emphasizes the learner's cognitive structure in the acquisition of information. According to him, new experience is always fitted to what the learner already knows. "Existing cognitive structure, that is an individual's organization, stability and clarity of knowledge in a particular subject matter field at any given time, is the principal factor influencing the learning and retention of meaningful new material". A cognitive structure that is clear and well organized facilitates the learning and retention of new information. A cognitive structure that is confused and disorderly, on the other hand, inhibits learning and retention. Learning can be enhanced by strengthening relevant aspects of cognitive structure.

Learning and retention is built around the concept of subsumption (Ausubel 1963). When a new idea enters consciousness it is processed and classified under one or more of the inclusive concepts already existing in the learner's cognitive structure. New meaningful material becomes incorporated into cognitive structure as long as it is subsumable under relevant existing concepts. Subsumers provide a basic structure around which information is organized. Ausubel (1963) described subsumption as facilitation of both learning and retention. Subsumers in cognitive structure act as anchoring posts for new information. The availability of anchoring ideas facilitates meaningful learning. If this ideational scaffolding is clear, stable and well organized, it provides better anchorage for new learning and retention than if it is unclear, unstable and poorly organized.

It is obvious therefore, from Ausubel's theory that if students are able to link the theory behind practical with the practical itself, there will be better understanding of the practical and hence improvement in the general performance of students in science subjects.

The standard theory of problem solving initially outlined by Newell, Shaw and Simon (1958) in Meighung (2000) focuses on how humans respond when they are confronted with unfamiliar tasks. The theory makes a number of claims about human cognition. The most basic is that problem solving involves the mental inspection and manipulation of list structures. According to the theory, problem solvers utilize means-ends analysis. This involves a combination of selecting differences between the desired and current states selecting operators that will reduce the chosen differences, and either applying the operators or creating sub-problems to transform the current states into ones in which they can apply.

Therefore, if students have a conceptual meaningful learning of inorganic chemistry qualitative analysis, standard problem solving theory could be applied in solving problems in practical chemistry.

1.2 Statement of the problem

The current situation of science teaching and learning in most secondary schools in Nigeria has become a concern to all, including government and the society at large (Okebukola 1997) cited in Nwosu (2006). Mari, (1994) reported that the majority of teachers in Nigerian secondary schools use traditional lecture method approach in teaching science. Effective science teaching ought to involve students in active participation in the teaching learning process.

Chemistry is an important science subject that occupies a prominent place in the school science curriculum. It serves as a prerequisite to the study of medicine, pharmacy agriculture, engineering, textile and clothing. Based on the above relevance, it is expected that the study of chemistry and performance in public examinations would be much emphasized to attained the goal of instruction. But indices from examinations such as those organized by the West African Examination Council (WAEC) showed both low enrolment and poor performance in chemistry. Ikejiorfor (1993) cited in Ikeobi (2010) reported, the need to find solution to students poor performance in chemistry, is therefore obvious. Many factors such as poor teaching methods, lack of adequate practical equipment, mathematical nature of chemistry concepts and laws account for students' poor performance. Exposure of students to laboratory activities and experiments is the hall mark of science education and in fact the future of education in science discipline both for skills acquisition and understanding of the basic principles and applications of science (Akano 2005) cited in (Nbina 2010). Ochonogor,(2001) revealed that a good mastery of practical procedures and practice of qualitative analysis at any level stands a sure way of producing bright students who would perform well in both chemistry and other sciences. This implies that understanding of qualitative analysis will enhance the performance of students in other aspects of chemistry, this translates to over all positive achievement in chemistry. This research work therefore, attempts to investigate the level of understanding of Inorganic chemistry qualitative analysis and its relationship with performance in volumetric analysis among senior secondary school students in Kafanchan, Kaduna state.

1.3 Objective of the Study

The objective of this study is to establish:

1. The level of understanding of qualitative analysis expressed by chemistry students under study.
2. If there is any relationship between chemistry students' understanding of qualitative analysis and performance in volumetric analysis.
3. If there is any gender difference in conceptual understanding qualitative analysis.
4. If there is any relationship in students understanding of qualitative analysis and volumetric analysis.

1.4 Research questions

The findings of this study will be used in answering the following research questions:

1. What is the level of understanding of qualitative analysis expressed by chemistry students under study?
2. What is the relationship between chemistry students' conceptual understanding qualitative analysis and performance in volumetric analysis?
3. What is the difference in performance between male and female students in conceptual understanding of qualitative analysis be?
4. What is the difference in performance between male and female students volumetric analysis?

1.5 Research hypotheses

The following research hypotheses were tested at $p \leq 0.05$

1. There is no significant relationship between chemistry students' conceptual understanding of qualitative analysis and performance in volumetric analysis.
2. There is no significant difference in performance of male students in qualitative analysis and male students in volumetric analysis.
3. There is no significant difference between the performance of female students qualitative analysis and female students in volumetric analysis.
4. There is no significant difference between the performance of male and female students in qualitative analysis.
5. There is no significant difference between the performance of male and female students in volumetric analysis.

1.6 Significance of the Study

The findings of the study will hopefully uplift the standard of chemistry in the following areas:

1. The findings of this study would be useful to teachers as it would assist them in ensuring that students acquire the conceptual knowledge behind practical before embarking on the real practical.
2. Textbooks writers would find this work useful as it would assist them in selecting contents to be incorporated in the textbook by ensuring that concepts behind any chemistry practical are treated before the real practical.

3. The research will also serve as a reference material for other researchers, who may wish to carry out the same or similar research. It is hoped that other researchers who may be interested in investigating this topic or a similar one, can use this work as a reference material, since it will be made available in libraries.
4. If it is found that there is a significant relationship between chemistry students conceptual understanding of qualitative analysis and performance in volumetric analysis, chemistry students will be encouraged to pay more attention to inorganic chemistry qualitative analysis concepts. This would improve their performance in volumetric analysis and their general achievement in chemistry.
5. Curriculum planners would also find this work useful as it would assist them in selecting contents to be included in the curriculum.

1.7 Scope of the Study

The study examined the relationship between students' conceptual understanding of qualitative analysis and performance in volumetric analysis among secondary school students in Kafanchan Zonal Inspectorate Division, Kaduna State. The study is delimited to SSS III students in 5 selected secondary schools in Kafanchan Zonal Inspectorate Division of Kaduna state. Five schools covering public schools participated in the research. SSS3 are used for the research because usually qualitative analysis is taught at SSS3.At SSS3 students would have acquired adequate knowledge in inorganic qualitative analysis. This was also due to proximity, time constraint and money. Therefore, generalization of the research should be within the study area.

CHAPTER TWO

REVIEW OF LITERATURE

2.0 Introduction

This study aimed at investigating the relationship between students' conceptual understanding of qualitative analysis and performance in volumetric analysis among secondary school students in Kafanchan zonal inspectorate division, Kaduna State. In this chapter, literature related to the subject of this study is reviewed. This literature is reviewed under the following sub-headings:

- General Performance of Chemistry Students in Science .
- Gender Differences and Academic Performance
- Qualitative Analysis and Academic Performance of Chemistry Students.
- Volumetric Analysis and Academic Performance of Chemistry Students.
- Review of Related Studies.
- Implication of Literature Review on the Present Study.

2.1 General Performance of Chemistry Students in Science .

In Nigeria science teaching and learning have continually received criticisms from the society as a result of poor performance of Nigerian students in science subjects, relative to their counterparts in other countries. This is evident from the report of Second International Science Study in which Nigerian students came last in Primary Science and second to the last in Secondary Science among the participating countries of the world (Rossier 1990; STAN 1992) cited in (Udoh 2008). A similar underachievement in Science is further reported by Shelter Right Initiative, where Nigeria trail behind other West African countries in Science subjects for nine consecutive years (Olubusuyi 2003). Other research findings showed that lack of resources for effective practical and activity work in science teaching and learning could culminate in poor state of students' achievement in science (Ojukuku 2008).

It has been observed that students' performance in Science subjects in external examinations such as WAEC and NECO examinations has over the years been generally poor (Ezeh 2000 Ezeh, 2002). Some reasons have been adduced for the observed poor performance, prominent among which are lack of qualified science teachers, incompetence on the part of the few available science teachers, students lack of interest in science (Ezeh 2000, Ezeh 2002). In countries that are genuinely committed to the attainment of a high level of techno-scientific development, adequate attention is paid to the provision of effective STM education via a sustainable programme of capacity building for the serving STM teachers. This according to Ajeyalemi (2002) enhances the abilities and capabilities of human resources, identifying and meeting development challenges in sustainable manner.

According to Aliu (2001) the quality of schools as judged by the high failure rate in the Senior Secondary School Certificate Examination (SSCE) in STME may not solely be attributed to methodology but also to the failure of institutions to acquire resources and make the best of these resources in pursuit of objectives of STME. Agusiobo (1994) cited in Nwosu (2006) stated that, science teaching in Nigeria has been faulted for many reasons one of which is non – utilization of instructional resources by teachers. This has contributed to poor performance in science subjects (Soyibo 1986) cited in (Nwagbo 2006). Modern Science Technology and Mathematics (STM) teaching and learning stressed students participation in the learning process through series of activities, both within and outside the class room. This participation cannot occur in a vacuum. Teaching aids and materials as well as resources (human and physical) within and outside the school will provide the appropriate media for interaction. These will provide concrete experiences which students need in order to develop intellectually (Eniayeju 1995) cited in Udoh (2008). He further stated that, information and facts are better retained and learning becomes more meaningful and interesting when resources are carefully selected and skillfully used by the teacher.

Performance of students in science at the Senior School Certificate Examination (SSCE) has however persistently continued to be on the low side (Okebukola 1997) cited in Nwosu (2006). He attributed this to topic difficulty, over loaded curriculum and inadequate facilities in laboratories of many schools. According to him, our laboratories may not be much different from classrooms in terms of equipment and materials. what is commonly observed in most schools is a classroom space called the laboratory Bajah (1979) cited in Lawal (2006) in his study on school environmental factors that affect students performance in Chemistry, stressed that in the study of science, laboratory facilities and instructional programme materials to which students are exposed are contributing factors to their overall achievement in science. The problems of poor achievement in science have become too obvious and have been the concern of many conferences and strategies aimed at addressing the situation. As a result of such measures, many reasons have been advanced for the poor achievement in science, school and classroom factors inclusive (Akpan 1986) cited in Bassey (2006).

Chemistry is an important science subject that occupies a prominent place in the school science curriculum. It serves as a pre-requisite to the study of Medicine, Pharmacy, Agriculture, Engineering and Textile and Clothing. Based on the above relevance, it is expected that the study of Chemistry and performance in public examinations would be on the increase. But indices from examinations such as those organized by the West Africa Examination Council (WAEC) showed both low enrolment and poor performance in Chemistry (WAEC 2009, 2010, 2011, 2012). The failure in Chemistry has been attributed to a number of factors among which are, lack of qualified science personnel and equipment (Abdullahi 1982) cited in (Nwosu 2006) inappropriate medium of instruction (Obemeata, 1995), poor classroom management (Pwol, 1993), admission of unqualified students (Igwe, 1994) cited in (Achimugu 2012) and students perception of difficulty in some Chemistry concepts (Bello, 1990; Akinsola and Igwe, 1999) cited in (Udoh 2008). Recently, attention has been focused on some aspects of chemistry in order to find out what exactly was responsible for the high failure rate in Chemistry. Most of these literatures point to poor and ineffective instructional strategy as a major culprit responsible for the poor performance (Lasisi 1998) cited in (Udoh 2008). There is therefore, urgent need to look for appropriate and effective instructional strategy to teach the difficult concepts in Chemistry since it has been found out that not all aspects of it that posed difficulty to students (Akinsola and Igwe 1999) cited in (.Udoh 2008)

In Nigerian secondary schools, students enrolment in science and chemistry in particular has not been quite appreciable. This situation coupled with poor formation of science concepts among students (Ezeh, 1995) cited in (Edu 2006) poor interest in science (Achimugu 1995) cited in (Udoh 2008) and overall poor academic achievement of secondary school students in science raise doubt about the efficacy of the existing instructional approaches in science. In fact, the current approaches to science instruction in Nigeria has been criticized as hopeless and incapable of bridging the gap between the initial background of the learners and the new field of knowledge (Fafunwa, 1983) cited in (Okechukwu, 2002). The current instructional models has been criticised of estrangement and lacking in indiginised approaches (Adesoji and Akpan, 1991) cited in (Nbina 2010).

Shuaibu and Mari, (2000) stated that the process approach to instruction sees science education as a human enterprise requiring both the teachers and the learners to be actively involved in the teaching learning process to make both teaching and learning effective and meaningful. According to them, the process approach by its nature is cost intensive and in Nigeria the harsh economic realities in the country has made it virtually impossible for the government and school proprietors to provide adequate science equipment and facilities for meaningful hands-on-activities by the learners. This has resulted in teachers continual teaching of science as a body of abstract knowledge with little or no students involvement in the learning process. The results have become persistent poor performance in internal and public examinations, general lack of interest on the part of the students in science and declining enrolment in science and related courses in tertiary institutions.

Despite the indispensability of science and technology education in economic development of any nation, yet science education at all levels in Nigeria is in a deplorable state.

A review of literature revealed that there is fluctuating trend in students' performance in science particularly chemistry at secondary school level (Ifeake 2005). Okafor (2000) explained that the poor capital investment in terms of provision of science resources contribute to students low level of academic performance. Commenting on students low achievement in chemistry, the WAEC Chief Examiner's report on Chemistry, May/June 2004 noted that, generally candidates performance was poor compared to previous years. The mean score for the paper was 20 as against 26 for May/June 2003 WASSCE, while the standard deviation was 9.6 as against 10.34 for May/June 2003 WASSCE. He further stated that this could be attributed to poor exposure of candidates to practical work and inability of candidates to pay good attention to the study of Chemistry.

2.2 Gender Differences and Academic Performance

Gender according to Adeyemi and Adebara (2001) cited in Udoh (2008) deals with socially defined sex roles, attitudes and values which are acquired through socialization and ascribed by a given community as appropriate for one sex or another, it affects power sharing, decision making and division of labour. The slogan that what a man can do a woman does it better may not be true as confirmed by Awoniyi (2007) cited in Ezeh (2011) that male candidates perform better than female candidates in subjects requiring quantitative ability like signs. According to him, any science and science enrollment and performance of females are always very low compared to that of their male counterparts. Ajao and Aina (2007) cited in Aina (2012) noted that a wide gap exist between the girl child and the boy child going to school and this also brings disparity in the courses they offer in school. According to them females mind are tailored towards economically viable courses leaving such courses like engineering, medicine, mathematics etc to men. Olarewaju (2006) cited in Ibe (2013) in her study on gender difficulties in the learning of biology concepts in the era of technology, revealed that gender inequalities, have in recent years been recognized as one of the major obstacles to women development world wide. Amusat and Awoyemi (2006) on the influence of gender difference on students' level of achievement in chemistry, concluded that gender difference has influence on students' level of achievement in chemistry at secondary school level. According to them, many factors are responsible for gender difference in terms of enrollment and performance. Many if not all of these factors are man-made and they can be avoided if the country is ready to pay the price.

According to Okeke (1990) cited in Aina (2012) male students often perform better than their female classmates in science subjects at O'level. The gap in science achievement between the sex widens in favour of boys in co-educational schools but not in single sex schools (Dipilla, 1991) cited in Nbina (2010). The wide gender gap in students achievement in science in co-educational schools has been attributed to uncondusive classroom environment for girls due to intense sex role stereo typing and apparent boys domination of science learning activities (Njoku 1993) cited in Edu (2006). Attempts at exploring ways of enhancing girls performance in science in co-educational schools have often involved modifications of the classroom environment and interaction patterns to make them more conducive for science education of girls (Goldman, 1991; Johnson, 1991) cited in Aina (2012). Njoku, (2002) stated that cooperative grouping has been found to enhanced female achievement in science. Njoku, (2002) citing Sabar and Lovin (1987) stated that, in co-educational science classrooms, boys to dominate the learning activities especially during practical work. He reported that girls interest and participation in science activities under co-educational setting are seriously inhibited by their fear of competition from boys who thus take over the activities and dominate them. Boys' competition and domination of science activities tend to frustrate the girls such that the girls step aside from the mean stream activities, and become watcher, helpers and secretaries to record group findings, while the boys grapple with concepts equipments and materials and problem solving (Shapiro, Kramer and Humerberg, 1981) cited in (Ibe 2013).

Mari, (2002) citing Backer, (1982) attributed the sex difference in achievement in science to teachers who often spoke more frequently to boys, asked the boys higher order questions and protest them from quality work and girls for neatness. Shemesh (1990) cited in Ezeh (2012) attributed sex differences in science reasoning to gender related difference to reasoning skill. Many studies demonstrated that boys are superior to girls in their level of performing piagetion like formal reasoning task (Howe and Shayer, 1981) cited in Ikeobi (2010). Mari; (2002) citing Shemesh (1986), in a survey of students cognitive development in Israel revealed that gender related differences in performance of Piagetian – like tasks were not observed before the ninth grade (14 – 15 years). According to him, some researchers have identified teaching strategies as a cause of sex related differences in science performance. For instance, Ajewole, (1990) cited in Adesoji, (2008) studied the effects of the guided discovery and expository instructional methods on students transfer of learning. Analysis of results revealed no significant difference in the transfer of learning between male and female students exposed to guided discovery and expository methods. Similarly, Mari; (1994) and Ajagun, (1998) in independent studies demonstrated the superiority of girls over boys in the use of science process skill. In the studies girls were found to superior in the use of skill of observing, inferring, predicting, hypothesizing making operational definitions and interpretation of data. The boys on the other hand, were better than girls in experimenting and measuring. This suggests, that the process – based instruction could enhance female student in science better than their male counterpart, as female subjects in the studies were found to perform better than male subjects in science process skill. Of greater interest is the link that has been established between the acquisition of science process skills and formal reasoning ability. Mari; (2002) citing Baid and Borich, (1985) who investigated that correlation between science process skills and formal reasoning reported that the two variables though different are significantly correlated. Mari, (2001) has established that process – based instruction enhances acquisition of reasoning ability in students. He argued that girls are superior to boys in the use of science process skills because science process-based instruction promotes cognitive gains in girls more than boys. Mari, (2002) established that there is significant difference in performance between the male and female subjects in proportional reasoning, correlational reasoning and probability reasoning. He stated that though, the male subjects performed better than their female counterpart in conversation, combinatorial reasoning and control of variables, however the difference in the mean score was insignificant at P = 0.05 level.

Ibe, (2004) stated that education for the future that will equip the individual with the power to adapt to change irrespective of gender should be the most important goal of education. Women who have been and who are still the traditional social educators, environmentalists, nutritionist and health workers must come to the forefront and bring to bear their traditional strengths, accumulated knowledge, wisdom and roles upon the future direction of national and international science (Nwosu 2004). The qualities and roles of women must be translated into a modern scientific plan of action.

These can only be realized through viable STM education. However, research studies in STME have indicated in these areas.

- School enrolment especially in the physical science and engineering in favour of males.
- Achievement in STME at all levels of education in favour of males.
- Access to science and technology related carriers especially in engineering fields, oil companies in favour of males (Ibe 2006).

A lot of research on gender issues and performance has been carried out. While some of these studies have found gender disparity in STME achievement in favour of males, (Ajunwa, Awodeji 2000) cited in Aina (2012). Others have found none, (Madu, 2004, and Ibe, 2004). Hence gender differences in achievement in science are inclusive. A careful consideration of the statistics of contribution in STM in Nigeria reveals that participation of women is significantly low. Bolarin, (1987) as cited in Nsofor, (2001) lamented that this problem has been and still in existence. Bolarin, (1998) cited in Ibe, (2006) reported of the acute shortage in number of females that gain access to scientific technological training at the University level.

Although low participation by women is persistent, there is no evidence of males being more intelligent than women. This calls for need to closely scrutinize the paradigms that govern the practices of science and technology education. There is the need to go to the foundation which is teaching science at secondary school level, which forms the bedrock upon which tertiary education is based. Factors, which affect achievement in STME such as non-availability of equipments for students to manipulate in STME as well as the method of instruction and the use of non-innovative science methods, have to be considered. Higher achievement by males may be due to more opportunities given to them in life compared to those given to females. It therefore becomes necessary to study achievement in science in a conducive environment where females are given equal opportunities with males.

Ukwungu (2002) stated that, in Nigeria, considerable efforts have been expended on trying to see how gender effect can be implicated in the seemingly poor performance of girls in science. Unfortunately these research efforts have not produced any definite clear-cut picture from their findings as they do not agree on the magnitude and direction of gender differences in performance in science. Splindler (1983) cited in Aina (2012) opined that females will benefit more from instruction that incorporate culture and totality of environment. Davidson (1987) cited in Ikeobi (2010) also identified that culture at times isolates females from some practices necessary for the complete awareness of their environment and mastery of its functioning. With unbiased science instruction, the females will begin to appreciate the inherent realities in some natural phenomena, which their culture has alliterated them from, and also the relationship between these cultural realities and western concepts. As such, their interest in science will increase and they will invariably show more interest in science. He noted that culture based science instruction offers a better opportunity for girls, it should also be appreciated that in the current modern society, girls are no more given the type of treatment they used to received during the pre-colonial era. As such, the gap between boys and girls may not be as wide as it could have been.

As stated earlier, gender differences in achievement in science are inconclusive. While some are o the opinion that the male students show superiority over the female students some are of the opinion that the female students show superiority over the male students in some areas. Similarly, some are of the opinion that given the female students equal opportunity in life with their male counterparts they will perform just like the male students. The researcher is of the opinion that the male students show superiority in terms of achievement in science over the female students.

2.3 Qualitative Analysis and Academic Performance of Chemistry Students

Akpan (2005) observed that lack of practical activities by Chemistry students has resulted in poor communication and observational skills. The absence of these skills gave rise to students' poor performance in chemistry. A review of past senior secondary certificate examination chemistry question papers shows that there are usually three questions . Question one is usually on quantitative analysis involving acid-base titration and computation of unknown variables using the data generated. Question two is usually qualitative chemical analysis which involves identification of given chemical substances through the analysis of their constituent ions and functional groups. Question three is theory of practical which requires cognitive understanding of basic principles behind chemistry practical.

Qualitative analysis is a difficult topic for students to learn as it involves both process skills as well as the understanding of many chemistry concepts. Chemistry teachers in Singapore frequently complain that their students do no understand what they are doing in the qualitative analysis practical sessions (Tan, 2000). He observed that many students adopt a recipe approach, cannot carry out the experimental procedures properly. An example of students' lack of understanding of qualitative analysis was the examiners' comments that in procedures involving the addition of aqueous ammonia to the unknown samples, many students wasted time testing for ammonia gas which, not surprisingly, they were able to detect (NECO 2006, 2007). However, students can score high marks in qualitative analysis practical examinations without much understanding of qualitative analysis. This is because the examinations mainly assess students ability to carry out procedures and write observations (Tan, etal 2001). Thus there is the need for alternative means to assess students' understanding of the qualitative analysis.

Studies on qualitative analysis conducted by Treagust (1995) cited in Abba (2012) concentrated on how students can be adequately equipped with essential science process skills in O-Level qualitative analysis practical work. He developed a two-tier multiple choice instrument which was used to determine students understanding of the concepts involved in qualitative analysis. The items in two – tier multiple choice diagnostic instruments are specifically designed to identify alternative conceptions and misunderstanding in a limited and clearly defined content area. The first part of each item consists of a multiple choice content question usually having two or three choices. The second part of each item contains a set of four or five possible reasons for the answer to the first part. Incorrect reasons (distracters) are derived from actual students alternative conceptions gathered from the literature, interviews and free response tests. Tan, etal (2001) used this instrument in their study titled 'Development and Application of the Two-Tier Multiple Choice Diagnostic instrument to Assess High School Students' Understanding of Inorganic Chemistry Qualitative Analysis". Their study revealed that students may learn facts without an adequate understanding of the prepositions and concepts involved. It also revealed that the students' lack of consistency of alternative conceptions could point to their having more than one conception for a particular concept, and different conceptions can be brought into play in response to different problem contexts. According to the researchers, the lack of consistency could also be due to students not having adequate understanding of the topic and resorting to guessing.

Akpan, (2005) observed that candidates loose marks in qualitative analysis for the following reasons:

1. Improper reporting of tests, observations and inferences. He stated that wrong test gives wrong observations and wrong inferences, even if student did not write anything in the test

column, but the candidate writes and gives his/her observations the student can score the marks for observation and inference because the test has been given in the question and as such no marks is awarded for the test.

2. Omitting the state of the chemical used. Wrong states leads to wrong test, resulting to wrong inference – Example writing sample C tested with litmus paper instead of solution instead of solution of sample C tested with litmus paper.

3. Use of wrong terminologies. Students don’t use correct words or terms example solution, precipitate and residue precipitate solution is a wrong term it is either a precipitate or a solution.

4. Identifying colours of solutions, gases and precipitates. It must be stated as observed, wrong colours gives wrong report of observation.

5. Incorrect chemical names, symbols, formulae and radicals. Wrong symbols, formula, chemical names leads to lost of marks. Chemical names like sulphate is wrong, sulphate could be SO_3^{2-} or SO_4^{2-} so they should be specified, and say trioxosulphate (iv) ions for SO_3^{2-} and tetraoxosulphate (vi) ions for SO_4^{2-}.

Ochonogor, (2008) citing Oriaifo (1985) stated that qualitative analysis is aimed at demonstrating proficiency in making experimental observations, making reasonable acceptable and accurate inferences from experimental observations and identifying unknown ions vis-à-vis elements present in compounds. Observation that leads to proper inference is a key to the practice of science. Hence a good knowledge of qualitative analysis will always produce better chemists and scientists. The steps involved in true qualitative analysis are systematic and a jump of any of them results in unwanted reactions and negative results.

2.4 Volumetric Analysis and Academic Performance of Chemistry Students

A review of past senior secondary certificate examination chemistry question papers shows that there are usually three questions.Question one is usually on volumetric analysis involving acid-base titration and computation of unknown variables using the data generated. Question two is usually qualitative chemical analysis which involves identification of given chemical substances through the analysis of their constituent ions and functional groups. Question three is theory of practical which requires cognitive understanding of basic principles behind chemistry practical. Ochonogor (2008) stated that personal experiences and other reports such as WAEC chief examiners' report over the years have always recorded poor students performance in practical chemistry especially volumetric analysis with its attendant effects on their overall performance in chemistry. Similarly, studies by Ochonogor (2001), Ababio (2004) revealed that a good mastery of and practice of volumetric analysis at any level stands a sure way of producing bright students who perform well in chemistry and other sciences. Many students dread this aspect of chemistry for reasons such as:

a. poor reporting style employed

b. improper manipulation of materials and apparatus for effective results

c. poor mathematical skills to enable them find the unknown variable from the data generated

d. failure of many teachers to make volumetric analysis an interesting aspect of practical chemistry before the students.

Similarly, Ojukuku (2008) stated that if students are familiar with what examiners are looking for in acid-base titrations and have the required knowledge on the procedure for solving problems on acid-base titrations then there would be a marked improvement in the performance of students in WAEC and NECO practical chemistry examinations which would translate to their over all performance in chemistry.

Nnaobi (2008) suggested that discussion and demonstration methods of teaching can help teachers to effectively execute volumetric analysis as an aspect of practical chemistry. The methods could be appealing to any practical chemistry where reception mode of learning is prevalent. Students will gain new ideas while teachers posses new ideas if these methods are employed to teach volumetric analysis.

2.5 Review of Related Empirical Studies

A number of researchers have worked on empirical studies on qualitative analysis, volumetric analysis and gender difference in STME. Many reasons were advanced to have been affecting the students' performance in both qualitative analysis and volumetric analysis. For example,

Tan (2000) carried out a research titled development and application of a diagnostic instrument to evaluate secondary students' conception of qualitative analysis. The sample of his study consisted of grade 10 students drawn from 11 schools. The instrument used for data collection was Qualitative Analysis Diagnostic Instrument (QADI). The QADI was ad ministered to 915 grade 10 students from 11 selected secondary schools 360 grade 11 and 12students, 38 undergraduate and 56 graduate trainee teachers from one university, the results obtained were analysed using descriptive statistical technique The result showed that alternative conception exists among the subject under study in displacement reaction, redox reaction, heating, addition of acid.

Gazi, Oluruntegbe and Tunde (2010) carried out a research titled Volumetric Analysis and Chemistry Students' Performance: Combined influence of Study habit, Physiological factors and Psychological factors. They used two hundred forty randomly selected senior secondary two students from six secondary schools in Akure South Local Government Area of Ondo State as population of the study. The researchers adapted the study habit inventory from Bakare (1977), with reliability co-efficient 0.83 for the study. The results obtained were analysed using chi-square at 0.05 level of significance. The results indicated that these factors actually influenced the attitudes of the subjects towards volumetric analysis exercises. They therefore, recommended that chemistry teachers need to have proper understanding of these physiological and psychological factors to enable them enhance students' attitudes and performance in practical chemistry.

Meighung (2000) carried out a research titled Algorithmic problem solving and conceptual understanding of chemistry by students. He used a sample of 152 senior secondary two students. The sampled students were given a set of twelve questions test where they were required to answer all the questions and provide both the solution paths and an argument for their answers. For the sake of data analysis, a scoring scheme was developed to measure students' performance. Due to the short answers being given by the students, the scoring scheme was designed to have 0 (incorrect) or 1 (correct) point, no partial scores were considered. On average the percentage of correct score for the students' performance on all items was 80.37% and standard deviation of 13.10. The percentage of correct answers for each category, algorithmic problem and conceptual problems were 83.31 (s.d=16.99) and 75.44 (s.d=17.53) respectively. t-test was used to test the hypothesis at 0.05 level of significance. A significant difference was found in students' performance in the two category of questions (t=3-83, p=0.0001). The students did significantly better in algorithmic problem than in conceptual questions.

Eriba, (2013) conducted a research titled, Effects of Concept Mapping Strategy on Students' Understanding of difficult Chemistry Concepts. The sample consisted of 1,357 Senior Secondary II Chemistry Students drawn from two schools in two local Government Area of Benue State of Nigeria. The researcher developed one instrument for data collection, Test of Understanding of Chemistry Concepts (TUCC). The data obtained was analysed using Analysis of Covariance (ANCOVA). Two hypotheses were tested at 0.05 level of significance. The study adopted a Quasi-experimental design since experimental and control groups were used for the research. The result of the analysis showed that there was a significant difference in the mean achievement scores of students taught using concept mapping and those taught using the conventional method. Similarly, the result also showed that there was a significant difference between male and female students taught using concept mapping. Based on these results the researcher recommended that, since concept mapping is found to be an effective teaching strategy for improving students' achievement in Chemistry, Chemistry teachers should accept it as one of the strategies they can use in chemistry classroom. Also, teacher training Institutions should include the concept mapping strategy in their Chemistry course contents. This would ensure that pre-service Chemistry teachers known the value and how to use the concept mapping strategy effectively.

Barak and Dori (2005) Conducted a research titled, Enhancing Undergraduate Students' Chemistry understanding through Project Based Learning in an Information Technology (IT)

Environment. The sample consisted of 180 undergraduate Chemistry students in Massachusetts Institute of Technology, Cambridge. The researchers developed and instrument on the use of representational resources within a computer-based environment, called ChemSence, to support High School Chemistry Students' representational practices and their understanding of key Chemical concepts. The data obtained were analysis using Analysis of Covariance (ANCOVA). It was observed that, after using ChemSence along with structured laboratory activities for two weeks, students developed a deeper understanding of the geometrical and connectivity –related aspects of solubility. Specifically at pre-test, few students were able to correctly represent the shape or charge distribution of a water molecule, correctly show the alignment of water molecules with ions and with each other, or adequately discuss relevant connectivity issues. At post-test, students were much more able to show the shape and alignment of water molecules with each other and with dissolved ions, accurately represent correct bonding changes and connections between the macroscopic and nanoscopic levels and use formal representations to represent the underlying nanoscopic- level solubility phenomena. The researchers concluded that when using representational resources as part of collaborative investigations, the nature of students' conversation becomes more "chemical" and students deepen their understanding of the molecular nature of physical phenomena that have, as a result become chemical.

Barak and Dori (2011) also conducted a research titled, Enhancing Undergraduate Students' Chemistry through Project-Based Learning. The sample consisted of 215 Chemistry students in Technion, Israel Institute of Technology. The distribution of the sample into experimental 9N=95) and control (N=120) groups was not random. Rather, it was based on the students' preferences of carrying out the project. Two instruments were used for the research to examine the performance of the subjects under study both qualitatively and quantitatively. The qualitative instruments which were applied to only the experimental group, included projects' content analysis, "think aloud" interviews and observation while the quantitative instruments were concerned with students' attitudes and abilities toward web-based and project based learning. This section included 14 statements on a 1 to 5 likert scale, with 1 being "strongly disagreed and 5, strongly agree. Analysis of Covariance (ANCOVA) was used to investigate the effect of the PBL on students achievement for both the post-test and the course final examination. The results revealed that he experimental group students received significantly higher scores than their control group classmates in the question related to transversing the four Chemistry understanding level. Their findings also show that students explore new concepts, examined and validated new information and organized it to generate creative solutions to the problems and riddles with which they were presented.

2.6 Implication of literature reviewed on the present study

This chapter reviewed literature related to the conceptual understanding of inorganic chemistry qualitative analysis and Performance of secondary students in volumetric analysis.

From the literature reviewed it was established that the performance of students in chemistry in public examinations organized by both WAEC and NECO showed both low enrollment and poor performance in chemistry (WAEC 2009, 2010, 2011, 2012). The failure rate in chemistry is attributed to lack of practical activities by chemistry students which resulted in poor communication and observational skills. The absence the absence of these skills give rise to poor performance in both qualitative analysis and volumetric analysis which translate to overall poor performance in chemistry (Akpan 2005). He observed that candidates loose significant marks in qualitative analysis which usually translate to overall failure in chemistry examination in both WAEC and NECO. Ojukuku (2008) opined that if students are familiar with what examiners are looking for in both qualitative and volumetric analysis then there will be marked improvement in the performance of students in WAEC and NECO practical chemistry examination which would translate to their overall performance in chemistry. Nnaobi (2008) suggested that discussion and demonstration methods of teaching can help teachers to effectively execute qualitative analysis and volumetric analysis in practical chemistry. The methods could be appealing to any practical chemistry where reception mode of learning is prevalent. Students would gain new idea if these are implored to teach qualitative analysis and volumetric analysis. WAEC (2006) noted students' poor performance in practical examination and attributed this to poor exposure of candidates to practical work.

CHAPTER THREE

METHODOLOGY

3.0 Introduction

This chapter focuses on the methodology employed in conducting the research. The chapter is presented under the following sub-headings.

- Research Design
- Population of the Study
- Samples and Sampling Procedure
- Instrumentation
- Data Collection Procedure
- Data Analysis

3.1 Research Design

This study employed a correlational survey study. According to Ogunleye, (2000) cited in Olayiwola (2007) a survey research is one in which a group of people or items are studied by collecting and analysing data from only a few people or items considered to be representative of the entire group. Best and Khan (1989) in Olayiwola (2007) stated that, survey research involves a clearly defined problem and definite objectives. It requires expert and imaginative planning, careful analysis and interpretation of the data gathered and logical and skillful reporting of the findings.

3.2 Population of the Study

The population of the study comprised of all SS III chemistry students from secondary schools in Kafanchan Zonal Inspectorate Division of Kaduna State. The schools comprised of only public owned secondary schools. There are twenty nine (29) senior secondary schools in Kafanchan Zonal Inspectorate Division. From the twenty nine senior secondary schools there are one thousand five hundred and twenty (1,520) senior secondary three (SS3) chemistry students in 2011/2012 session which constituted the target population. The detail description of population is presented in Table 3.1 bellow.

S/N	Name of School	No of Male	No of Female	Total
1.	G.S.S. Rafin Raga	7	3	10
2.	G.G.S.S. Kafanchan	-	86	86
3.	G.S.S. Kafanchan	48	12	60
4.	G.S.S. Ung. Fari	45	22	67
5.	G.S.S. Bakin Kogi	8	2	10
6.	G.S.S. Zipak	41	36	77
7.	G.S.S. Fadan Koma	18	12	30
8.	G.S.S. Fori	8	2	10
9.	G.S.S. Kukum Daji	27	11	38
10.	G.G.S.S. Kwoi	-	70	70
11.	Govt. College Kagoro	70	-	70
12.	G.S.S. Kagoro	53	27	80
13.	G.S.S. Malagum	54	46	100
14.	G.S.S. Tum	12	8	20
15.	G.S.S. Kadarko	90	41	131
16.	G.S.S. Fadan Atakar	36	24	60
17.	G.S.S. Manchock	70	40	110
18.	G.S.S. Zankan.	11	4	15
19.	G.S.S. Bondon	49	23	72
20.	G.S.S. Zangang	6	4	10
21.	G.S.S Kuriyas	46	14	60
22.	G.S.S. Bello Kushi	20	10	30
23.	G.S.S.Ngasha	31	14	45
24.	G.S.S. Sabzuru	22	18	40
25	G.S.S Ramindop	13	9	22
26	G.S.S Ankun	39	16	55
27	G.S.S Nok	23	17	40
28	G.S.S Angwa Rimi	22	10	32
29	G.S.S Afana	48	22	80
	Total	917	603	1520

Source:(Kafanchan Zonal Inspectorate Division, 2013)

3.3 Sample and Sampling Procedure

In this study, the sample was selected to the size of the population of the study. Five senior secondary schools were randomly selected with replacement using balloting. In balloting, the names of schools in the Zonal Inspectorate Division were written on pieces of papers and squeezed and then pick at random. The first five schools selected represented the sampled schools. Random sampling technique was used to ensure homogeneity and accurate representation (Olayiwola, 2007).

On the whole, a total of seventy five secondary three (SS3) students were selected as samples from the five sampled schools. Fifteen students were randomly selected from each of the sampled schools using table of random numbers. This is to ensure that participants have equal chances of being selected. The detail description of the sample is presented in Table 3.2 bellow.

Table 3.2 The Study Sample

S/N	Name of School	No. of Males	No of Females	Total
1.	G.G.S.S. Kwoi	-	15	15
2.	Govt. Colledge Kagoro	15	-	15
3.	G.S.S. Manchock	10	5	15
4.	G.S.S. Malagum	8	7	15
5.	G.S.S.Fadan Kagoma	9	6	15
	Total	**42**	**33**	**75**

3.4 Instrumentation

The instruments used for data collection in this research are;

i. Test of Understanding of Qualitative Analysis (TUQA)

ii. Test of Practical Skills TOPS.

TUQA is adapted from Tan, Chia and Treagust (2001). The instrument is modified by the researcher to include the following concepts: solubility, test for gases, identification of cations and anions.

TUQA consists of 30 multiple choice items set based on the following concepts: test for gases, solubility, identification of cations and anions. The instrument is adapted from Tan, Goh, Chia and Treagust, (2001). The instrument is in three sections. Section A consists of introduction letter of the researcher, section B consists of the Bio-data of the respondents and section C consists of 30 multiple choice items to test students understanding of Qualitative

Analysis. Each correct answer to a question attracts two marks totaling 60 marks see marking scheme presented in Appendix C.

TOPS is developed by the researcher. It is also in three sections. Section A consists of introduction letter of the researcher, section B consists of Bio_ data of the respondents and Section C consists of practical questions to test students practical skills in volumetric analysis. The question attracted 60 marks see Appendix E.

Table 3.3: Table of specification on Test of Understanding of Qualitative Analysis (TUQA)

Content	Weight	knowledge	Comprehension	Application	Total
	%	33%	50%	17%	100%
Identification of cations	33	3	5	2	10
Identification of anions	47	5	7	2	14
Identification of gases	7	1	1	0	2
Solubility	13	1	2	1	4
Total	**100**	**10**	**15**	**5**	**30**

3.4.1 Validity of the Instruments

The Test of understanding of Qualitative Analysis (TUQA) has been validated by the original authors Tan, Chia and Treagust, (2001). TUQA and the corresponding marking scheme were validated by two lecturers from science education department, ABU Zaria and one lecturer from Department of Chemistry, ABU Zaria. They were requested to critically examine and asses all the items of the instrument paying attention to the following:

1. Whether the test conformed to subject specification.

2. Whether the questions are clear, precise and free of ambiguity.

3. Whether the questions match the ability of the students.

TOPS was also validated by two lecturers from science education department and one lecturer from Department of Chemistry, ABU Zaria. They were also requested to critically examine and asses the instrument paying attention to the following:

1.whether the test conformed to subject specification.

2.whether the questions are clear, precise and free from ambiguity.

3.whether the questions match the ability of the students.

3.4.2 Pilot Testing

The Test of understanding of Qualitative Analysis TUQA and Test of Practical Skills TOPS were pilot tested using the 2011/2012 session senior secondary three (SS3) chemistry students. One school from Kafanchan Zonal Inspectorate Division was used to pilot test both instruments. In this study, 15 students were randomly selected using table of random numbers from SS3 in the school selected for the pilot study. The pilot testing was done to determine the appropriateness of the instrument and to re-establish the reliability of the instruments. The reliability index was determine using the formula F=R/T where F=facility index, R= number of candidates who got the items right, T= total number of candidates who attempted the items. The reliability co-efficient for TUQA was found to be 0.76 and the reliability co_efficient for TOPS was found to be 0.68.

3.4.3 Reliability of the Research Instruments

The reliability of TUQA has been determined by its original authors. The researcher confirmed this using Test Retest Reliability method. The reliability co-efficient was found to be 0.76.The reliability of TOPS was determined by researcher using Test Retest Reliability method and it was found to be 0.68.

3.5 Procedure for Data Collection

In administering the instruments, the researcher distributed the Test of understanding of Qualitative Analysis (TUQA) items to the study sample. The researcher allowed the subjects to read through the written instructions on how to answer the test ite. Subjects were allowed to ask questions for further clarification. 60 minutes was given to the subjects to answer the test items. The researcher sought for the assistance of the chemistry teachers in each of the 5 sampled schools to ensure co-operation of the subjects. The researcher then collected the answered scripts. Two days later the test items on Practical skills TOPS was administered where the subjects were required to read the written instructions before answering the test items.90 minutes was given to the subjects to answer the test items after which the scripts were collected. Two schools were covered on a day and one day for the last school. The chemistry teachers in the 5 sampled schools assisted in distribution of the test items to the subjects and collection of the test items from the subjects after answering the test items.

After the collection of the answered test items, the researcher then marked the collected answered test items. The scores in marked TUQA were correlated with the scores obtained from TOPS marked by the researcher. The data obtained was then compiled for analysis.

3.6 Procedure for Data Analysis

The data collected for this study were analysed based on the hypotheses and the research questions formulated for testing as follows:

HO_1 There is no significant relationship between chemistry students conceptual understanding of qualitative analysis and performance in volumetric analysis.

Pearson's Product Moment correlation statistical technique was used to test if there exist any significant relationship between students' understanding of qualitative analysis and performance in volumetric analysis. Rejection and retention of hypothesis was at 0.05 level of significance $P \leq 0.05$.

HO_2 There is no significant difference in performance of male students in qualitative analysis and male students in volumetric analysis. t-test statistical technique was used to test if there is any significant difference between the performance of male students in conceptual understanding of qualitative analysis and male students in volumetric analysis. Retention and rejection of this hypothesis was at 0.05 level of significance $p \leq 0.05$.

HO_3 There is no significant difference in performance of female students in conceptual understanding of qualitative analysis and female students in volumetric analysis. t-test statistical technique was used to test if there exist any significant difference between female students conceptual understanding of qualitative analysis and female students in volumetric analysis– Rejection and retention of this hypothesis was at 0.05 level of significance $P \leq 0.05$.

HO_4 There is no significant difference between male and female students in conceptual knowledge of qualitative analysis. t-test statistical technique was used to test if there is any significant difference between male and female students in conceptual knowledge of qualitative analysis-Rejection and retention of this hypothesis was at 0.05 level of significance $p \leq 0.05$.

HO_5 There is no significant difference between the performance male and female students in volumetric analysis. t-test statistical technique was used to test if there is any significant difference between the performance of male and female students in volumetric analysis-Rejection and retention of this hypothesis was at 0.05 level of significance $p \leq 0.05$.

CHAPTER FOUR

ANALYSIS OF RESULTS AND DISCUSSION

4.1 Introduction

This chapter contains description of data analysis, results, summary of major findings and discussions. The data were generated using two instruments, Test of Understanding of Qualitative Analysis (TUQA) and Test of Practical skills (TOPS) the instruments were used to measure students' conceptual understanding of qualitative analysis and performance in volumetric analysis respectively. Two variables were compared at significance level of $P \leq 0.05$ which formed the basis for retaining or rejecting each of the Null hypotheses stated. Pearson's product moment correlation and t-test statistics were used to test the hypotheses.

4.2 Analysis

Research Question 1

1. What is the level of conceptual understanding of inorganic analysis expressed by chemistry students under study?

Table 4.1 Summary of mean and standard deviation of students' conceptual understanding of qualitative analysis and their performance in volumetric analysis.

Variable	N	$\overline{X}$	S.D
QA	75	30.45	6.47
VA	75	30.54	6.90

To answer research question 1, mean and standard deviation was calculated for conceptual understanding of qualitative analysis and performance in volumetric analysis. The result presented in Table 4.1 shows that the mean of the conceptual understanding of the students in qualitative analysis is 30.45 which constitute 50.75% and standard deviation of 6.47. This clearly indicates that the level of conceptual understanding of qualitative analysis expressed by the students under study is average.

Research question 2

2. What is the relationship between chemistry students' conceptual understanding of qualitative analysis and their performance in volumetric analysis.

Table 4.2: summary of pearson's product moment statistics of conceptual knowledge of qualitative analysis and volumetric analysis

Variable	N	$\overline{X}$	S.D	r
QA	75	30.45	6.47	
				0.867
VA	75	30.54	6.90	

Table 4.2 shows that the person's product moment correlation coefficient is 0.867. this clearly indicates that there is a strong positive relationship between students conceptual understanding of qualitative analysis and their performance in volumetric analysis.

Research question 3

3. What is the difference in performance between males and females students in conceptual understanding of qualitative analysis.

Table 4.3 Summary of means, standard deviation on performance of male and female in conceptual understanding of qualitative analysis

Variable	N	$\overline{X}$	S.D
QA	75	30.00	6.17
VA	75	31.27	6.53

Table 4.3 shows that the male students have a mean score of 30.00 and standard deviation of 6.17 while the female students have a mean score of 31.27 and standard deviation 6.53. This shows that there is a slight difference in performance of male and female students in conceptual understanding of qualitative analysis with the female students performing better than the male students.

Research question 4

Table 4.4 summary of means, standard deviation on performance of male and female students in volumetric analysis.

4. What is the difference in performance between male and female students in volumetric analysis.

Variable	N	$\bar{X}$	S.D
MALE	42	29.42	7.03
FEMALES	33	29.88	7.20

Table 4.4 Shows that the male students have a mean score of 29.42 and standard deviation of 6.17 while the female students have a mean score of 29.88 and standard deviation of 7.20. This shows that there is a slight difference in the performance of male and female students in volumetric analysis with the female students performing better.

Hypothesis testing

In this study, a total of five hypotheses were tested. The first hypothesis was tested using Pearson's product moment statistics while the other four were tested using t-test statistics at $p<0.05$ level of significance. The results are presented in Table 4.5 - 4.8.

Hypothesis 1:

$H0_1$, there is no significant relationship between chemistry students' conceptual knowledge of qualitative analysis and their performance in volumetric analysis.

Table 4.5: pearson's product moment statistic of student conceptual knowledge in qualitative analysis and their performance in volumetric analysis.

Variable	N	Means	STD	r
QA	75	30.45	6.47	
				0.867
VA	75	30.54	6.90	

From table 4.5, the result revealed that pearson's product moment correlation coefficient is 0.867 at 0.05 level of significance. This revealed that there is a strong positive correlation between the students' conceptual knowledge of qualitative analysis and their performance in volumetric analysis, the null hypothesis which states that there is no significant relationship between students' conceptual knowledge of qualitative analysis and their performance in volumetric analysis was rejected.

Ho_2 there is significant difference in performance male students in Qualitative Analysis and male students in volumetric analysis.

Table 4.6 summary of t-test analysis of performance of male students in and male students in Volumetric Analysis

Variable	N	$\bar{X}$	SD	Df	t-value	p.	Remark
QAM	43	29.81	6.33				
				84	1.03	0.31	xxNS
VAM	43	31.27	6.96				

xx No significant difference at $p \leq 0.05$ level

Result in Table 4.6 shows t-value of 1.03 with a p-value of 0.31 and the degree of freedom 84. The p-value is greater than the stated level of significance set at $p \leq 0.05$. This infers that there is no significant difference in performance of male students in qualitative analysis and male students in volumetric analysis. Therefore, the null hypothesis which states that there is no significant difference between the performance of male students in qualitative analysis and male students in volumetric analysis.

Hypothesis 3

$H0_3$, there is no significant difference in performance of female students in qualitative analysis and female students in volumetric analysis.

Table 4.7 Summary of t-test analysis of Performance of Female Students in Qualitative Analysis and Female Student in Volumetric Analysis.

Variable	N	$\bar{X}$	SD	Df	t-value	p.	Remark
QAF	32	29.67					
				62	0.951	0.34	xxNS
VAF	32	31.12	6.96				

xx No significant difference at $p<0.05$ level

Result in Table 4.7 shows t-value of 0.951 with a p-value of 0.34 and the degree of freedom 62. The p-value is greater than the stated level of significance set at $p\leq0.05$. This infers that there is no significant difference in performance of female students in qualitative analysis and their performance in volumetric analysis, the null hypothesis which states that there is no significant difference between the performance of female students in volumetric analysis and female student qualitative analysis was retained.

Hypothesis 4.

$H0_4$ there is no significant difference the performance of male and female students in qualitative analysis.

Table 4.8 Summary of t-test analysis of performance of male and female students in qualitative analysis.

Variable	N	$\bar{X}$	STD	Df	t-value	P. value	Remark
Male	43	29.81	6.14				
				84	0.943	0.293	xxNS
Female	32	29.67	6.11				

xx No significant difference at $p \leq 0.05$ level

Result in Table 4.8 shows a t-value 0.943 with a p-value of 0.29 and the degree of freedom 84. The p-value is greater than the stated level of significant set of $p \leq 0.05$. This infers that there is no significant difference in performance of male and female students in qualitative analysis. Therefore the null hypothesis which states that there is no significant difference in performance of male and female students in qualitative analysis was retained.

Hypothesis 5

$H0_5$ there is no significant difference between the performance of male and female students in volumetric analysis.

Table 4.9 summary of t-test analysis of performance of male and female students in volumetric analysis.

Variable	N	$\bar{X}$	STD	Df	t-value	P. value	Remark
Male	43	31.27	6.98				
				48	1.23	0.34	**NS
Female	32	31.12	6.43				

** No significant difference at $p<0.05$

Result in Table 4.9 shows a t-value of 1.23with a p-value of 0.34 and the degree of freedom 84. The p-value is greater than the stated level of significance set at $p\leq0.05$. This infers that there is no significant difference in performance of male and female students in volumetric analysis therefore, the null hypothesis which states that there is no significant difference between the performance of male and female students in volumetric analysis was retained,

4.3 Summary of Findings

From findings of the study it was observed that: -

1. There was a significant relationship in students' conceptual knowledge of qualitative analysis and performance in volumetric analysis.
2. There was no significant difference in performance of male students in qualitative analysis and male students in volumetric analysis.

3. There was no significant difference in performance of female students in qualitative analysis and female students in volumetric analysis.
4. There was no significant difference in performance of male and female students in qualitative analysis.
5. There was no significance difference in performance of male and female students in volumetric analysis.

4.4 Discussion of the Findings

This research work investigated the relationship between conceptual understanding of qualitative analysis and performance in volumetric analysis. Five hypotheses were stated and tested based on the scores of the subjects obtained in TUQA and TOPS.

Analysis of the data obtained are presented in tables 4.5 to 4.9 in accordance with the stated hypotheses. The findings of the analysis are discussed below:

The result presented in table 4.5 shows that there is a strong positive relationship between students conceptual understanding of qualitative analysis and performance in volumetric analysis. This supports observation by Mari (2001) that performance in practical skills is often enhanced by conceptual understanding of some basic concepts. This tend to suggest that proper understanding of some concepts could enhance the acquisition of practical skills. Tinley (1983) cited in Mari (2001) reported that conceptual knowledge of concepts and performance in practical skills is interrelated, acquisition of one could enhance understanding of the other. This shows that concepts behind qualitative analysis should be taught along with practical.

The result presented in table 4.6 shows that there is NO significant difference in conceptual understanding of qualitative analysis and performance in volumetric analysis. The mean score indicated that students performed better in volumetric analysis than qualitative analysis. This might be because of the conceptual knowledge acquired by the students which enable them to understand volumetric analysis. This shows that conceptual understanding of qualitative analysis is interrelated with understanding of volumetric analysis, therefore, understanding of one could enhance understanding of the other. This also support the

findings of Mari (2001) that performance in practical skills is enhanced by conceptual understanding of some basic concepts. Tinley (1993) cited in Mari (2001) reported that conceptual knowledge and performance in practical skills are interrelated; acquisition of one could enhance the other.

The result presented in table 4.7 shows that there is no significant difference in male students' conceptual knowledge of qualitative analysis and male students in volumetric analysis. The mean score is in favour of volumetric analysis this might be as a result of their acquisition of conceptual knowledge of qualitative analysis. This finding is also similar to Tinley (1983) cited in Mari (2001) who found that conceptual knowledge and performance in practical skills is interrelated such that acquisition of one enhances understanding of the other. This also indicates that concepts behind qualitative analysis should be taught along with practical.

The result presented in table 4.8 shows that there is no significant difference between female students conceptual knowledge of qualitative analysis and female students in volumetric analysis. This is because the female students who understand concepts of qualitative analysis also understand volumetric analysis and hence performed better in practical chemistry than the female students who do not understand the concepts of inorganic chemistry qualitative analysis. This finding is also similar to Mari (2001) who observed that performance in practical skills is often enhanced by conceptual understanding of some basic concepts. This implies that proper understanding of some concepts could enhance acquisition of practical skills.

Table 4.9 shows that there is no significant difference between the performance of males and females in qualitative analysis with the mean score in favour of males. This finding is contrary to that of Okeke (1990) who found a significant difference between the performance of male and female students. He stated that male students often perform better than their female classmates in science subjects. Similarly, Amusat and Awoyemi (2006) on the influence of gender on students' level of achievement in chemistry concluded that gender difference has influence on students' level of achievement at secondary school level. According to them, there are many factors causing gender differences in performance in science in Nigerian schools. Many of these factors are man- made and can be avoided if the country is ready to pay the price. Different communities have different view of formal education, some belief in giving equal education opportunity to both male and female while some belief female education is not important. Some communities belief women should be restricted to their traditional role of full time housewife, as mother and house keeper, permissible vocations for women include teaching or nursing. Such communities do not encourage women into science and technical courses such as engineering. The difference between these findings of Amusat and Awoyemi (2006) might be because of the awareness that most communities are now having concerning the female child, this encourage to study the science hence improvement in their performance in science subjects.

CHAPTER FIVE

Summary, Conclusion and Recommendations

5.1 Introduction

This study investigated the relationship between conceptual understanding of qualitative analysis and performance in volumetric analysis. The chapter is presented under the following sub-headings:-

- Summary
- Conclusion
- Recommendations of the study
- Limitation of the study
- Suggestions for the study

5.2 **Summary**

The study aimed at investigating the relationship between conceptual understanding of qualitative analysis and performance of students in volumetric analysis. The population of the study comprised of all SS3 Chemistry students in public schools in Kafanchan zonal Inspectorate Division. There are 29 public secondary schools in Kafanchan division consisting of 1,520 chemistry students. 75 chemistry students constituted the sample drawn from Five sampled schools namely: G.S.S. Kadarko, G.S.S. Malagum, G.S.S Fadan Kagoma, G.G.S.S Kwoi, G.C. Kagoro.

Two tests Test of Understanding of Qualitative Analysis (TUQA) and Test of practical skills (TOPS) were administered to the subjects. TUQA was first administered to the subjects in order to test their conceptual knowledge in qualitative analysis .Two weeks later TOPS was administered where they performed real practical in order to test their knowledge in practical chemistry .The data obtained from the score of the students were analysed and used at 0.05 level of significance. The following are the summary of the major findings:-

1. There was a significant relationship in students conceptual knowledge of qualitative analysis and their performance in volumetric analysis.
2. There was no significant difference in performance of male students in qualitative analysis and male students in volumetric analysis.
3. There was no significant difference in performance of female students in qualitative analysis and female students in volumetric analysis.
4. There was no significant difference in performance of male and female students in qualitative analysis.
5. There was no significant difference in performance of male and female students in volumetric analysis.

5.3 Conclusion

The following conclusions can be drawn from the outcome of the study.

1. Conceptual knowledge of qualitative analysis relates high with the performance of students in volumetric analysis which is an indication that conceptual instruction of concepts in qualitative analysis could enhance performance in volumetric analysis.
2. Male and female students seems to have similar conceptual understanding of qualitative analysis which could be an indication that the learning of qualitative analysis is not gender bias.

3. Gender does not have an effect on the students' performance in volumetric analysis. This is an indication that conceptual knowledge of qualitative analysis has similar impact or influence on performance in both males and females.

5.4 Recommendations of the study

Based on the findings of the study the following recommendations were made.

1. If the learning of chemistry would be promoted, effort should be made by chemistry teachers to ensure that attention is given to conceptual instruction of qualitative analysis. This could improve students performance in chemistry practical and chemistry in general.
2. The notion by parents, teachers government and other stake holders and the society at large that male students perform better than female students in sciences should be discouraged. Instead the female as well as male students should be encouraged to study chemistry and other science subjects in mixed group or classes.
3. The government should send teachers on training on how to give conceptual instruction for students to have thorough grasp or deep understanding of basic concepts of qualitative analysis.
4. Government should organize seminars, workshops and conferences for secondary schools chemistry teachers on how best they can give conceptual instruction of qualitative analysis.

5.5 Limitation of the Study

1. The major limitation of this study was, the schools used for the study were government owned; the situation may be different in private schools .Thus the findings may not imply on private schools.
2. The researcher restricted his study to southern part of Kaduna state, the situation may be different in the northern part of the state .This might affect generalization made on the findings.

5.6 Suggestions for further Study

Based on the findings of this study the following suggestions may be found useful.

1. A similar study should be conducted involving secondary schools in other zonal inspectorate division. Effort should also be made to cover both government and privately owned schools.
2. The result obtained in this study apply to only chemistry, a similar research can be conducted in other science disciplines (physics, Biology and integrated science).
3. This study should be replicated out at tertiary institutions like colleges of education, schools of basic and remedial studies and polytechnics, to compare the findings.

5.7. **Contribution to Knowledge.**

This research has contributed to knowledge in the following areas:

1. It was established that there is a strong positive relationship between conceptual understanding of qualitative analysis and volumetric analysis.
2. The study showed that there is no significant difference between performance of students in qualitative analysis and volumetric analysis.

3. It was found that the gap existing between the performance of males and females in sciences particularly chemistry is bridging up.

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APPENDIX A

REQUEST FOR VALIDATING A RESEARCH INSTRUMENT DEPARTMENT OF EDUCATION, ABU, ZARIA.

TO--
--

I have adapted a research instrument designed to generate data for my M.Ed Thesis on understanding of inorganic chemistry Qualitative Analysis in Secondary Schools in Kaduna State.

The instrument tiled Test of Understanding of Qualitative Analysis (TUQA) consist of 30 multiple choice items drawn from SSCE syllabus.

As an experienced Chemistry lecturer your inputs would surely improve the quality of the instrument, I would like you to examine the items with respect to the following:

1. Do the items relate to Inorganic Chemistry Qualitative Analysis concepts expected of Senior Secondary School Students?

2. What general criticism and suggestions can you give for the improvement of the instrument?

I very much thank you and appreciate your assistance.

Yours faithfully,

Ayuba Jonathan

APPENDIX B

TEST OF UNDERSTANDING OF QUALITATIVE ANALYSIS (TUQA)

SECTION A

Dear Chemistry Students,

I am a postgraduate student of the Faculty of Education, Ahmadu Bello University, Zaria. I am conducting a research on the topic: Relationship Between Students' Understanding of Inorganic Chemistry Qualitative analysis and their performance in practical Chemistry among Secondary School Students in Kaduna State in partial fulfillment for the award of M.Ed Science Education Degree.

Please, your assistance is highly solicited in supplying the correct answers to the question items below. Your honest response will help in uplifting the quality of science education as it relates to the findings of the study.

Yours sincerely,

Mr. Ayuba Jonathan

TEST OF UNDERSTANDING OF QUALITATIVE ANALYSIS (TUQA) SECTION "B" BIO-DATA

a. State:____

b. Name of School:______________________________________

c. Sex: Male [ ] Female [ ]

d. Age: 14-16yrs [ ] 17-19yrs [ ]

20-22yrs [ ] 23yrs and above [ ]

e. Boarding school [ ] Day school [ ]

SECTION C

Instruction:

Please study each of the experiments carefully and answer the questions that follow by circling the right options

Experiment A

Step	Test	Observation
a.	To a sample of aqueous zinc chloride, add aqueous sodium hydroxide until a change is seen	A white solid is obtained
b.	Add excess of aqueous sodium hydroxide to the mixture from (a)	White solid disappear in excess reagent to give a colorless solution.
c.	Add dilute nitric (V) acid (HNO_3) to the mixture from (b) until no further change is seen.	White solid reappears. When excess acid is added, the solid disappears giving a colorless solution

1. What happens when aqueous sodium hydroxide is added to aqueous zinc chloride resulting in the white solid?

A. Displacement
B. Precipitation
C. Redox

2. Reason/Justification

A. The solution is too concentrated with sodium chloride so the sodium chloride comes out of the solution as a solid.
B. Sodium hydroxide lose oxygen in forming sodium chloride and zinc chloride gains oxygen in forming zinc hydroxide.
C. Sodium ion is more reactive than zinc ion.
D. Zinc ions combine with the hydroxide ions.

3. In Step b, a colorless solution is obtained because the white solid – the excess sodium hydroxide.

A. dissolves in
B. reacts with

4. Reason/justification

A. More solvent is added so there is more space for the white solid to dissolve.
B. No further reaction is seen except for the disappearance of the white solid and no new reagent is added.
C. Sodium ion displaces the cation from the white solid
D. The white solid forms a new soluble compound with the excess sodium hydroxide.

5. A student concludes that the white solid obtained in Step C is the same as the white solid obtained in Step a. Do you agree with the student's conclusion?
A. Yes
B. No

6. Reason/Justification
A. Different reagents were used
B. The acid reacts with the excess sodium hydroxide to form sodium nitrate (V) which appears as the white solid.
C. The acid react with the zinc compound to form zinc nitrate (V) which appears as the white solid.
D. The acid reacts with the mixture to reverse the formation of the soluble compound in Step b.
E. The acid removes the solvent which dissolves the white solid in Step b, so the white solid reappears.

7. The student also concludes that in Step C, the white solid dissolved because more solvent [dilute nitric (V) acid] is added. Do you agree with the student's conclusion?
A. Yes
B. No

Experiment B

Step	Test	Observation
a.	Q is an aqueous solution of a compound containing a cation and an anion which could possibly be chloride To a portion of Q add an equal volume of aqueous silver nitrate (V) ($AgNO_3$). Divide the mixture into two portions.	A white solid is obtained
b.	To the first portion, add dilute nitric (V) acid.	No visible reaction. The white solid remains.
c(i)	To the second portion, add aqueous ammonia	White solid disappear and a colorless liquid is formed.
c(ii)	To the mixture from c (i) add dilute nitric (V) acid until a change is seen.	White solid appear.

8. What is the white solid obtained in Step a?
A. AgCl
B. $ZnCl_2$
C. Zn $(NO_3)_2$

9. Reason/Justification
A. The silver ions are displaced by the more reactive cations from Q
B. The silver ions combine with the chloride ions.
C. The white solid disappears when aqueous ammonia is added in step C (i).
D. The nitrate (V) ions are displaced by the more reactive chloride ions

10. In Step b, the purpose of adding the dilute nitric (V) acid is to:
A. Acidify the mixture
B. Determine if the sample contain carbonate ions
C. Dissolve the white solid.

11. Reason/Justification
A. All nitrate (V) salts are soluble
B. Carbonate ions form a white solid with silver nitrate (V) which will react with nitric (V) acid.
C. Dilute nitric (V) acid is a strong oxidizing agent
D. Dilute nitric (V) acid is a good solvent
E. So that Q can react properly with silver nitrate (V)

12. In Step b, can dilute hydrochloric acid be added instead of dilute nitric (V) acid
A. Yes
B. No

13. Reason/Justification
A. Both nitrate (V) and chloride ions are already present in the mixture
B. Chloride ions from dilute hydrochloric acid will interfere with the test.
C. Dilute hydrochloric acid can be used as it has similar properties and reactions as dilute nitric (V) acid.
D. Dilute hydrochloric acid will not react with the white solid .
E. Dilute hydrochloric acid will react with the white solid

14. In Step c (i), it can be concluded that the white solid disappeared because it reacted with the aqueous ammonia to form ammonium chloride.
A. True
B. False

15. Reasons/Justification
A. Ammonium chloride is a soluble salt
B. chloride ions still present in solution react with the aqueous ammonia.
C. The ammonium ion is more reactive than the silver ion, so it displaces the silver ion.
D. The aqueous ammonia reacts with the white solid to produce a soluble compound which is not ammonium chloride.

16. In Step c (ii) the hydrogen ions in the acid reduce the silver ion present to form the white solid.
A. True
B. False

17. Will you test for oxygen gas when you heat an unknown solid?
A. Yes
B. No

18. Reasons/Justification
A. All gases must be tested when a substance is heated
B. Oxygen gas is produced only when acids react with compounds containing oxygen.
C. Oxygen gas will not be liberated during heating instead, it would be used up.
D. Some compounds decompose on heating to give oxygen gas.

19. A student is given a solution which may contain a carbonate ion, she decides to add aqueous barium nitrate (V) (Ba NO_3) to the solution first, followed by dilute nitric (V) acid. Is it possible for her to determine whether a carbonate ion is present when she carries out he above procedure.
A. Yes
B. No

20. Reason/Justification
A. An insoluble carbonate would be formed, leaving no free carbonate ions in solution to react with the acid.
B. Dilute nitric (V) acid will react with both a soluble and an insoluble carbonate.
C. The above procedure is strictly to test for the presence of sulphate (VI) only.

D. The acid must be added directly to the solution to test for the presence of a carbonate.
E. The unknown compound will only react with the dilute nitric (V) acid and not with the barium nitrate (V).

21. Instead of dilute nitric (V) acid, can the student add dilute sulpharic (VI) (H_2SO_4) after the addition of barium nitrate (V) in Question 11?
A. Yes
B. No

Experiment C

Step	Test	Observation
a.	To a sample of aqueous copper (II) sulphate (VI), Add aqueous ammonia until a change is seen.	A light blue solid is obtained.
b.	Add excess of aqueous ammonium to the mixture from (a).	Light blue solid disappear in excess aqueous ammonia to give a deep blue solution
c.	Add dilute sulphuric (VI) acid to the mixture from (b) until no further change is seen.	

22. What happens when aqueous ammonia is added to aqueous copper (ii) sulphate (VI) in Step a?
A. Displacement
B. Precipitation
C. Redox

23. Reasons/Justification
A. Aqueous ammonia gains oxygen in forming ammonium sulphate (VI(but copper (II) sulphate (VI) loses oxygen in forming copper (II) hydroxide.
B. Copper (II) ions combine with the hydroxide ions
C. Copper (II) ions is more reactive than ammonium ion.
D. Copper (II) ion is less reactive than the ammonium ion.

24. In Step b, why does the light blue solid disappear?
A. It dissolves in aqueous ammonia
B. It reacts with aqueous ammonia

25. Reasons/Justification
A. Ammonium ion displaces the cation from the light blue solid
B. More solvent is added so there is more volume for the light blue solid to dissolve in.

26. The light solid obtained in Step a and in Step c is the same
A. True
B. False

27. Reasons/Justification
A. Different reagents were used
B. The acid reacts with the copper (II) compound to form copper (II) sulphate (VI), which appears as the light blue solid.
C. The acid reacts with the mixture to reverse the formation of the soluble compound in Step (b).

D. The acid removes the solvent which dissolves the light blue solid in Step b, so the light blue solid appears.

28. Excess dilute sulphuric (VI) acid acts as a solvent for the light blue solid in Step c.
A. True
B. False

Step	Test	Observation
	R is colorless aqueous solution of a compound containing a cation and an anion which could possibly be iodide.	
a.	To a portion of R, add an equal volume of dilute nitric (V) acid.	No visible reaction; a colorless solution remains
b.	To the mixture from (a), add a small volume of aqueous lead (II) nitrate (V) [$Pb(NO_3)_2$]	

29. The purpose of adding the dilute nitrate (V) acid in Step a is to
A. acidify the mixture
B. determine if R reacts with the acid

30. How is the yellow solid formed?
A. Displacement
B. Precipitation.

APPENDIX C

Marking scheme for Test of Understanding of Qualitative Analysis (TUQA)

1.	B	2	A	3	A	4	D	5	A
6	E			7	A	8	A	9	B
10	B	11	B	12	A	13	C	14	A
15	C	16	B	17	A	18	D	19	B
20	C	21	B	22	B	23	B	24	B
25	D	26	A	27	C	28	B	29	B
30	B								

APPENDIX D

TEST OF PRACTICAL SKILLS (TOPS)

SECTION A

Dear Chemistry Students,

I am a postgraduate student of the Faculty of Education, Ahmadu Bello University, Zaria. I am conducting a research on the topic: Relationship between students understanding of inorganic chemistry qualitative analysis and performance in practical among senior secondary school students in Kaduna State, in partial fulfilment for the award of Med Science Education Degree.

Please, your assistance is highly solicited in supplying the correct information demanded by the question items below. Your honest response will help in upliftment of the quality of science Education as it relates to the findings of the study.

Yours Sincerely,

Ayuba Jonathan.

TEST OF PRACTICAL SKILLS (TOPS)

SECTION B BIO-DATA

State:

a. Zone..
....

b. Name of School...
....

c. Sex: Male( )
Female( )

d. Age: 14-16yrs ( )
17-19yrs( )
20-22yrs( )
23 and above ( )

TEST OF PRACTICAL SKILLS (TOPS)

SECTION B BIO-DATA

State:

a. Zone..

b. Name of School...

c. Sex: Male( )
   Female( )

d. Age: 14-16yrs ( )
   17-19yrs( )
   20-22yrs( )
   23 and above ( )

TEST OF PRACTICAL SKILLS (TOPS)

SECTION B BIO-DATA

State:

a. Zone...
....

b. Name of School...
....

c. Sex: Male( )
Female( )

d. Age: 14-16yrs ( )
17-19yrs( )
20-22yrs( )
23 and above ( )

SECTION C

INSTRUCTION:

Kindly perform the following experiments and record your observations and answer the questions that follow.

1 A is a solution of impure tetraoxosulphate (V1) acid containing 4.00g in 250 cm^3.B is a solution of pure sodium hydroxide containing 6g per dm^3.

a .put A into the burette and titrate it against 25cm3 portion of B using methyl orange as indicator. Tabulate you're your burette readings and calculate the average volume of acid used. The equation of the reaction involved in the titration is : $H_2SO_4 + 2NaOH =$ Na_2SO_4 $+H_2O$. (H=1,O=16,Na=23,S=32.)

b. From your results and the information provided above calculate:

i. Concentration of B in mole per dm^3

ii. Concentration of the pure acid in solution A in mole per dm3

iii. The percentage impurity of the acid in solution A.

APPENDIX E

Marking Scheme for TOPS

Titration

Burette Reading	**Rough titration (cm^3)**	**1st Titration (cm^3**	**2nd Titration (cm^3)**	**3rd titration**
Final	15.50	31.00	20.60	25.40
Initial	0.00	15.60	5.20	10.00
Volume of acid used	15.50	15.40	15.40	15.40

Average volume of acid used = $\dfrac{15.40 + 15.40 + 15.40cm^3}{3}$

= 15.40cm^3

20marks

i. Conc of B in mole /dm^3

Conc in mole/dm^3 = $\dfrac{concing / dm^3}{molarmass}$

Conc in g/dm^3 = 6.0g/dm^3

Molar mass of NaOH = 23 + 16+1 = 40.Og/mole

$\therefore$ conc of B in mole/dm^3 = = $\dfrac{6g / dm^3}{40g / mole}$

= 0.150 mole/dm^3

10marks.

ii. Conc. of pure acid in solution A in Mole/dm^3

Using $\frac{C_A V_A}{C_B V_B} = \frac{n_A}{n_B}$

CA = ? C_B = 0150 Mo/dm^3 V_A = 1540cm^3 V_B = 25cm^3

N_A = 1 n_B =2

$$\frac{C_A x 15.40}{0.150 x 25} = \frac{1}{2}$$

$$C_A = \frac{0.150 x 25 x 1}{15.40 x 2}$$

C.A = 0.12mol/dm^3

10 marks

iii. The percentage impurity of the acid in

Solution A.

Conc of pure acid in A in g/.dm^3

Molar mass x conc in mole/dm^3

Molar mass x conc in mole/dm^3

Molar mass of H_2SO_4 = 2 (1) + 32 + 4 (16) = 98g/mole

$\therefore$ Conc of pure acid in g/dm^3 = 0.121x98

= 11.9g/dm^3

Conc of impure acid in solution A in g/dm^3

= 4g dissolves in 250cm^3

? Dissolves in 1000cm^3

$= \frac{4x1000}{250}$

$= 16g/dm^3$

$\therefore$ Conc of impurity in g/dm^3 = 16-11.9

$= 4.10g/dm^3$ 10 marks

Percentage impurity = $\frac{coning / dm^3 of impurity}{concing / dm^3 of impure acid}$

$= \frac{4.10}{16.0} x100\%$

= 25.6% 10 marks