EFFECT OF PROBLEM SOLVING STRATEGY ON CHEMISTRY STUDENT'S PERFORMANCE IN SENIOR SECONDARY SCHOOLS IN GOMBE STATE.

BY

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SPS/11/MED/00013

BEING A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES, THROUGH THE DEPARTMENT OF EDUCATION, BAYERO UNIVERSITY, KANO, IN PARTIAL FULFILMENT OF THE REQUIREMENT FOR THE AWARD OF MASTER OF EDUCATION DEGREE IN CURRICULUM STUDIES

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APPROVAL PAGE

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DECLARATION

I Farida Mohammed Dunama of the Department of Education, Bayero University Kano hereby declare that this research work was done by me. The Research work has not been presented wholly or partially for the award of any degree or publication elsewhere and the work does not contain any materials whose source has not been duly acknowledge.

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DEDICATION

This research work is dedicated to Late Mohammed M. Dunama,Mrs Hajara M. Dunama, Mr Ibrahim Musa Yerima, Fatima Ibrahim, Nafisa Ibrahim, Salamatu Ibrahim whose Love, Care and Support Elevated me to where I ‘am today.

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OPERATIONAL DEFINITION OF TERMS

1. problem-This is a situation where a student is presented with a problem to find solution.

2. problem solving-This is a process whereby the students answers the defined problem being provided to the unknown goal using previously learned task.

3. strategy-This is defined as a method the student uses in answering the problem.

4. problem solving strategy-This is a method of instruction or teaching use to help the students level of academic performance. This involves the active participation of both the teacher and the students in providing answers to stated problem aimed at achieving the objectives of the subject.

Performance- This shows the level of students' performance at the end of the course using test questions.

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ABSTRACT

The widespread poor performance and the negative attitude of students toward chemistry have been largely ascribed to teaching problems. This study was aimed at determining the effect of problem solving strategy in teaching chemistry on student performance in senior secondary schools. A quasi experimental pre-test and post-test control group design was used. A population of 23905 senior secondary school 2 (SS2) students and a multi stage sampling technique was used to draw two schools and eighty (80) SS2 students were used for the study. Chemistry problem solving ability test questions (CPSAT) was design to check the students' performance when exposed to problem solving strategy. Data collection instrument were validated by experts in chemistry and the research supervisor, the reliability of the instrument was obtained using test re test method and were subjected to Pearson Product Moment Correlation Coefficient, a reliability index of r=0.84 was found. Data collected were analysed using descriptive statistics to answer the research questions and t-test at 0.05 level of significance to test the null hypotheses. The results shows significance difference in the performance and the problem solving skills of student taught using problem solving strategy and students' taught using the traditional method. There was no significance difference in gender when exposed to problem solving and those exposed to traditional method of teaching. It was recommended that, chemistry teachers should be encouraged to use problem solving strategy as a method of instruction in our Nigeria secondary schools.

CHAPTER ONE

INTRODUCTION

1.1 Background of the Study

Science education is an important part of education that involves training and acquisition of science knowledge which the individual acquires in order to fit himself in the society. This type of education has been identified as the bedrock of any technological development of a country (Ibrahim, 2009). Science education leads to the production of important specialists which are required for the development of any nation economy. These specialists include technologist, technicians, craftsmen and so on.

Avaa (2007), maintained that this type of education in Nigeria can help to elevate Nigeria from a consumer nation to a producer nation and from a developing nation to a developed nation within the context of science education .

chemistry is one of the science courses offered in Nigerian secondary schools and it has been identified as a very important science subject that contribute immensely to the development and transformation of any nation.

Chemistry education can be seen as the acquisition of knowledge or ideas relevant to chemistry. It is concerned with the impartation of knowledge on properties, components, transformations and interactions of matter. Chemistry education is therefore the systematic process of acquiring the fundamental knowledge about the universe (Emendu, 2014). It is as a result of the recognition given to chemistry in the development of individual and the nation that it was made a core-subject to be offered among natural science subjects offered in Nigerian schools (Adesoji, 2008). Chemistry is an essential basis for many facets of our everyday lives and has many unforeseen potential benefits for our future. An understanding

of chemistry allows us the opportunity to make sense of, and explain the world around us. It develops basic knowledge of how to live in this world, how to deal with the issues of daily life and how to make decision concerning our action as humans (Ogunleye, 1999). Chemistry as a science offer unique opportunities for learning about how science works and about the interaction of a lot of general skills for example, problem solving skills, thinking models, being sensitive and aware of hazards for environmental protection or understanding how of science contributes to society's sustainable development. In this way chemistry has the potential to contribute to general educational skills. (Emendu, 2014).

The relevance of chemistry as a requirement for technological advancement of a nation cannot be underrated. The classification of any nation into developed, developing and underdeveloped could be measured accurately by the number of chemists, physics, engineers, pharmacist, doctors, agriculturist and science educations the nation could produce. (Ahiakwo, 2002). Okeke and Ezekannagba (2000), define chemistry as branch of science that deals with composition and changes of matter. Chemistry education can be seen as the acquisition of knowledge or ideas relevant to chemistry. It is concerned with the impartment of knowledge on properties, components, transformations and interactions of matter. Chemistry education is therefore the systematic process of acquiring the fundamental knowledge about the universe (Emendu, 2014).Chemistry teaching involves a lot of practical and technical aspect which requires the participation of both teacher and the students. The teaching is suppose to be student centred, this can only be achieved when the student are willing and the teachers are ready to guide using appropriate method and resources needed (Avaa, 2011).

The best way for students to learn science is by giving them challenging problems and forcing their minds, stimulating habituation to think and doing action related to problems solving (Tanrere, 2008). He also stated that Problems solving skills is one of the important goals of chemistry education that any chemistry curriculum set this skill as a criterion for any

planned instruction to reach its goal. Nakhleh (1993), defines problems solving as a thinking process in which the learner discovers a combination of previously learned rules that he can apply to solve novel problem. Problems solving skills are specifically important in solving quantitative problems in chemistry. He point out that high school and freshmen chemistry students have difficulties on solving quantitative chemistry problems because of their abstract nature. The strategy helps the student think systemically, employ implicit planning and reflects explicitly on their problems solving behaviour.

The problems facing science teaching in schools are easy to identify. Since 1968, efforts have been made to improve science education in Nigeria. These efforts include restricting the science curriculum content, regular teacher education programme for serving science teachers, government incentives to science teachers, improved evaluation techniques and strategies and provision of infrastructures in schools to create a better opportunity for science teaching and learning (Hofstein, Eilks &Bybee, 2011). Despite these attempts, the explosion in science knowledge and particularly in the population of students in schools and with the corresponding slow growth rate of teacher production and in the supply of science equipment and method of teaching have made the problems of science teaching in schools complex.

Government policy on science education in schools has been clear and consistent. Science is to be taught to all levels of our educational system, primary science is intended to provide functional literacy by focusing on the understanding of some basic information and on the processes of science. The Junior Secondary School Science Programme emphasizes the understanding of some basic principles, the acquisition of skills particularly process skills and the development of desirable attitude like honesty, patience and co-operation. While Senior Secondary School Science is to be diverse and to prepare students for future activities in the area of science and technology it teaching should be activity oriented and centred on the

students. It should also be functional and creative (Federal Republic of Nigeria, 1977) cited in (Bilgin, 2005).

Gender is the range characteristics pertaining to, and differentiating between masculinity and femininity. Depending on the context, these characteristics may include biological sex (that is the state of being male, female). John money introduced the terminological distraction between biological sex and gender as a role in 1955. Before his work, it was uncommon to use the word gender to refer to anything but grammatical categories. Today the distinction is strictly followed in some contexts, especially the social sciences and documents written by the world health organization (WHO). However, in many other contents, including areas of social sciences, gender includes sex or replaces it. This change in the meaning of gender can be traced to the 1980s, a small acceleration of the process in the scientific litreture was observed in 1993 when the USA's food and Drug Administration (FDA) started to use gender instead of sex. In 2008, the FDA reversed it position and began using sex as the biological classification and gender as a person's self representation as male or female or how that person is responded to by social institutions based on individual's gender representation (Lawal, 2009).

The influence of gender of students' academic achievement has for long time been of concern to many researchers but no consistent result has been established for instance, Iyang and Jegede (1991), Okeke (2001) and Aluko (2005) reported that gender has no effect on students' achievement in science. Shua'ibu and Mari (1997) and Lawal (2009) explained that female students are significantly better than their male counterparts and that there is a significant difference between the male and female subjects in their ability to solve quantitative problems. Some instructional strategies are gender bias while some are gender friendly. However, the degree of gender related differences in learning vary from one method of instruction to the other. The performance of students in the WASSCE in Gombe state shows a declining nature of students failure and negative attitudes towards chemistry. This was seen in the examination written in 2011 were out of the percentage of students who sat

for the examination in the state only 23.18% of them passed. In 2012, 26.20 % passed the examination while in 2013, only 27.69% passed. This result gotten from the chief examiners report in WAEC clearly show the low performance of students in chemistry in Gombe state. This however prompted the researcher to view if problem solving strategy will have an effect on the students performance in the state.

1.2 Statement of the Problems

Researchers have shown the decline in the performance of students in chemistry. According to Samba and Eriba (2012), it is due to the abstract nature of chemistry concept. Mailumo, Agogo and Kpagh (2009), linked it on students and teachers related factors and Agogo, (2003), Agwai, 2008), think it is due to concepts difficulty and there are however difficult level of concept difficulties experienced by chemistry students and those concept are perceived by both boys and girls. Performance of students in public examination conducted by the West African Examination Council (WAEC) Through the chief examiner reports (2011, 2012, 2013), shows a decline in the student's performance. It is stated that most of the chemistry candidate display in ability to accurately write down chemical formula, do calculation in chemistry and balance chemical equation. Out of the percentage of students who sat for the WASSCE, the percentage of failure is higher than those who passed the subject. In 2011 only 23.18% passed the subject, 26.20% passed in 2012 and27.69% passed in 2013.This failure was attributed to lack of qualified teachers, inability to use good teaching strategy, lack of instructional materials which are factors that can contribute to students failure in chemistry.

However, due to this decline in the level of student's performance in chemistry, the study sought to find out the effect of problem solving strategy in teaching chemistry on students performance in senior science secondary schools in Gombe state.

1.3 Objectives of the study

The study is aimed at achieving the following objectives;

1. To determine the effect of problem solving strategy on students performance and the students problem solving skills in chemistry.
2. To determine the effects of problem solving strategy on students performance in chemistry as a result of gender differences in Gombe state..
3. To determine the effect of treatment on male and female students exposed to problem solving strategy.

1.4 Research Questions

1. What is the difference in the academic performance and the problem solving skills of students exposed to problem solving strategy and those exposed to traditional method of teaching chemistry?

2. What is the difference in the performance of male and female students exposed to problem solving strategy and those expose to traditional method of teaching chemistry?

3. What is the effect of treatment in the performance of male and female students exposed to problem solving strategy?

1.5 Research Hypotheses

1. There is no significant difference in student's academic performance and problem solving skills when exposed to problem solving strategy and those expose to traditional method of teaching chemistry.

2. There is no significant difference in the performance of male and female students exposed to problem solving strategy and those exposed to traditional method of teaching chemistry..
3. There is no significant differences in the performance of male and female students when expose to problem solving strategy.

1.6 Significance of the Study

In an effort to improve the teaching of chemistry in Nigeria senior secondary schools and to make teaching and learning of chemistry attractive to student through finding the effect of problem solving strategy in teaching chemistry on student performance. The study will be of immense importance to the students, teachers, policy makers, curriculum planners, textbook writers, scholars, and researchers.

- One of the aims and objective of teaching chemistry in secondary schools is to enable students develop their knowledge and skills in chemical science and project their effort in education so as to be useful to themselves and true society in general. The need to find a suitable method of understanding the subject is very important. The student exposure to a good method of teaching or instruction in the classroom will help aid in understanding the subject better. This will help increase the level of student academic performance positively.
- The teacher is an important tool in educational system, this is because he facilitates the learning process in which failure to instruct well or use a good method of instruction will lead to the production of poor outcome. Therefore the teachers have to use a good method of instruction in order to help the student understand the subject better.
-The policy makers will also benefit from these study because when the students understand the subject better, it help to reduce the rate at which students fail the subject and lead to the

production of a positive outcome which will be employed and used by the government to better the nation.

- The curriculum planners and the level of student mental development must be considered for learning of chemistry to be effective in schools, who to teach what to teach and how to teach should be important to the curricular planner. Therefore this study will produce important information to the curricular expert on the important of the method of instruction in teaching chemistry so that it will be included in the chemistry curriculum.
- Most of our chemistry textbooks are written reflecting the traditional method of teaching chemistry in our secondary schools. This study provide information on the effect of problem solving strategy so that the textbooks will reflect the method of instruction so as to help the students intellectually.

1.7 Scope and Delimitation

The study examined the effect of problem solving strategy in teaching chemistry on students' performance in senior secondary schools in Gombe state. The study was carried out on one of the important science subject that is chemistry. This indicates that only senior secondary students and secondary schools offering chemistry were involved in the study. The study covers the following topic in order to determine the effect of the method of instruction. Calculation of empirical formula, Chemical combination, Calculation of atomic and molecular mass of a substance, Separating technique.

These topics were selected because most of the students tend to have problems with the calculative aspect of chemistry. That was why the researcher selected the following topic in order to determine if the effect of the method of instruction will enhance the students' level of performance. The study was conducted in Gsombe state and there 99 secondary schools in the state, but for the purpose of this researcher 23 science based senior secondary school since the study was conducted in science subject.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

Literature relevant to the study were reviewed and organized in the following sub. Conceptual frame work of problem solving strategy, the concept of chemistry education, the concept of problem solving strategy ,the importance of problem solving strategy, the problem's in science classroom, teaching problem solving, teachers' role in teaching problem solving, Principle of teaching problem solving strategy, instructional implication of teaching of problem solving .Models of problem solving strategy, theoretical framework of problem solving, the history of science education in Nigeria, the nature of science and chemistry, orientation of chemistry curriculum, the idea of the curriculum emphases, knowledge development in chemistry, the chemistry core curriculum, gender in science, empirical studies, summary and uniqueness of the study.

2.2. Conceptual Framework of problem solving strategy.

The concept of chemistry education, concept of problem solving, the importance of problem solving, the problem in science class room, teaching problem solving, teachers role in teaching problem solving, principle of teaching problem solving, instructional implication of teaching problem solving were discussed.

2.2.1 Concept of Chemistry Education.

Chemistry is popular science subject among senior secondary school students in Nigeria. Due to it nature, It addresses the needs of majority, though its relevance and functionality in

content, practice and application. Chemistry education has been identified to be one of the bedrock for the transformation of our nation economy (Emendu, 2014).

Chemistry education is a vehicle through which chemical knowledge and skill reach the people who are in need of capacities and potentials for development, it addresses the social objective of substance development as education is now the primary means for empowerment, participation, cultural presentation social mobility and equity (Emmanuel, 2013).

Chemistry education plays an important role in enhancing the quality of teaching and research, as well as ensuring that student are equipped with good knowledge to produce intensive goods and services to meet human needs for food, health care product and other materials aimed at improving the quality of life. Every simple material thing in the universe is manufactured from chemicals and the ability to understand and manipulate these chemical to plastics and computers (Emendu, 2014).

Chemistry is an experimental science which relies primarily on the harmony between theories and practical. The understanding of concept in practical chemistry will assist in enhancing students understanding. The learning standard of chemistry encourages the inclusion only of important for discovery them (Ikeobi, 2010).

The aim and objectives of teaching chemistry in secondary schools are to enable the students to develop their knowledge and skills in chemical science and project their effort in education so as to be useful to themselves and the society in general. For this reason, students have to appreciate the subject and pay special attention to its teaching. Giving the students opportunities for developing manipulative skills that will enable them function effectively in the society within the limit of their capacity through the different method of teaching based

on teacher's competence will encourage them make the learning process effective and rewarding.

According to Reginald (1980), methodology is defined as the method by which the teacher present his materials to the students and engage then in task at hand. Awoniyi in Okpala (2006), also observes that to be effective, the teacher has to be many things.

- A source of information and a guide.
- An organizer of opportunities for learning.
- Someone who can structure a suitable environment for learning.
- A superior and a consultant. The teacher has to be aware of current innovations in teaching so as to determine the most suitable method to use as a method of instruction. The method to use as a method of instruction. The method used in teaching either promotes or inhibit learning. As a subject most students are afraid of teachers of chemistry. Therefore, the teacher must use appropriate method so as to arouse the student's interest and encourage them to develop positive attitude for effective learning outcome.

Hence, the need to use the appropriate methods that can stimulate the interest of students toward teaching of chemistry at all level of educational system to make chemistry realize its, ultimate goals in the curriculum and in the national policy education.

2.2.2 Concept of Problem Solving

Educators have devoted their attention on trying to define and teach problem solving skills for most of the 20^{th} century. In the early 1900s, problem solving was viewed as a mechanical, systematic and often abstract (decontextualized) set of skills, such as those use to solve

riddles or mathematical equations this problem often have correct answers that are based on logical solutions with single correct answer (convergent reasoning) (Foshay, 1996).

Under the influence of cognitive learning theories, problem solving shifted to represent a complex mental activity consisting of a variety of cognitive skills and actions. Problem solving includes higher order thinking skills as "visualization, association, abstraction needed to be managed and cooperated" (Garofalo and Lester, 1985).

Problems solving strategies are important skills that every students needs to be successful. The teaching of specific problem solving skill gives student and teachers a language to talk about the strategies used to solve problems This language allows teachers to communicate methods students need to answer real world problems within the confines of the class room. These problems solving skill should also be transferred to successful discoveries outside the classroom. As educators we need our students to be independent thinkers for a lifetime, not just during a course, thus these skills must be transferable to other areas of students' lives so as to have a meaningful and effective live (Gundserson, 2011).

He also stated that developing and enhancing problems solving abilities of student have long been important objectives of science education. He defines problems solving abilities as the ability to think critically to reason analytically and to create productively. These involve all quantitative, communicative, manual and critical response skills. He further explained that problems solving is an integral part of science and it should permeate throughout the entire science curriculum. Teaching must involve student in inquiries-oriented investigation in which they interact with their teachers and peers. So that they can apply science content to new questions, and they can engage in problems solving, planning, decision making and group discussion.

Gagne (1985) defines problems solving as a thinking process in which the learner discovers combination of previously learned rules that he can apply to solve a novel problems. Problems solving strategies are specifically important for quantitative problems in chemistry.

Gabel and Bunce (1994) indicated that the use of problems solving instructional strategies and techniques to teach science influences the problems solving skills of students. (Tanrere, 2008) said that the best way for the students to learn science is by giving them the challenging problems and forcing their mind which will help in stimulating to think and do actions related to problems solving. (Gunderson, 2011) stated that perseverance in solving Problem is important because students need to realize that some problems require a lot of time to solve. Many problems in science and technology, engineering and mathematics take many complex steps that students need to recognize a pattern and formulate a method to solve, this is where understanding a large quantity of information may allow students to solve problems faster and more accurately than others. Solving a problem requires students to understand the problem, make accurate observation, interpret data, formulate a valid hypothesis and find solution to the problem.

Science educators have published a list of successful techniques that good problem solvers posses, many of those strategies contain a sequential set of procedures that students' carryout to solve homework problems or test questions. Some example of processes that good problem solver uses are:

i. Represent the problem verbally.
ii. Sketch a diagram of the problem, representing any movement of object with arrows.
iii. Select a set of equation describe the problem.

Barrow and Tambalyn (1980), explain problems solving as an attitude or predisposition towards inquiry as well as the actual process by which individuals attempt to give knowledge.

2.2.3 The Importance of Problem Solving

An information and technology based society requires individuals who are able to think critically about complex issues, people who can analyze and think logically about new situation, devise unspecified solution procedures and communicate their solution clearly and convincingly to others (Baroody, 1998). To prepare students to function in such a society, teachers have a responsibility to promote in their classrooms the experience of problem solving strategies and to foster in students positive disposition toward problem solving (Rodgers, 2002).

In promoting problem solving, teachers encourage students to reason their way to a solution or to a new learning. During the course of problem solving, teachers further encourage students to make conjectures and justify solutions. The communication that occurs during and after the process of problem solving helps the students to see the problem from different perspectives and opens door to a multitude of strategies for getting a solution. By seeing how others solve a problem, students can begin to think about their own thinking metacognition and the thinking of others and can consciously adjust their own strategies to make them as efficiencies and accurate as possible in their everyday experiences. Students are intuitively and naturally solving problems, they seek solutions to sharing toys with friends or building elaborate structures with construction materials. Teachers who use problem solving as the focus of the science class help their student to develop and extend these intuitive strategies.

Through relevant and meaningful experiences student develop a repertoire of strategies and process example states for solving problems that they can apply when solving problems. In fostering positive dispositions in their students toward problem solving, teachers deal with

the affective factors that have a impact on students behaviour in both positive and negative ways (Schoenfeld, 1992).

As students engage in problem solving, they participate in a wide variety of cognitive experience that help them to prepare for the many problem solving situations they will encounter throughout their lives. They learn mathematical concepts with understanding and practice skills in context. A problem solving curricular however, requires a different role from the teacher. Rather than directing a lesson, the teacher needs to produce time for students o grapple with problems, search for strategy and solutions and their own and learn to evaluate their own results. Although the teacher need to be very much present in the primary focus in the class needs to be on the students thinking process (Burns,2000).

2.2.4The problems in the Science Classroom

Most practicing science teachers do not posses adequate training for the job since the science world is continuously changing. Teachers, require be training and retaining to update and upgrade their knowledge in the job and in the contents to be facilitated. It is a common adage that no educational system can rise above the level of its teachers. Two spheres of science teachers exist in the school system. The first groups are the proper professionally trained teacher and educators who lack in depth knowledge of the science subject content. The second groups are those who have mastery of the subject but are not professionally trained teachers. They all perfect on job with years of experience science teaching has both content aims and process aims, the guiding principle should be connecting knowledge to life outside school, ensuring that learning shift away from rote method and enriching the curriculum so that it goes beyond textbook.

Garson (1988), documented that, the challenge of science education are to bring the fall range of young people a comprehension of the nature of science as humanistic enterprise. He stated that:

> *If children are to learn science, we must give them respect for observation rather than the pronouncements of the textbook and teacher prophets. We must see to it that students understand experimentation as a means of compelling nature to answer their questions. Children must give children must know that no one really knows. If we can give children these insights, they will have learnt science no matter what context they have covered (Garson, 1988. 17).*

Researchers have found out that no one single method is best for teaching. It is the responsibility of the teacher to find out the best approach to conduct his lesson. Teachers who properly understand and appreciate science and reasons for teaching science are conversant with the best method for achieving the goal that is why Nwachukwu (2005) investigated the effect of the use of cooperative and competitive interaction strategies in teaching chemistry in secondary schools. The research revealed that the two strategies are superior to the convectional practices in Nigeria. The female students outperformed the males in cooperation where as the males outperformed the females in competition.

Also Chukwneke and Nwachukwu (2006) investigated the use of concept mapping in teaching biology in Nigerian secondary schools. The study revealed that the use of concept mapping enhance the acquisition and retention of biology better than the convectional practices.

2.2.5 Teaching Problem Solving.

Problem solving is a basic skill needed by today's learners, as education has come across criticism from different sectors. Educators have looked for ways to reform teaching and learning and the curriculum. Many have argued that the outcome of content from application has adversely affected our educational system. Learners often learn facts and rote procedures with few ties to the context and application of knowledge (Herebert 1996). Problem solving has become the means to region content and application in a learning environment for basic skills as well as their application in various contexts.

Today there is a strong movement in education to incorporate problem solving as a key component of the curriculum. The need for learners to become successful problem solvers has become a dominant theme in many national standards (AAAS, 1993,NCTM, 1991). For example the 1989 curriculum standards of the national council focus on the mathematics curriculum. As such, it is a primary goal of all mathematic instruction and an integral part of all mathematical activity. Problem solving is not a distinct topic but a process context in which concepts and skills can be termed. The US Secretary's Commission of Achieving Necessary Skills (SCANS) made recommendation on how to educate students to meet future needs. A key element to emerge from the SCANS Report (1991) was that "teaching should be offered in context, and students should learn content while solving realistic problems", Professional training standards addressing problem solving skills. Medical collage engineering, and business schools are revamping their curriculum to focus on problem solving as a key component of the professional curriculum. (Barrows and Tambyn 1980).

Teaching students how to use problem solving procedure is very important. (Ott, 2001), listed some instructional practices used in teaching problem solving skills these include;

i) Teach students to read problem.

ii) Encourage the use of resource materials outside the textbook.

iii) Encourage the use of estimating quantities to solve problems.

iv) Teach the skill of breaking a problem into parts and solving the sequential part.

He also indicated the instructional pattern used by Halpern (1992) which includes:

i) Set aside laboratory and/or class time for small group problem solving session.

ii) Assign problems that require more than the rote application of a previously learned formula.

iii) Teach students to begin the problem solving task by diagramming the information and/or writing a summary of the given information and the desired answer require students to estimate the size of the answer before they begin to solve the problem and check the obtained answer with their estimate.

iv) While teaching, highlight transferable skills.

Ott (2001), also identifies that one of the frequently suggested practice based on the work of Piaget, strongly recommends that subject matter needs to start with concrete concepts that are easily observable in a classroom and not intangible ideas. Another science educator Beistel also gives an important instructional practice by warning that trying to move students up the learning taxonomy too quickly is one of the most harmful teaching techniques. By taking the suggestion for good problem solving practice and for the suggestion for good instructional practices specific problem solving-strategies have been created by science educators as aids to assist students. Instructors hope that by learning and following this problem solving strategies students can improve their ability to solve homework problems and test questions.

2.2.6 Teachers Role in Teaching Problem Solving

The teacher's role is crucial in providing for students an effective problem solving experience. Functioning as a problem solving facilitatier, the teacher helps the students by

- Providing appropriate and challenging problems.
- Supporting and extending students learning.
- Questioning and prompting students.
- Using think aloud to model how a problem is tackled.
- Observing students and assessing their work as they solve problems.
- Anticipating conceptual stumbling blocks, noticing students who encounter these blocks and helping them recognize and address their misconceptions.

2.6.7 Principle for Teaching Problem Solving.

The understanding of problem solving leads to important principles of teaching problem solving, these can be applied in the classroom.

- **Model a useful problem solving method:-** problem solving can be difficult and sometime tedious, show students by your example how to be patient and persistent and how to follow a structured method, such as woods' model, Polya's model. Articulate your method as you use it so students see the connection.
- **Teacher within specific context:-** teach problem solving skill in a context in which the will be use (example mole fraction calculation in chemistry course). Use real life problem in explanation, examples and exams. Do not teach problem solving as an independent, abstract skill.
- **Help students understand the problem:-** In order to solve problems, students need to define the end goal. This step is crucial to successful learning of problem solving

skills. If you succeed at helping student answer question "what" and "why", finding the answer "how" will be easier.

- **Take enough time:-** When planning a lecture/tutorial, budget enough time for; understanding the problem and defining the goal, both individually and as a class, dealing with questions from you and your students; making, finding, and fixing mistakes; solving entire problem in a single lesson.
- **Ask question and make suggestion:-** Ask students to predict "what would happen if …." Or explain why something happened. This will help them develop analytical and deductive thinking skills. Also, ask questions and make suggestion about strategies to encourage students to reflect on the problem solving strategies that they use.
- **Link error and misconception:-** use errors as evidence of misconceptions, not carelessness or random guessing. Make an effort to isolate the misconception and correct it, then teach students to do this themselves. We can all learn from mistakes. (Foshay and Kirkley, 2003 ;12).

2.2.8 Instructional Implication of Teaching Problem Solving

Every problem that teachers give to students can serve more than one purpose. One major purpose is to explore, develop and apply a conceptual understanding of science concept (Teaching through problem solving). A second major purpose is to guide students through the development of inquiry or problem solving processes (Kypatrick & Swatfford, 2003).

When teaching about problem solving and when selecting instructional problems, Teachers should ask themselves.

- What is the purpose of the lesson? It is to develop a concept? It is to develop problem solving processes or strategies? Or it is to develop both?
- What problem would help children to learn the concept or to develop the process or strategy?

- What will the context of the problem be meaningful to all students and engage them in a meaningful way.
- What kind of sharing and discussion about the concept or about the strategy will happen at the end?
- What misconception might students have? How will conceptions be addressed throughout and at the end?
- What form of assessment will provide information about student learning and effectiveness of instructional practice? (Stiggins, 2001)

The chart table below outline how one problem can be used both for the purpose of concept development and for the purpose of strategy development, while students are solving a problem, the teacher is observing for both purposes and using the questions in the chart to guide his or her observation. The teacher has to monitor for both purpose throughout the lesson. For example a teacher needs to stop part way through a lesson to ask both conceptual questions such as what is Empirical formula and problem solving question like

What strategy are you using ?

Problem solving situation

For the purpose of developing concept teachers as themselves	For the purpose of fostering the development of problem solving strategy teacher ask themselves.
Do students demonstrate understanding?	What strategy are student using?
How do students demonstrate understanding?	Are they using efficient strategy?
Does the concept need to be revisited?	Do they understand the problem?
Are student making connections?	How are they representing ideas?
How do students communicate their understanding?	Are they sharing their strategy with others?

If understanding is not evident, where or how is the concept breaking down?	Do students have logical process of solving problem?
Are students aware of their thinking process (metagognition)?	What attitude do students display throughout the process?

(Hiebert & Carpenter, 1992)

2.3 Models of Problem Solving Strategies

During the 1960s and 70s, researchers developed general problem solving models to explain problem solving processes Newell & Simon, 1972; Polya, 1957; Bransford & Stein, 1984). The assumption was made that by learning abstract (decontextualized) problem solving skills, one could transfer these skills to early situations (context). Example of the problem solving model are;

Bransford's IDEAL Model

i. identify the problem

ii. define the problem through thinking about it and sorting out the relevant information.

iii. Explore solution through looking at alternatives, brainstorming and checking out different point of view.

iv. Act on the strategies

v. Look back and evaluate the effect of your actively.

1) Polya's Model of Problem Solving Strategy

Polya's four steps problem solving process

Step 1: Understand the problem

- Do you understand all the words?
- Can you restate the problem in your own words?

- Do you know what is given?
- Do you know what the goal is?
- Is there enough information?
- Is their extraneous information?
- Is their problem similar to another problem you have solved?

Step 2: Device a plan

Can one (one or more) of the following strategies (heuristics) be used?

- Guess and test
- Use a variable
- Draw a picture
- Look for a pattern
- Make a list
- Solve a simpler problem
- Draw a diagram
- Use direct reasoning
- Use indirect reasoning
- Use properties of numbers
- Solve an equivalent problem
- Work backward
- Use cases
- Solve an equation
- Look for a formula
- Do a simulation
- Use model

- Use dimensional analysis
- Identify sub goals
- Use coordinates
- Use symmetry

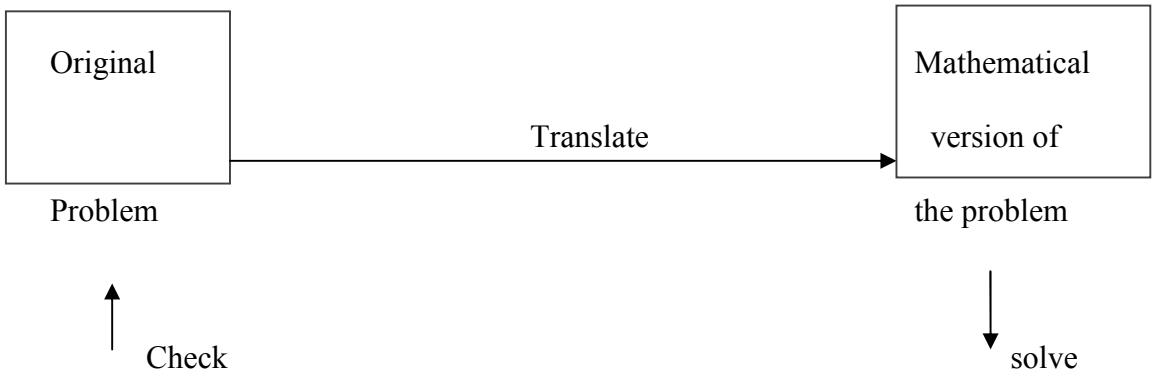
Step 3: Carry out the plan

- Implement the strategy or sub strategy that you have choosen until the problem is solved or until the course of action is suggested.
- Give yourself a reasonable amount of time which to solve the problem. If you are not successful seek hints from others or put the problem aside for a while (you may have a flash or insight when you least expect it).
- Do not be afraid to start over often, a fresh start and a new strategy will lead to success.

Step 4: Look Back

- Is your solution correct? Does your answers satisfy the statement of the problem.
- Can you see how you can extend your solution to a more general case?

  Usually, a problem is stated in words, either orally or written then, to solve the problem, or translate the words into an equivalent problem, and then interprets the answer. This process is summarized in the table below.



Polya (1957)

The researcher adopted Polya's problem solving model in the research process this is because Polya focuses on the mental processes of learning and problem solving, he uses the cognitive stage of the learner to outline his four steps to find easy ways for solving problem.

2) Woods' Problem Solving Model

i. Define the problem.

- The system:- Have students identify the system understudy (e.g a metal bridge to certain forces) by interpreting the information provided in the problem statement. Drawing a diagram is a great way to do this.
- Know(s) and concepts:- list what is known about the problem, and identify the knowledge needed to understand (and eventually), solve it.
- Unknown(s):- ones you have list of unknowns, identifying the unknown(s) becomes simpler. One unknown is generally the answer to the problem, but there may be other unknown(s). Be sure that students unknown under standard what they are expected to fine.
- Unit and symbols:- one key aspect in problem solving is teaching students how to select, interpret, and use units and symbols. Emphasize the use of units whenever applicable. Develop a habit of using appropriate units and symbols yourself at all times.

- Constraints:- all problems have some stated or implied constraints. Teach students to look for the constraints.
- Criteria for success:- help students to consider from the beginning what logical type of answer would be , what characteristics will it possess? For example a quantitative problem will require an answer in some form of numerical units (e.g, kg product, square, centimetre, etc) while and optimization problem requires an answer in the form of either a numerical maximum or minimum.

ii. Think About It

- Let it simmer:- use this stage to ponder the problem ideally, students will develop a mental image of the problem hand during this stage.
- Identify specific piece of knowledge:- students' need to determine by themselves the required background knowledge from illustration, examples and problems covered in the course.
- Collect information:- encourage students' to collect pertinent information such as conversion factors, constants and tables needed to solve the problem.

iii. Plan a Solution

- Consider possible strategies:- often, the type of solution will be determined by the type of problem. Some common problem solving strategies are : compute, simplify, use an equation, make a model, diagram, table or chart backwards.
- Choose the best strategy:- Help students' to choose the best strategy by reminding them again what their requite to fine or calculate.

iv. Carry out the Plan

- Be patient:- most problems are not solve quickly or on the first attemted. In other cases executing the solution may be the easiest step.

- Be persistent:- if a plan doest not work immediately, do not let students' get discourage. Encourage them to try a different strategy and keep trying.

v. Look Back

Encourage students' to reflect once a solution has been reached, students' should ask themselves the following questions.

- Does the answer make sense?
- Does it fit with the criteria establish in step one?
- Did one answer the question(s)?
- What did I learn by doing this?
- Could I have done the problem another way?

(Woods, Wright, Hoffman, Swartman, and Dolg, 1975) cited in (Foshay and Kirkley, (2003 p 28).

4. (SARA) Model of Problem Solving

(scanning, Analysis, Response and Evaluate)

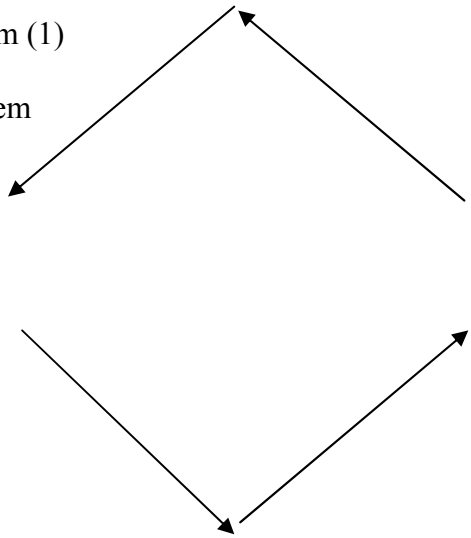
Is a common approach used by community policing agencies to identify and solve repeat crime and community problems.

The steps are shown below

SCANNING

Identify the problem (1)

Describe the problem



(4) ASSESSING RESULT

process evaluation

impact evaluation

New Problem Assessment.

ANALYSIS

Identify persons involved document

Scope, determine (2)

Causes

Describe physical setting and social context

(3) RESPONDING

Collaborate on solutions

community involvement action plan

2.4 Theoretical Framework of Problem Solving

Historical Progression of Problem Solving Theories As theories of how learning occurred, the understanding of the solving process also evolved the dominant. The learning theories are discussed within the conceptual domains of behaviourism, cognitive psychology, and

information processing. Behaviourists view problem solving as a process that develops through positive and negative reinforcement mechanisms. Cognitive psychology view problem solving as a process that includes introspection observation, and the development of heuristics. The information processing view of problem solving is based on general problem solving skills and artificial intelligence. (Hardin, 2002 p 15).

Cognitive Theory

The cognitive psychology progressed as a discipline, more interest and effort was directed toward the mental processes of learning and problem solving. An early cognitive approach to problem solving is to identify the mental stages through which problem solving preceded. Two noted cognitive psychologists, Wallas and Polya, developed a four stage model of problem solving. The four stages of problem strategy developed by Wallas were:

1. Preparation:- defining the problem and gathering information relevant for it.
2. Incubation:- thinking about the problem at a sub conscious level.
3. Inspiration:- having a sudden insight into the solution of the problem. And
4. Verification:- checking to the certain that the solution was correct (Ormrod, 1987).

Polya (1954) in Hardin (2002) described the following four steps in the problem solving process.

1. Understand and the problem.
2. Devise a plane.
3. Carry out the plan and
4. Look forward.

Cognitive Heuristics

Polya promoted the idea that the application of general problem solving strategies was a key to problem solving expertise and intellectual performance. General problem solving strategies have also been called heuristics. The word heuristics comes from the Greek, heuristic, meaning "serving to discover" a commonly used synonym for heuristic is rule of thumb.

2.5 History of Science Education in Nigeria

The historical background of science education in Nigeria stated before the advent of western education in Nigeria, certain aspect of scientific knowledge were included in traditional forms of education (Abdullahi, 1984). The arrival of the British missionaries on the cost of Lagos in 1859 and subsequent establishment of churches and elementary schools in the town of Topo near Badagry in 1861 marked the beginning of western education in Nigeria. Abdullahi (1982) notes, the foundation for science teaching in Nigeria were laid between 1861 and 1897 when the rudiments of science were introduced in the time table of some missionary primary schools, however commenced after 1931 with the establishment of secondary schools. Bajah (1982), argues that the science curriculum in secondary schools at the time was nature study, which involves learning about the environment, plants, animals and non-living things. Consequently the coverage and depth of science subject taught in secondary schools were very low due to scarcity of trained teachers and resources for science teaching (Abdullahi, 1984). Very few students in secondary schools attempted science at external examinations conducted by oxford and cambridge examination board before 1931, while most of those students who attempted it, failed (Ogunleye, 1999).

The Nigerian nationals who had the opportunity to study abroad and the subsequent education ordinances that is legislation on education led the colonial government to establish post secondary institutions and this mark the beginning of modern science teaching in Nigeria

secondary schools. The first post secondary institution, Yaba College which was later upgraded in 1963 to be known as Yaba College of technology was established in 1932 and the first graduates from the college went to secondary schools to teach science and lay the foundation for the development of appropriate curriculum in science for secondary students (Ogunleye, 1999).

A notable problem during this period was that science curriculum was modelled on British syllabi with content and activities in science that were beyond the experience of the Nigerian students and culturally in appropriate. Also the sciences taught in secondary schools reflect the British requirement and aspirations rather than those in Nigeria (Taiwo, 1975).

Abdullahi (1984) started that, the teaching and learning of science during the period was classical and emphasized rote learning of unrelated laws, definitions and concept. Also teachers rarely conducted practical lesson in science for secondary students due to the lack of funds for laboratory facilities. These unfavourable conditions led to high failure and attrition rate in science subject and a drift to arts subjects by most students because they perceived science to be very difficult to learn. Between 1932 and 1960 when Nigeria attained her independence from the British government, a number of educational returns took place including.

5. The introduction of the higher school certificate courses in some of the existing secondary schools in 1951 to afford students the opportunity to further study science with emphasis being on laboratory work so as to meet the practical requirement of science subjects.
6. The establishment of West African Examination Council (WAEC) in 1952 to conduct senior secondary examination in West African countries with it Headquarters in

Accra, Ghana, Nigeria, Sierra leone and Gambia. WAEC conducted its first senior secondary examination in 1955 and had a significant influence on science curricula.

7. The science Teachers Association of Nigeria (STAN) was established in 1957 with the aim of promoting co-operation among science teachers in Nigeria with a view to raising the standard of science teaching in the country (Bajah & Bello, 1996).
8. The federal colleges of Arts sciences and Technology at Ibadan in 1950, Zaria in 1952 and Enugu in 1954 were established with the aim of promoting the teaching of science.

The abolition of Oxford and Cambridge Examination, and the establishment of the West African Examination Council in 1952 to conduct secondary school examination in Nigeria brought many changes into the science curriculum and indigenized the content and scope of science teaching and learning in Nigerian schools. It further led to the first science curriculum development project in Nigeria known as the Basic science for Nigeria secondary schools (BSNSS) written by Nigerians and published in 1967 with a teacher guide. This project was jointly funded by the ford foundation of America and the western Nigeria regional government and coordinated by the comparative education study and adaptation centre (CESAC) of the University of Lagos. This curriculum in general science covered the first two years of secondary education in Nigeria and emphasized discovery teaching methods and laboratory oriented activities (Ogunleye, 1999).

The national policy on education document was revised in 1981 and 1998 and has since being used in Nigeria schools until the present time. The document sets out clear educational objectives at all levels, which are related to the overall national objectives of building a free, democratic, egalitarian, strong, just and self reliant Nigeria society, full of opportunities for all citizens (FGN,1998). The policy documents emphasized the important of science and technology with both state and federal governments encouraging citizens to pursue science

related activities. The broad aims of secondary education in relation to science education as enunciated in the policy document include;

- To diversify the school curriculum by or open to cater for differences in talents, opportunity and roles possessed by or open to students after their secondary school courses.
- To raise a generation of people who can think for themselves, respect the views and feeling of others, respect the dignity of labour and appreciate those values specialized under our broad national aims, and lives as good citizens (FGN, 1998, P.16).

The science content mandated in the national core curriculum for senior secondary school students is both preparatory and an interface with what is taught during the first year in the tertiary institution. It is worth nothing that at the senior secondary levels, physics, chemistry, and biology are taught to students as if they will all be science students at the university (FME, 1982).

The science Teacher Association of Nigeria (STAN) has over the years contributed toward science curriculum innovation and renewal and has been rightly supportive of integrated science progamme at the Junior Secondary level and has contributed to improving the teaching and learning of science at the senior secondary level by organizing seminar, workshops and conferences for science teacher and students.

Currently, the teaching and learning of science on Nigeria secondary schools is being limited by a number of factors. A national survey conducted by the science teachers Association of Nigeria (STAN, 1992) identified gross under finding, overloaded classroom, short ages of qualified science teachers and poor teaching strategies among other factors as contributory to students under achievement in science. Reports by Ivowi, (1999) and Okebukola (1997) further confirmed that the problems still lingered in the schools. There reports are

disheartening and concern teachers, Science educators, curriculum planners and other key stakeholders including Government.

2.6 Nature of Science and Chemistry

Scientific and technological literacy are considered as important goal for education (Hodson, 2003). As part of scientific literacy the nature of science is often seen at the core of the curricular aims of science education both of the secondary and university level. Although there is no general agreement on the exact definition of nature of science, some efforts to define nature of science have been made. Osborne, Collins, Ratcliffe, Millan, and Duschl (2003) consulted experts to fine out the central ideas about science that should be taught in school science. The nine central ideas about science to be taken into account in science education were.

1. Scientific method and critical testing
2. Creativity
3. Historical development Of scientific knowledge
4. Science and questioning
5. Diversity of science thinking
6. Analysis and interpretation of data
7. Science and certainty
8. Hypothesis and prediction
9. Cooperation and collaboration in the development of scientific knowledge

Based on their view of the literature on philosophy, sociology and history of science, Lederman, Abd-El Khalick, Bell, and Schwartz (2002) suggested including the following set of ideas about science in science curricular.

1. The empirical nature of scientific knowledge.
2. Observation, inference and theoretical entities in science.
3. Distinction and relationship between theories and laws.
4. The creative and imaginative nature of science knowledge.
5. The theory Laden nature of scientific knowledge
6. The social and cultural embeddedness of scientific knowledge
7. The myth of the scientific method
8. The tentative nature of scientific knowledge.

There are differences between all the scientific fields and the interdisciplinary field of the philosophy of chemistry highlights the domain specificity of the nature of chemical knowledge (Erduran & Scerrs, 2002). Like any other field of science, chemistry is not just a collection of knowledge, but more of a culture with learned patterns for thinking and acting transmitted through theory, skills and value (Dalgety, Coll & Jones, 2003). According to Mac Comas and Olson (1998), Nature of science can be seen as amalgamation of four fields of science, the sociology of science the psychology of science. Nature of chemistry is defined as part of Nature of science which includes the philosophical, historical, sociological and psychological perspective of chemical education play in society.

In recent times, there has been a growing public anxiety about the teaching and learning of science in Nigeria schools, studies showed that large number of students seems to learn very little science at school, learning tend to be by rote and student find learning of science to be difficult. (Eyibe, 1990, Jegede, 1992 Salau, 1996).

Okebukola (1997), paints gloomy description of science teaching in Nigerian schools when he asserts that the science class should begins with a brief chat as an introduction. This is followed by the reading of notes by the teacher to the students. At the end of the lesson, the

left over notes on the topic is given to the captain in the class free time, the class captain copies the note on the board or models the teacher by reading the notes for other students to copy.

2.6.1 Orientation of the Chemistry Curriculum

Chemistry curricula as a whole or single lesson plans can use different approaches towards the learning of chemistry. Some are arranged parallel to academic others provide meaningful contents to motivate the learning of chemistry. Chemistry curriculum approaches can stem from the structure of the discipline, or history of chemistry via everyday life contents, industrial application, or environmental issues towards socio scientific issues.

Reviewing the chemistry and science curriculum from 1960's and 1970s one see that at that time the main goal of science curriculum in general, and chemistry curricula in particular, was to give a limited portion of students a solid foundation in science to recruit and prepare these few students for future careers in science, engineering, or medicine. The results were that science curricula mainly focused on learning of pure chemistry and were structured analogous to chemistry text books from the university (Hosftein, Eilks &Bybee 2011).

Since the 1980s, new goals and standards for science curricula emerged that is the concept scientific literacy for all. The focus was no longer the preparation of single students for their future career in science and engineering. Most national science education standards worldwide started acknowledging that every future citizen needs a basic understanding of science in general and of chemistry in particular. This re-orientation of the objectives of science education led to intense debate about a potentially promising orientation and structure of the chemistry curriculum to fulfil the newly set goals (Hofstein, Eilks and Bybee, 2011).

The re-orientation of the curriculum becomes guiding theory of educational policy in many countries. New standard started asking chemistry education to move thoroughly to contribute to general educational objectives. The innovative work science for all Americans and subsequent by the project 2061, for example the Benchmark for science literacy, (A merican Association of the Advancement of Science, 1993) and the National science education standard (NRC, 1996) in the USA, directly influenced similar national standards and policies in other countries such as UK, Germany, (National curriculum 2004). The OECD in their frame work for the program for international student Assessment (PISA), described the overriding target for any science education to allow all students achieving scientific literacy in the means of.

> *"The capacity to use scientific knowledge to identify questions and to draw evidence-based conclusion in order to understand and help make decision about the natural world and the change made to it through human activity (OECD 2006",(p3).*

Since the 1980s there were different suggestions for organizers regarding the question of relevance in science education. Among these ideas there are found in several papers. These aspects can be summed up in three dimensions of potential reference chemistry education can have of which all three having an actual component (connect to the students interest) and future component.

- Relevance for the individual: meeting students' curiosity and interest, giving them necessary and useful skills for coping in their everyday life today and in future, or contributing the students' intellectual skill development.
- Relevance for future profession-offering orientation for future professions preparing for further academic or vocational training or opening formal career chance (e.g by having sufficient course and achievements for being allowed to study medicine).

- Relevance for the society: understanding the interdependence and interaction of science and society, developing skills for societal participation, or competencies in contributing to society's development.

The combination of these different dimensions of relevance in the context of chemistry education has many important consequences for structuring the chemistry curriculum, both concerning the chemistry content, as well as for the instructional techniques. One has to be aware that not only the explicit information is presented to the students. A curriculum or lesson plan may also provide subtle hidden ideas to the students, for example the purpose of learning chemistry, its potential use or about the nature of chemistry (Avaa, 2011).

2.6.2 The Idea of the Curriculum Emphases

In the 1980s, Doug Roberts reviewed science curricula covering almost one hundred years from the educational system of Northern America. (Roberts, 1982, p.245) cited in (Eilks and Hofstein, 2013), found that every curriculum has aside the specific content, a set of hidden message about science itself. The set of message he called the curriculum emphasis described

> *"A coherent set of message about science (rather them within science) such messages constitute objectives which go beyond learning the facts, principles, law and theories of the subject matter it self- objectives which provide answers to the students question why am learning this?"(Eilks and Hofstein, 2013. p245).*

From his analysis of the curricula, Roberts derived seven different emphases. Although Robert stated that these different curriculum emphases are not sharply detached from each other, that they might change by time and that they are often combined towards completely new meaning, they nevertheless allow the teacher to reflect about his own focus of teaching chemistry, his curriculum or textbook.

Table 1: The curriculum emphases on science by Roberts (1982 p 5) and illustration with the focus and chemistry

Curriculum Emphases	**Description**	**Illustration**
Everyday Coping	Science is presented as a way to understand natural or technical objects and events of everyday importance and relevance.	Learning chemistry facilitate the understanding of the function e.g of detergents. Fuels.or fertilizers.
Structure of Science	The curriculum focuses the understanding of how science functions as an intellectual enterprise, e.g the interplay of evidence and theory, the adequacy of a scientific model. Or the theory development in science.	Learning is about e.g bounding theory as a distinction principle between difference between inorganic, organic and physical chemistry, or the development of the theory of atomic structure and the periodic system of the elements.
Science, technology and decisions	Science and technology are distinguished, and the difference from value-laden considerations in personal and societal decision making about scientific issues in everyday life is dealt with.	Socio-scientific issues, e.g the use of bio-fuels, are not only delt with concerning their scientific and technological background, but also ethnical and societal values of their use and consequences to society are reflected.
Scientific skill development	The curriculum aims on the competence in the use of processes that are basic skills to all science.	General methods of solving problems and applying specific strategies and techniques from chemistry are dealt with.
Correct explainer	The curriculum stress the ‘’products’’ from science as accepted tools to correctly interpret events in the world.	Chemistry is offering accepted theories. Like heat absorption in gases. To explain the greenhouse effect.
Self as explainer	The curriculum focuses the character of science as a cultural institution and as one of man’s capabilities.	Growth of scientific knowledge is explained as a function of human thinking in a specific era within cultural and intellectual preoccupations. E.g along the change in the different atomic models in the early 20^{th} centuary.
Solid foundation	The role of science learning is to facilitate future science instructions.	Secondary chemistry should be organized to best prepare the students for later studying chemistry courses in the university.

More recently, Van Berkel, (2005) tried to update and reflect the idea of the curriculum emphases with respect to more recent curriculum and with focus of the domain of chemistry education. Van Berker refined the original seven emphases into three more general emphases, or one might say general aims in most chemistry curricula.

Table 2: Refine curriculum emphases by Van Berkel (2005 p 6).

Fundamental chemistry (FC)	Fundamental chemistry emphases the preferential learning of theoretical concept and facts. Behind this curriculum stands the philosophy that concepts and facts need to be taught first. Because it is believed that they later on will provide the best basis for understanding phenomena from the natural world and provide the best starting point for the students' further education.
Knowledge Development in Chemistry (KDC)	A central orientation on knowledge Development in chemistry is connected with the idea that students should learn that. How and in which socio-historical context knowledge in chemistry is and was developed. The students should learn to see chemistry as a culturally determined system. In which knowledge is constantly developing.
Chemistry, technology, and society (CTS)	chemistry, technology and society focuses explicitly on the relationship between science and technology and the role of science within societal issues. It is believed that the students should learn to communicate and make decisions about societal issues that are connected to aspects of chemistry and technology.

2.6.3 Knowledge Development in Chemistry (Oriented Science Curricula)

While in the 1960s to the 1980s chemistry curricula were overwhelmingly structured as a mirror of academic chemistry textbook, in the last 30years a lot of alternatives were proposed by science education research and promoted within curriculum development. One idea was to place more focus on Van Berkel's KDC emphases as mentioned above; this point of view was considered to be an additional toward curricula which were more or less exclusively structured on the pure transmission of scientific theories and facts as stable and approved knowledge, following on from Roberts emphases.

The basic goal of KDC driven curricula, is to enhance students learning in the areas underpinning the content and theories of science. The students are taught to learn about the

nature of chemistry itself. Curricula focusing on the nature of chemistry are intended to promote learning about how scientific knowledge is generated. The students should learn that scientific theory is culturally embedded into the epoch where it was developed. Chemical theories and models change over time and chemical facts can be reinterpreted in the light of new evidence. The history of chemistry is full of examples where theories were considered true until a new observation or new theory damned the theory to be replaced (Hodson, 2008).

2.6.4 The Chemistry Core Curriculum

The aim of science and technology curriculum is to provide a student-centred learning environment based on a cognitive and constructivist learning approach instead of a rigid and strict behavioural approach. The principles of multiple intelligence and active learning based on individual differences have also been adopted with the new science and technology curriculum. Students are expected to gain the skill that they previously lack, that is Critical and creative thinking, communication, scientific research, problem solving, using information technology and entrepreneurship. Students are also expected to become science and technology literate with the new science curriculum Udo, Ramsey and Mallow(2005).

The core curriculum is written to assist teachers and supervisors as they prepare curriculum, instruction and science content. It presents major understanding that gives more specific details to the concept underlying in the core is consistent with the approaches recommended in the National Science Education Standard (National Research Council) and Benchmarks for science Literacy (American Association for the Advancement of Science). The local courses designed using this core curriculum, are expected to prepare students' to explain both accurately and with appropriate depth concepts and models relating to chemistry. The core addresses only the content and skills to be assessed at the commencement level by the physical setting/chemistry reagents examination. The core curriculum is prepared with the

assumption that the content, skills and vocabulary as outlined in the learning standard for mathematics, science and technology at the elementary and intermediate level are taught. Example of a core curriculum is:

The Geogia Performance Standard:- They are designed to provide students with the knowledge and skills for proficiency in science. The project 2061's Benchmarks for science literacy is used as the core curriculum to determine appropriate content and process skills for students. Technology is influenced into the curriculum.

The relationship between science, our environment, and our everyday world is crucial to each student's success and should be emphasized. The performance standard should drive instruction. Hands on, students centred, and inquiry based approaches should be the emphases of instruction. This curriculum is intended as a required curriculum that would show proficiency in science and instruction should extend beyond the curriculum to meet the students' needs.

2.7 Gender in Science

Sitting in the same classroom, reading the same text book, listening to the same teacher, boys and girls receive very different educations (Sadker, 1994). In fact, upon entering a school, girls perform equal or better than boys on nearly every measure of achievement, but by the time the graduate high school or college they have fallen behind. However, the discrepancies between the performance of girls and the performance of boys in elementary education, leads some critics to argue that boys are being neglected within the education system.

Across the country, boys have never been in more trouble. They earn to percent of D's and F's that teachers dole out. They make up two thirds of students labelled "learning disabled"; they are culprits in a whopping 9 of 10 alcohol and drug violations and the suspected

perpetration 4 out of 5 crimes that end up in juvenile court. They account for 80 percent of high school dropout and attention deficit disorder diagnoses.

The socialization of gender within our schools assures that girls are made aware that they are unequal to boys. Gender factor can occur within subject areas and school activities, for example in subject such as mathematics and the sciences. There are different participation pattern for girls and boys. The participating in science has increased and achieved partly with boys in biology chemistry and algebra. However, subject that are prerequisite for college major such as engineering or physics remain dominated boys only 25% of high school students enrolled in physics are female there has been a little increase in the percentage of women in engineering programs.

Males are also more likely than female to be in remedial programs, and students race also impact these patterns.

Differences in perceptions of science and technology between boys and girls have been examined by researchers. Ogunjuyigbe, Ojofeitimi and Akinlo (2006). The studies have reported that male students have greater interest and achievement than female students in science and technology, specifically, Boser, Palmer and Daugherty, (1998) reported that female students constantly perceived technology to be less interesting than male students do. In other related subject, Jewett (1996), Silverman and Pritchard (1993), found out that technology, mathematics and science still considered non traditional areas for female and that societal perceptions and expectation contribute to women's reduced interest in the so field. Ogunboyede (2003), conducted a research comparing the academic achievement of boys and girls at primary school level he find out that boys are not better than girls in terms of educational achievement. Iorchugh (2006), did a research on the influence of cognitive style, cognitive level and gender on students achievement in physics, he did not find either of the

gender performing better than the other. The most striking difference between male and females in science is not in achievement or in opportunities to learn, but in confidence. Even when female have similar exposure to courses and a similar achievement level. They are less confident in their ability feel less prepared and lack interest in science and technology. Sax (1995).

2.8 Empirical Studies

College chemistry students need to develop the ability to solve unfamiliar problems to be successful in the professional world. Some instructions and techniques for solving these problems are frequently demonstrated and practices in college chemistry courses. The researchers find out the effect of problem solving strategy in teaching chemistry on students' performance in Gombe state. This sub theme provides the reader with relevant studies conducted so far on the research topic. Research evidences have proved that chemistry's contribution to quality of life and nation building are worthwhile in all aspects, that is why the federal government of Nigeria through her national policy on education made chemistry a compulsory sciences subject at secondary schools level (FRN, 1984, 2004). Despites the prime position chemistry occupies in our educational systems and the effort made by different researchers to enhance students' performance in chemistry and science the result is still low. Avaa (2011), did a research on the challenge of effective teaching of chemistry in zaria. His objectives was to investigate the low achievement in chemistry within the variables Attitude, Qualification, choice and career attitude. H e uses a descriptive research design with a sample of sixty students from SS1 and SS2. Questionnaire addressing the questions related to teacher factors Attitude, Qualification and students factors choice or career were asked. He identifies some of these reasons to be the cause of students failure in chemistry.

i. Teachers attitude

ii. Examination malpractice

iii. Non coverage of syllabus

iv. Class size

v. Non professionalism

vi. Environment and method of instruction

He further explained that most teachers are in teaching profession not by choice, they considered teaching to be a waiting ground for better jobs. For example a teacher said, 'I have been teaching for the past fifteen years but my heart is not there I am waiting for better job'. Student's fear of chemistry also contributed to the rate at which they fail the subject. This research is similar to the present research in terms of finding the cause of failure in chemistry but the difference is in the design the researcher used and the instrument used in the data collection. Hes findings only shows the factors suspected to be the cause of students failure in chemistry but does not provide the lasting solution to the problem, this presents research however will fill the gap that will provide a possible solution to the problem.

Udo (2011), conducted a research on the effect of problem solving, guided discovery and expository teaching strategies on student performance in redox reaction in chemistry Ondo state. The objective of the study was to determine the relative effectiveness of problem solving strategy in enhancing students performance in redox in reaction compared with guided discovery method, to determine the relative effectiveness of problem solving strategy in enhancing students performance in redox reaction compared with guided discovery and expository teaching method considering their mathematical background. Hes research question are; How do students differ in their performance in redox reaction when taught using problem solving and guided discovery and expository teaching method. What is the difference in the performance of students with high, average and low mathematical ability in

redox reaction when taught using problem solving, guided discovery and expository teaching method. The hypotheses state that there is no significant difference in students performance in redox reaction when taught using problem solving, guided discovery and expository method of teaching, there is no significant difference in the performance of high, average and low mathematical ability in redox reaction when taught using problem solving, guided discovery and expository methods. The researcher uses a quasi experimental research using a non randomized pre-test post test control group design with expository method as control group. The population target was all the 850 SS2 chemistry students in 12 public secondary schools in Uyo local government area Akwa Ibom State. 120 SS2 chemistry students from 3 co educational public schools were used as the sample for the study. The instrument used in collecting the data were 2 developed 25 multiple choice objective items known as the Chemistry Achievement Test and Mathematical Ability test. The statistical tool used in analysing the data was analysis of covariance ANCOVA. The result of his findings shows that those students taught using problem solving method performed significantly better than those taught with guided discovery and expository method. Expository method was the least facilitative. The study further affirmed that students performance was observed not to be dependent on their mathematical ability. The difference between these finding and the present one is Udo uses three method of instruction and three groups that is each group with one method of teaching while the present finding focuses on two method of teaching. The researcher uses ANCOVA as his statistical tool while this research uses t test. There is difference in the population and sample size. The similarities between the two research is the fact that their all finding the effectiveness of problem solving strategy as a method of teaching on students performance.

Nbina and Joseph (2011), report a study on the assessment of the effect of problem solving instructional strategy on students' achievement and retention in chemistry in Rivers state .

Their objective was to determine the effect of problem solving instructional strategy on students achievement and retention in chemistry with respect to location. To ascertain if a significant difference exist in the achievement and retention mean score of urban and rural students taught by various problem solving strategies. The research questions are what are the relative effect of problem solving strategies PF, PM and PCon students achievement in chemistry with respect to location as determined by chemistry achievement test. What are the relative effects of problem solving strategies on students retention in chemistry with respect to location. The research hypotheses state that, there is no statistically significant difference in the post test chemistry achievement mean score of urban and rural subject taught chemistry respectively by PF, PM and PC. There is no statistically significant difference in the chemistry retention mean score of urban and rural subject taught chemistry respectively by PF, PM and PC. A quasi experimental pre-test post test control group design was adopted for the study. 428 SS2 chemistry students were selected from the rural and urban area of the state. A chemistry achievement test (CAT) and mathematics ability test (MAT) was used as the instrument for the study. The data was collected and analysed using Analysis of Covariance ANCOVA. The result of the findings shows that problem solving method enhance the students achievement and retention and that there is no significant difference in the achievement of students due to location, this shows that achievement in chemistry is not dependent on the type of environment under which it is taken place. There are differences in these research and the present research the sample size, location and variables used

Uygulama (2010), reported a study on the effect of problem solving and cooperative learning strategies on senior secondary school students achievement in physics. The researcher uses a quasi experimental research design. 141 senior secondary 2 (SS2) students were used as the subject of the study. He uses a Physics Achievement Test (PAT) and a problem solving work sheet as the instrument for the study. Analysis of Covariance ANCOVA was used for data

analysis. The findings shows that students taught using problem solving strategy perform significantly better than their counterpart in either of the cooperative learning strategy and the conventional method.

Gabel and Bunce(1994), in a research on problem solving said that the Working Memory Space (WMS) is where new information from the outside world and information retrieved from Long Term Memory (LTM) is held and processed. The size of the (WMS) coupled with previously held knowledge in (LTM). This is therefore a major determining factor in learning and problem solving. Students failure in problem solving could possibly be attributed to their lack of sufficient experience in problem solving lessons, methods commonly used by teachers rely predominantly on presenting information, showing prototypical examples of workout problem and giving students practice in solving similar kinds of problems.

Gabel and Bunce (1994), Proposed that

"the factors affecting students success in problem solving are three fold: The type of problem and the underlying concepts of the problem, the learner characteristics, including cognitive styles, development levels and knowledge base; and learning environmental factors, including problem solving strategies or methods, individual or group activity"(Gabel and Bunce 1994. p3)

Overton and Potter(2007), reported on open ended problem solving and the influence of cognitive factors on students success. The paper investigated on the effect of cognitive style and attitude on the problem solving abilities of students in a department of chemistry. A set of context based open ended problems was designed with the aim of helping students develop higher order cognitive skill. Test for cognitive style were performed by group of students and were followed at a later date by problem solving sessions. Attitude chemistry problem solving and the use of real life context were also assessed by the use of questionnaire. Data was gathered from the test result , performance in the problem solving sessions, performance in A level and the degree so far. Statistical analysis was then performed on these data to look for correlation between any of the variables. Attitude questionnaire were then analysed for significant changes.

Students were selected for interview, the result shows that there appears to be a correlation between A level scores and problem solving ability. All the students found the open ended problem solving more challenging yet more enjoyable than the conventional ones.

(Overton and Potter, 2007), Stated that,

> *"most problem solving activities in chemistry focus on the development of quantitative skills and the solving of algorithmic problems. Problems which are more open ended in nature are less often encountered and are more difficult to develop and to assess in terms of students performance. However, such problems presents advantages in terms of motivating students and in providing a more realistic experience of problem solving skill".(Overton and Potter, 2007 p5)*

Nakhleh (1993), examined that chemical educators and teachers have often assumed that success in solving chemistry problems should indicate mastery of the chemistry concept. According to him the best way for students to learn science is to experience challenging problems and the thoughts and actions associated with solving them. Ram (1999), wrote on problem based learning in undergraduate education, he affirmed that problem solving using ill-structured problems motivates students and encourages the understanding of the epistemology of the discipline.

He also indicated that students as humans respond to whatever situation exposed to base on the situational influence on their attitude. Attitude, therefore affects people in everything they do and in fact reflects what they are, hence a determining factor of students behaviour.

Reid and Yang (2002), stated that in their research the solving of problem in chemistry, they observed that the students problem solving behaviour as well as some systematic studies indicate that there are some common difficulties associated with teaching and learning problem solving these include:

- Lack of science knowledge pertaining to the problem.
- Lack of an organized hierarchical knowledge structure which can be easily remembered and appropriately retrieve in complex content.

- Lack of problem solving skills such as translation and linkage skills. Students have difficulty in translating the problems into meanings and setting goals or sub goals for the problem, especially the unfamiliar ones.
- Lack of knowledge of a problem solving strategy and the procedure for problem solving

Gayon(2003), reported on the problem solving ability of high school chemistry students and its implications in redefining chemistry education. The researcher uses a descriptive design, factor analysis was utilized to identify the factors underlying the problem solving ability in chemistry. The study buses a population of 1599 third year (grade 9) students in a public school, a sample of 118 students were used for the study. The researcher developed chemistry problem solving ability test questions as an instrument to determine the relationship between problem solving ability and achievement of the students. Data was collected and analyzed and the result shows that chemistry problem solving ability test scores has a positive significance prediction on chemistry final grade which is the measure of achievement in chemistry.

Festus and Ekpete (2012), reported a research on improving students performance and attitude towards chemistry through problem based solving techniques. They use a quasi experimental pre-test post test control group design. The study has a population of 98 senior secondary school 2 students. Two different classes were used one assigned experimental group and one as control group. The researchers' uses problem based solving test as an instrument for data collection. T test was used to establish difference between students taught with problem based solving and those taught with conventional method. The result from the findings shows that students taught using problem based solving performed better than the student taught using the conventional method.

2.9 Summary and Uniqueness of Study.

The researcher reviewed relevant literature on chemistry and problem solving. Chemistry is identified as the bedrock of any technological development of a country (Emendu, 2014). It is seen as the acquisition of knowledge or ideas relevant to human life. Chemistry education is defined as the systematic process of acquiring the fundamental knowledge about the Universe. Due to the important chemistry plays in the society it was made a compulsory science subject to be taught in Nigerian secondary schools (Adesoji 2008). Despite the fact that chemistry occupies an important role in the transformation of the nations' economy, research has shown that the rate at which students fail the course is too high. Samba and Eriba (2012), said this decline in performance is due to the abstract nature of chemistry concept. Agogo, 2013, Agwi, 2008) think it is due to concept difficulty in chemistry which is perceived by both boys and girls at all level of education. However the need to find a suitable method of instruction which will help in the understanding of these concepts is important. The study reviewed the concept of problem solving where Gagne (1985) ,defines problem solving as a thinking process in which the learner discovers combination of previously learned rules that he can apply to solve a novel problem. The theory that discussed about problem solving strategy is the cognitive theory solving was reviewed in which the researcher uses the Polya's problem solving 4 step method to conduct the research.

The polya's 4 step are: Step I- Understand the problem

Step II- device a plan

Step III- carry out the plan.

Step IV- look back

The researcher uses the four steps in order to find out the effect of problem solving strategy in teaching chemistry or performance in senior secondary schools.

A lot of researches have indicate the important of problem solving as a method of instruction in teaching chemistry Gabel and Bunce (19994),indicated that, the use of problem solving instructional strategy and techniques to teach chemistry influence the students problem solving skills. Ram (1999), affirmed that problem solving using ill-structure problem motivate students and encourage the understanding of the epistemology of the discipline.

These indicate the that problem solving strategy has either positively or negatively effect on the students performance that is why this study was carried out to examines the possible effects of using problem solving strategy on chemistry students performance, and to ascertain if the students problem solving skills is developed . The study was conducted in Gombe state, the population size, the tribe found in the state and the sample size make the research work unique from others reviewed.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The researcher at this point outlined all the strategies or method used in finding the effects of problem solving strategy on the performance of students . The chapter includes the design, target population, sampling techniques, the instrument used in collecting the data, the validity and reliability of the data collection instrument and the data collection procedure and analysis were also discussed.

3.2 Research Design

The researcher used a quasi pre-test-post –test experimental research design in order to determine the effects problem solving strategy on students performance in chemistry. This is because it involving method of teaching which requires experiment to determine it effectiveness on the subjects. Symbolically, the design of the study may be represented as shown below.

$0_1 \rightarrow x \rightarrow 0_2$ = Experimental Group.

$0_1 \rightarrow z \rightarrow 0_2$ = control Group

Where 0_1 = pre-test.

0_2 = post-test.

X = problem solving strategy.

Z = traditional teaching strategy.

3.3. Population and sample.

3.3.1 Population of the Study

The study was conducted in Gombe state. Gombe state is located in the north eastern part of Nigeria. It has 11 local governments Area, there are tribes like Fulani, Tera, Waja, Tangale, Jukun, Filiya. The people of Gombe state mostly practice Islamic religion and Christianity. The study was conducted in senior science secondary schools offering chemistry in the state. There are total number of 23 science secondary schools across the state. But for the purpose of this research, the target population comprise of 23905 senior secondary two (2) students from Government secondary schools in Gombe state. Their age ranged from 15-17 years and they comprises of both male and female students. The population is represented on the table 3.3.1 below.

Table 3.3.1 Summary of the population

S/N	Name of Schools	Male	Female
1	G.S.S.S DOMA	815	450
2	G.S.S.S GOMBE	1071	230
3	G.D.S.S BILLIRI	920	400
4	G.D.S.S KUMU	494	600
5	G.S.S.S PANTAMI	1000	210
6	G.D.S.S PILOT	915	220
7	G.D.S.S DADINKOWA	980	170
8	G.S.S.S NAFADA	733	450
9	G.D.S.S KALTUNGO	520	320
10	G.S.S.S FUNAKAYE	315	601
11	G.S.S.S KURI	482	240
12	G.D.S.S DEBA	415	314
13	G.D.S.S MALANGA	541	600
14	G.S.S.S GANDU	401	560
15	G.S.S.S FILYA	443	390
16	G.D.S.S BAJOGA	1022	410
17	G.D.S.S FUTUK	850	362
18	G.S.S.S KWAMI	581	215
19	G.D.S.S DUKKU	512	250
20	G.D.S.S TUNDUN WADA	594	350
21	G.D.S.S BOLARI	575	342
22	G.D.S.S JEKADAFARI	758	400
23	G.S.S.S BOLARI WEST	518	420
Total		15401	8504

Source: Min. of Education (2014)

3.3.2 Sampling techniques.

The researcher uses multi stage cluster sampling technique. cluster sampling was used to select the two science secondary schools used for the study in selecting the two (2) science secondary schools to be used for the study. Another cluster sampling was used to select two intact classes for the research, one will be used as experimental and the other as control group.

3.3.3 Sample size

Two Intact classes with 40 students each were used for the study. A total number of 80 (SSII) Chemistry students were used as subject of study from the 2 selected science

secondary schools. This was because the study is a quasi experimental research which according to Gay, Mill and Aresion (2009) stated that a minimum number of thirty students is satisfactory. The selected schools are represented table 3.3.2 :

Table 3.3.2 summary of sample size

Name of school	**No. of teachers**
GSSS Doma	40
GSSS Gombe	40
Total	**80**

3.4. Data Collection Instruments

The researcher developed 2 measuring instrument for the conduct of the research.

The Chemistry Problem Solving Ability Test consist of 30 multiple choice items developed by the researcher, some of the questions are adopted from WAEC standardized examination questions. The CPSAT were drawn from topics like empirical formula, chemical combination, calculation of atomic and molecular mass of a substance, periodic table and separating techniques. The maximum score is 60 and the minimum is zero. The CPSAT was used in assessing both the pre-test and the post test experimental and control group.

3.5 Validity & Reliability of the instruments

3.5.1 Validity of the instruments

To ensure face and content validity of the instrument, the test items develop by the researcher was moderated by two lecturers from science education department in Bayero University Kano. The lecturers have a Bsc. Ed degree in chemistry. The test items was also given to two experience senior secondary school chemistry teachers who have a Bsc. Ed in chemistry with a minimum of 4 years working experience. The instrument was given to the project

supervisor for final observation and approval. These experts and teachers were asked to examine the test items critically and assess:

- If the content of the instrument are correct and appropriate to the level of students.

- If the items are clearly, readable and free from ambiguity and suitable for the level of students they were design for.

- Give suggestion and criticisms that would be helpful in improving the quality of the test items that are found unsuitable.

- Whether the items were testing the chemistry concept they are meant to or not. The instruments were revised based on corrections and recommendations made by the experts.

3.5.2 Reliability of the instruments

The reliability of the instrument was determined using test re-test method with two weeks interval from the first test using 10 samples drawn from Government science secondary school Kumo which was out of the study population. Scores obtained from the first and second administration of the instrument was subjected to Pearson product moment correlation coefficient formula. The reliability index of the instrument was found to be R= 0.84. These significantly indicate that the instrument is highly reliable for use in the study.

3.6 Data Collection Procedure

The researcher visited the ministry of education in Gombe state to obtain permission to use the schools for the study. She also visited the schools to obtain permission from their principals to use their schools as a sample for the study. 4 teachers' with a degree in chemistry and with at least a minimum of 4 years working experience served as the research

assistants. The researcher takes a week to train the subject teachers using the validated instructional packages developed by the researcher for the experimental and control groups.

The study was carried out in 4 stages namely. The training, pre-testing, treatment, post-testing.

The training Stage:- This involves a week training programme for the chemistry teacher in the 2 selected schools. The training involves grouping the teachers to the group of students' they are to handle. That is 2 teachers each for the experimental and control groups.

The Pre-testing Stage:- The researcher along with the research assistant administer the CPSAT on the subjects in all the 2 selected schools. The CPSAT was administered to the 2 treatment groups as a pre-test in order to ascertain the homogeneity of the treatment groups. The groups were pre-tested and the mean score of the experimental and control group were obtained. The result shows that the group do not differ in their performance .the mean score of the experimental is 24.5 and that of the control group is 24.4. This clearly shows the equality and homogenity of the two groups.

Treatment Stages:- The 4 trained chemistry teachers commence treatment after their pre-testing session. During the treatment stage all the trained teachers applied what they learn from the training session. The lesson plan for the experimental group adopted Polyas' model of problem solving strategy, the lesson plan reflect the Polya's 4step

Post-test Stage:- The teachers administered the CPSAT at the end of the 5^{th} week of treatment of the subject in the 2 selected schools. The test methodology and the time allowed for the post-test measure was equal to the pre-tests and these generate a quantitative data which was analyzed.

3.7 Data Analysis Procedure

The researcher analysed the data using descriptive statistics to answer the research questions and *t*-test to test the null hypotheses of the study at 0.05 level of significance. This is because the research looked at differences between two means and t test is a statistical tool use in determining the differences between two mean

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter discussed the presentation and the analysis of data collected by the researcher. The subjects as stated earlier comprise of 80 SSII Chemistry Students from the two (2) science secondary school in the study area. A pre-test post test quasi experimental design was use in order to determine the effect of problem solving strategy in teaching chemistry on students performance. The researcher uses problem solving ability test question and a questionnaire in order to collect data for the study. Data was obtained from the pre -test and post test given to the subject before and after the treatment. The questionnaire was answered by the chemistry teacher that were used as the research assistant to provide information on the factors that affect the teachers use of problem solving strategy in teaching chemistry.

4.2 Data Presentation

The results were presented in a table according to the research questions and hypothesis of the study. All the hypotheses were tested at a probability of 0.05 level of significance.

4.3 Data Analysis.

The researcher discusses how the data was analyzed, research questions were answered and research hypotheses were tested.

4.3.1 Answer to Research Questions

The research questions were answered using a table to show the mean score and standard deviation.

Research Question 1

What is the difference in the academic performance and the problem solving skills of students expose to problem solving strategy and those expose to traditional method of teaching?

Table4.1: Summary of post-test mean score and standard deviation of control and experimental group

Group	Teaching strategy	Mean	S.D
Experimental	Problem Solving	35.9	9.22
Control	Traditional	26.00	7.10

Table 4.1 shows the summary of mean score and standard deviation of the post test given to the experimental and control group at the end of treatment. The result shows the mean score of students exposed to problem solving strategy to be higher than the mean score of those exposed to traditional method. The mean score of the experimental group is 35.9 and the standard deviation is 9.22, the mean score of the control group is 26.00 and the standard deviation is 7.10.This result answers the question what is the difference in the academic performance and problem solving skills of students expose to problem solving strategy and those expose to traditional method of teaching. This shows that those taught using problem solving strategy had better performance and have acquire problem solving skills more than those taught using traditional method.

Research Question 2

What is the difference in the performance of male and female students exposed to problem solving strategy and the male and female students exposed to traditional method of teaching?

Table 4.2.1: Summary of post-test mean score and standard deviation of male and female students of the experimental group

Group	Gender	N	Mean	S.D
Experimental	**Male**	20	34.6	8.0
	Female	20	33.0	5.3
Total		40		

Table 4.2.2: Summary of post-test mean score and standard deviation of male and female students of the control group

Group	Gender	N	Mean	S.D
Control	**Male**	20	25.7	6.42
	Female	20	23.5	6.17
Total		40		

The results in table 4.2.1 and 4.2.2 shows the mean score and standard deviation of the male and female students in the experimental and control group. The result shows the differences in the performance of male and female students in both groups. The result shows that the

male and female students taught using problem solving strategy have a mean score of 34.6 and a standard deviation of 8.0 for the male subjects and the mean score of 33 and the standard deviation of 5.3 for the female subjects. The male subjects in the control group have a mean score of 25.7 and a standard deviation of 6.42. The female subjects have a mean score of 23.5 and a standard deviation of 6.17. This shows that those subjects in the experimental group perform better than the subjects in the control group. Thus this result answer the question what is the differences in the performance of male and female students exposed to problem solving and the male and female students exposed to traditional method of teaching.

Research Question 3

What is the difference in the performance of male and female students when expose to problem solving strategy?

Table 3: summary of mean score and standard deviation of male and female students expose to problem solving.

Gender	**N**	**Mean**	**S.D**
Male	20	34.6	8.0
Female	20	33.0	5.8
Total	**40**		

The result in Table 3 shows the mean score and standard deviation of the male and female students performance of the treatment group, this is to ascertain if there is any difference in

the male and female performance when expose to problem solving strategy. The result shows that there is no difference in the male and female performance. The male students have a mean score of 34.6 and standard deviation of 8.0. The female students have a mean score of 33 and a standard deviation of 5.8. These result thus answers the question what is difference in the performance of male and female students when expose to problem solving strategy.

4.3.2 Testing Research Hypotheses

The researcher test the null hypotheses using the t test statistical tool. This enable the researcher to either accept or reject the null hypothesis.

Hypothesis 1

There is no significant different in the students' academic performance and problem solving skills when exposed to problem solving strategy and those exposed to traditional method of teaching.

Table 4.3: t-test value of the post-test of the experimental and the control group

Group	N	Mean	SD	df	SE	t-cal	Level of sig.
Experimental	40	35.9	9.22				
				78	1.84	5.38	0.05
Control	40	26.0	7.10				
Total	**80**						

Significant

Table 4 shows the post test mean score and t calculated value of the experimental and control group the result shows that at 0.05 level of significant and degree of freedom df 78 the t calculated value is 5.3807 and the t table value is 1.66. This shows that the t calculated value is higher than the t table value, this indicate that the problem solving strategy seems to be

more effective in improving the students' academic performance and problem solving skill in chemistry than the normal traditional method of teaching chemistry. It implies that, the subjects taught using problem solving strategy achieved significantly better than those taught using the traditional method. The mean score value of 35.9 for the experimental group and 26.00 for the control group further confirm that there is significant difference between students taught using problem solving strategy and those taught using traditional method . Therefore, the null hypothesis is thus rejected.

Hypothesis 2

There is no significant difference in the performance of male and female students exposed to problem solving strategy and male and female students exposed to traditional method of teaching.

Table 4.4: t-test value of the post-test of the male and female students of the experimental and the control group

Group	Gender	N	Mean	SD	df	SE	t-cal	Level of sig.
Experimental	**male/female**	40	49.3	11.6				
					78	2.54	7.48	0.05
Control	**male/female**	40	31.8	9.23				
Total	**80**							

Significant

The result in table 4.4 shows the mean score and t calculated value of the post test of male and female students of the experimental and control group. The mean score of the experimental is 49.3 and a standard deviation is 11.6. The control group have a mean score of 31.8 and a standard deviation of 9.23. The result shows that at 0.05 level of significance and df 78 the t calculated value is 7.48 and the t table value is 2.67. This indicate that the t cal is higher than the t table value which shows that there is a significant difference in the

performance of male and female students in the experimental and control group. The subjects taught using problem solving strategy perform significantly better than those taught using traditional method of teaching. Therefore the null hypothesis is rejected

Hypothesis 3

There is no significant difference in the performance of male and female students when expose to problem solving strategy.

Table 4.5: summary of t-test value of male and female students of the experimental group.

Gender	N	Mean	SD	df	SE	t-cal	Level of sig.
Male	20	34.6	8.0				
				38	2.21	0.7	0.05
Female	20	33.0	5.8				
Total	**40**						

Not significant

Table 7 shows the result of post test score for male and female subject in the experimental group. The result shows that the mean achievement score of male subject is 34.6 while the mean scores of female subject is 33, which implies that there is no much difference in the mean score of the boys and girls the T-calculated value at 0.05 level of significance and degree of freedom 38 is 0.7 and the T table value is 1.68. The T calculated value is lower than the T table value. These indicate that there is no significant difference in the performance scores of male and female subjects when taught using problem solving strategy. Therefore, the null hypothesis is retained. This means that the problem solving strategy is gender friendly.

4.4 Summary of Findings.

Findings from the results are as follows

1). The students taught using problem solving strategy performed and acquire problem solving skills significantly better than those students exposed to traditional method of teaching chemistry.

2). There was a significant difference in the performance of male and female students exposed to problem solving strategy and the male and female students exposed to traditional method of teaching.

3) There was no significant difference in the performance of male and female students in the experimental group.

4.5 Discussion of Result.

The findings in this study support the use of problem solving strategy as a method of instruction that will enhance the students 'performance and also develop their problem solving skills. The post test mean score of the experimental and control group were compared and the result shows that the students taught using problem solving strategy had the highest mean score than those students taught using traditional method of teaching. It also shows that the student taught using problem solving strategy have develop their problem solving skills more than those in the tradition method of teaching. This clearly indicates that the problem solving strategy used as a method of instruction increased the students' academic performance than the traditional method.

This finding is in line with that of Uygulama (2010) who discuss the superiority of problem solving instructional strategy on the effects of problem solving and cooperative learning

strategy on senior secondary school students' performance in physics and concluded that problem solving strategy provides an interaction of students with each other when solving problems. Udo (2011) also conducted a research on effects of problem solving, guided Discovery and expositing teaching strategies on students performance, his findings shows that those students taught using problem solving strategy performed significantly better than those taught using the other method of instruction. Nbina and Joseph (2011) discussed on the Assessment of the effects of problem solving instructional strategy on students Achievement and Retention in chemistry he found out that those taught using problem solving perform better. Gabel and Bunce (1994) in their research on problem solving indicated that the use of problem solving instructional strategy and techniques to teach sciences influence the students problem solving skills.

On the issues of significant on gender differences, the mean scores of both the male and female students' in the post test shows that there that was no much difference in the mean score of the male and female students. The results in table 6 indicate that the male and female students in the experimental group showed no significant difference in the academic performance of male and female students taught using problem solving strategy. This means that problem solving strategy used on the subjects is gender friendly. The result is in support of the finding of Ogunboyede (2003), who conducted a research comparing the academic achievement of boys and girls at primary school level. The finding shows that boys are not better than girls in terms of educational achievement. Also a research conducted by Lorchugh (2006), on the influence of cognitive style, cognitive level and gender on students, achievement in physics did not find either gender performing better.

This study thus shows that there is no significant difference in the academic performance of male and female subjects due to the fact that they are both exposed to the same teaching strategy that is problem solving, under the same condition, by the same teacher.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This chapter discussed the summary of the research finding draw conclusion and suggest recommendation.

5.2Summary

Chemistry being started as an important science subject that leads to the transformation of the nation. Despite the prime position chemistry occupies in our country the rate at which students fail the subject is increasing day by day. Effort was made by the researcher to find out the effect of problem solving strategies in teaching chemistry. In order to find out the impact these method of instruction or the position it occupies in improving the student level of performance in chemistry, objectives of the studies where to determine the student performance when taught using problem solving strategy in teaching chemistry, to find out if using problem solving strategy can develop the student problem solving skills. Determining the factors that affect the teachers' use of problem solving in teaching chemistry and gender factor was also observed.

Literature relevant to the study were reviewed to determine how far researchers have gone on understanding the method of instruction and to provide bases on where to begin. The study gathered a lot of research findings which supported the use of problem solving strategy as a good method of instruction that enhance the students' level of performance in chemistry.

Qua si experimental pre test, post test design was used for the conduct of the research. The study has a population of 23905 senior secondary two (SS 2) students. two senior science secondary schools offering chemistry were randomly selected and 2 intact class of 40 student

each were used for the study a total number of 80 senior secondary 2 student were used as a the sample of the study. The researcher uses chemistry problem solving ability test question and a questionnaire as the instrument use for data collection of the study. The test questions where designed to find out the effect of the method of instruction on the student performance and the students problem solving skills. While the questionnaire addresses the factors that affect the teachers use of problem solving strategy in teaching chemistry. The data was collected and subjected to data analysis. The test questions were analysed using T-test.

The result of the data analysis shows that students taught using problem solving strategy perform significantly better than students taught using traditional method. The students exposed to problem solving strategy have developed problem solving skills more than those exposed to traditional method of teaching. The method of teaching seems to be gender friendly because there was no significant difference in the performance of male and female student. They all concluded that the method of instruction could be a method of change to the students' academic performance. This indicates that problem solving strategy used effectively in the classroom can enhance the student's academic performance, develop their problem solving skills and reduce the rate at which students fail chemistry.

5.3 Conclusion

Based on the research findings the following conclusion were made;

The students taught using problem solving strategy performed significantly better than those students taught using traditional method of teaching chemistry. Therefore, the use of problem solving strategy as a method of instruction should be preffered. The students exposed to problem solving strategy developed their problem solving skills more than those exposed to traditional method of teaching chemistry. The findings clearly indicate that the use of problem solving strategies enhance the students problem solving skills.The teaching of

problem solving strategy was found to be gender friendly. These indicate that both male and female students benefit from the use of problem solving strategy as a method of instruction in teaching chemistry.

5.4 Recommendations.

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

5.5.1 Recommendations from the study

1. The study shows that, problem solving strategy enhance the student academic performance and problem solving skills, therefore the use of problem solving strategy by chemistry teachers should be encourage in Nigerian senior secondary schools.

2. Curriculum Planners should recommend and ensure that the problem solving strategy is used for teaching chemistry at senior secondary schools', it should be included in the curriculum. Government should provide funds for schools so as to provide enough instructional materials especially chemistry which requires a lot of practical materials.

3. Since the strategy is gender friendly, it could serve as an effective instructional strategy in both single sex and co-educational schools.

5.5.2 Suggestion for further studies.

a) There is need for more research on the effective method of teaching chemistry. These study only focuses on using problem solving strategy but there are other method of instruction like the guided discovery, focused group discussion which the researcher has not looked into and can be viewed to see if it can be effective in improving the students performance in chemistry.

b) Gender factor can also be viewed with the other method of instruction to see if they can be used not only in single schools but also in our co educational schools.

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APPENDIX I

CHEMISTRY PROBLEM SOLVING ABILTY TEST (CPSAT)

School---------- Age ----------

Term---------- Gender----------

class----------

1. A hydrocarbon contains 7.7% by mass of hydrogen and 92.3% by mass of carbon. the relative molar mass of the compound is 78. What is the empirical formula?
   a. CH b. CH_2 c. C_2H_5 d. C_2H_2 e. C_2H
2. What is the molecular formula of the hydro carbon?
   a. CH_2 b. CH c. C_2H_4 d. C_6H_6 e. C_6H_2
3. A mixture of calcium chloride and calcium trioxocarbonate (iv) in water can be separated by
   a. Evaporation b. sublimation c. distillation d. filtration e. decantation
4. $CuSO_4.5H_2O$ can be obtained from an aqueous solution of copper (ii) tetraoxosulphate (vi) by
   a. Evaporation to dryness b. using chromatography c. precipitationd. crystallization e. filtration.
5. What is the process involved in the treatment of water for town supply?
   a. Filtration b. coagulation c. chlorination d. distillation
6. The position of an element in the periodic table is determined by
   a. Density b. its atomic radius c. its relative atom is mass d. the number of protons in its atom e. the number of neutrons in its atom.
7. How many unpaired electrons are there in an atom of an element with the following electron configuration? $1S^2 2S^2 2p^6$
   a. O b. 1 c. 2 d. 6 e. 8
8. Which of the following group 1 element has the highest ionization energy?
   a. 55^{cs} b. 37^{RD} c. 19^{k} d. 11^{na} e. 3^{li}
9. Which of the following atoms contains the highest number of electron in the outmost shell?
   a. 8^{o} b. 10^{ni} c. 15^{p} d. 19^{k}
10. Which of the following properties increases down a group in the periodic table?

11.

a. Atomic radius b. Electro negativity c. electron affinity d. ionization energy

12. One mole of a compound $m(HCO_3)_2$ has a mass of 162g, calculate the relative atomic mass of m(H=1, C=12, O=16)

a. 122 b. 101 c. 53 d.40

13. 9.60g of a gas x occupies the same volume as 0.30g of hydrogen under the same condition. Calculate the molar mass of x (H=1)

a. 8gmol b. 16g/mol c. 32g/mol d. 64g/mol

14. Determine the mass of sulphur (iv) oxide obtained when 91.0g of oxygen react completely with sulphur according to the following reaction. $S_s + O_2 \rightarrow S0_2$ [S=32,O=16]

a. 123g b. 139g c.155g d.182g

15. Calculate the mass of sodium hydroxide in 5.00dm3 of a 0.125mol/dm3 solution. [NaOH=40g/mol].

a. 0.0156g b. 0.625g c. 1.00g d. 25.0g

16. What is the molecular formula of a compound whose empirical formula is CH_2O and the molar mass is 180? [H=1, C=12, O=16]

a. $C_4H_8O_2$ b. $C_4H_8O_3$ c. $C_6H_{10}O_5$ d. $C_6H_{12}O_6$ e. $C_{12}H_{22}O_{11}$

17. What is the empirical formula of hydro carbon containing 0.12mole of carbon and 0.36 mole of hydrogen is C_2H6

a. CH_2 b.CH c. C_2H_2 d. C_6H_6 e. C_2H_6

18. When a piece of sodium is exposed to the air it soon becomes tarnished. Which of the following equations best shows the reaction.

a. $Na+O_2=NaO_2$

b. $2Na+O_2=2NaO$

c. $4Na+O_2=2Na_2O$

d. $4Na+3O_2=2Na_2O$

e. $3Na+2O_2=Na_3O_4$

19. A certain metallic element 'm' burnt in oxygen to produce its oxide. The oxide was found to contain 50% by weight of m and 50% by weight of oxygen. What would be the empirical formula of the metallic oxide? (M=40, O=16).

a. MO b. MO_2 c. M_2O d. MO_3 e. M_2O_5

20. Which of the following compound is covalent?

a. $CaCl_2$ b. MgO c. NaH d.CH_4 e.C_2H

21. The atom of an element X has two electrons in its outermost shell. What is the formula of the compound formed when x combines with aluminium ($_{13}Al$)

a. AlX_2 b. Al_2X c. Al_2X_2 d. AL_2X_3 e. Al_2X_4

22. A hydrogen atom which has lost an electron contains

a. One proton only b. one neutron c. one proton and one neutron d. one proton one electron e. one proton, one neutron and one electron

23. Which of the following equation illustrate (s) substitution reaction?

a. $2CH_3CH_2OH+2Na\rightarrow 2CH_3CH2ONa+H_2$

b. $C_6H_6+HNO_3\rightarrow C_6H_5NO_2+H_2O$

c. $CH3CH2OH+HBr\rightarrow CH_3CH_2Br+H_2O$

d. $CH_4+Cl_2\rightarrow CH_3Cl+HCl$

24. Which of the following solid has a network structure?

a. Diamond b. iodine c. sulphur d. graphite iron

25. The following compound contain the same type of bond except

a. Sodium chloride b. hydrogen chloride c. magnesium chloride d. potassium chloride e. lithium chloride

26. Alkanols have unexpectedly high boiling points relative to their molar masses because of intermolecular

a. Hydrogen bonding b. metallic bonding c. covalent bonding d. ionic bonding e. Vander wall's forces.

27. An element x with electronic configuration 2,8,2 and element y with electronic configuration 2,8,7 are likely to combine by

a. Metallic bonding b. covalent bonding c. electronic bonding d. dative bonding e. hydrogen bonding

28. How many molecules are there in 14g of nitrogen at s.t.p? (n=14, avagadros' constant=$6.02x10^{23}$/mol)

a. $6.02x10^{23}$ b. $3.01x10^{23}$ c. $8.43x10^{24}$ d. $1.20x10^{24}$ e. $20x10^{23}$

29. Calculate the mass of chlorine gas which occupies a volume of 1.12dm at s.t.p [a=35.5:1mol of gas occupies 22.4dm3 at s.t.p]

a. 1.80g b. 3.55g c. 7.10g d.15.50g

30. Determine the molar mass of the compound: [H=1, C=12, O=16]

a. 45g/mol b. 61g/mol c. 122g/mol d. 123g/mol

31. What is responsible for metallic bonding?

a. Sharing of electrons between metal atoms

b. Attraction between the atomic nuclear and cloud of electrons

c. Transfer of electrons from one atom to another

d. Attraction between positive and negative ions.

APPENDIX II

LESSON PLAN FOR THE TEACHING OF EXPERIMENTAL GROUP USING PROBLEM SOVING STRATEGY

LESSON 1

Subject	Chemistry
Topic	Separation Techniques
Class	SS II
Date	
Duration	40 Min
Gender	Male % Female
Average of Age	16-17
Instructional Material	Salt, Water, Chalkboard, Chalk Color mixtures, sand
Behavioral Objective	At the end of the lesson, the Students should be able to. a. Explain what the meaning and properties of matter is. b. Identify matter around them. c. Describe the separation of mixture. d. Explain the change of state in matter.
Previous Knowledge:	The students have learnt a little about matter in SS1
Introduction:	The teacher introduces the topic by explaining what matter is and Examples in brief before they are represented during the lesson
Presentation:	The teacher presents the lesson in the following steps.

Steps1. Teachers Activity.

The teacher will present the problem to

the students and vividly explain how

to understand the concept of matter

and its properties and the separation

of solutions.

Students Activities.

The students will be asked observe the

Words to be sure if the understand what

They are given in matter and its

Component to know if they understand the goal

and Information of the problem.

Can the restate the problem in their own way?

Step II: Teacher Activities.

The teacher at this point Will provide a guide to the students to devices a plan on how to solve the problem by presenting the solvent

And salute to be used in making solution

To be separated it could either be missible

Or immissible solution for example. Salt

And Water which can be separated by evaporation.

Student Activities

The student will observe the plan given by the teacher and the teacher to a give them room to use direct or

indirect reasoning to make a list of possible ways to solve the problem of matter, show its properties and to separation mixtures.

Step III: Teacher Activities

The Teacher at this point will implement the suggested method that was chosen by him and the students until the problem is solve. He will define matter and state the properties of matter as anything that have mass and occupy space. He will state the physical properties and chemical properties of matter.

The method suggested for separating mixture

Like crystallization, sublimation and fractional

Distillation will be used.

Student Activities

The student will join the process of implementing the method chosen to solve the problem they will be given a reasonable time to solve the problem, if they are not successful, they will be asked to seek hint from other students who understand the problem solving process.

Step Iv: Teacher Activities

The teacher will ask the student to look back on their solution to see if the answers satisfy the statement of the problems and will be given mixture to the student if they can and use the suggested method.

Students Activities

The student will look back on what they have solve or done to find out if their solution is correct. And they will solve problem to see extent to which their solution

	can go they will use method of separating several mixture.
Evaluation	The teacher will evaluate the lesson by asking the students 1. What they understanding by matter. 2. State the properties of matter 3. Provide possible method of separating Mixtures
Summary/ Conclusion	The Teacher will summarize by Vividly going through the concept of matter and its properties and discussing the different method of separating mixture.
Assignment	The teacher will give the student the following activities. 1. What is the method to use in separating the mixture of sand and water. 2. What are the chemical properties of matter.

LESSON PLAN FOR THE TEACHING OF EXPERIMENTAL GROUP USING PROBLEM SOVING STRATEGY

LESSON II

Subject	Chemistry
Topic	Atoms, Moles, Formula& Equation
Class	SS II
Date	
Duration	40 Min
Gender	Male and Female
Average of Age	15-17
Instructional Materials	
Behavioral Objectives:	At the end of the lesson, the Student should be able to. 1. Define atom, molecule, relative atomic mass, and relatives' molecular mass of a substance. 2. Calculate mole of a substance 3. Calculate the molecular and atomic mass of a substance.
Previous Knowledge	The students have been taught Matter and had little knowledge On atoms and molecules.
Introduction	The teacher introduces the topic by

Defining basics terms use in the Topic.

- Atom is a smallest particle of an element which can take part in a chemical reaction.
- A molecule is the smallest particles of a substance that normally exist alone and still retain the chemical properly of that substance, be it element or compound.
- The relative atomic mass, A of an element is the number of times that element is heavier than one twelfth the mass of an atom of carbon 12.
- The relative molecular mass M, of an element or a compound is the of number of time the average mass of one molecule of it is heavier than one twelfth the mass of one atom of carbon 12.

Students activities

The students at this point will clearly see the definitions and understanding their meaning to be able to use them in answer problems during the lesson.

Presentation

Step I: Teacher Activities

The teacher presents a problem on relative molecular mass of a substance to the students.

Q1. What is the relative molecular mass

Of limestone.Ca Co_3 given (Ca=40, C=

12, 0=16). Calculate using the polya's 4

Steps.

Students Activities

The students will be asked to observe the

Question clearly and link it to the definitions. They will be asked if they can Understand the problem given to them

And if they can restate the problems in their own way.

Step II: Teacher Activities

The teacher at this point will provide a guide to plan on how to solve the problem.

One mole of CaCo3 has 1 Ca 1 c and 3 o atoms.

Students Activities

The teacher will asked the student to device a plan to use in solving the problem since all the variable are spelt out clearly. They are to observe use appropriate methods to solve the problem.

Step III: Teacher Activities

The teacher at this point will use the suggested method that was chosen until the problem is solved. He will calculate the molecular mass of a limestone as;

since the relative molecular mass of limestone is CaCo3.

1Xa of Ca +1 xAr of C+3XAr of 0.

Students Activities

The students will apply the formula to calculate the problem given to them

(1x40+1x12+3x16)

=100

Step IV: Teacher Activities

The teacher will asked the students to look back on the solved problem, to see if the answer is correct and to see if they can apply the method on any other compound.

Students Activities

The students will look back on what they have solve other problem to see if they can use the formula at any given point.

Evaluation

The teacher evaluate the lesson by asking the student.

i. To define the concept of molecular atom, molecular mass, atomic, mass.
ii. Calculate the percentage by mass o nitrogen in trioxonitrate (v) acid where (H=1, N=14, 0-16).

The molecular formula of trioxonitrate (v) acid is HNO3.

Summary/Conclusion:

The teacher will conclude the lesson by summarizing the key point of the lesson and restating the steps to use in Solving related problems.

Assignment

The teacher will assign students the following activities

1. What is the mass of 3 moles of oxygen, 0_2 ?
2. How many atoms are there in 6g of carbon, C?

LESSON PLAN FOR THE TEACHING EXPERIMENTAL GROUP USING PROBLEM SOVING STRATEGY

LESSON III

Subject	Chemistry
Topic	Calculation of Empirical Formula
Class	SSII
Date	
Duration	40 Minute
Gender	Male and Female
Average Age	15-17
Instructional Materials	Chalkboard, Calculators
Behavioral Objective	At the end of the lesson of the Students should be able to. 1. Define Empirical formular 2. Defined molecular 3. Determine the empirical and molecular formular of a compound
Previous Knowledge	The students have learnt about Molecule and atoms
Introduction	The teacher introduces the lesson By linking the previous knowledge With the existing topic
Presentation	**Step 1: Teacher Activities** The teacher will define empirical and Molecule formula as; empirical formula of a compound is the simplest formula that tells us the

- Component element in a molecule of the compound
- Ration in which these elements are can boil together. That is the mole ration.

  Molecular formula of a compound gives of the enact number of moles of the compound.

  The teacher will provide a problem to the students.

  Q1. What is the empirical formula of a compound which on analysis yield the following as reacting masses. Carbon = 2og hydrogen = 0.34g oxygen = 2.67g. From the result find the molecular formula of the compound if its relative molecular mass is 60.

  (C=12, H=1,0=16).

  Teacher Activities

  The teacher will allow the student observe the question carefully to see if they can understands what they are expected to do.

  Student Activities

  The student will the observe the problem carefully to be sure if they understand what is given to them.

  Step II: Teacher Activities

  The teacher will guide the student to device a plan in solving the problem of empirical formula.

  Students Activity

  The students will observe the plan given by the teacher and provide possible way to solve the problem.

  Step III: Teacher Activity

  The teacher will use the plan to solve of the problem.

Carbon Hydrogen

2.0/12 =0.17 0.34/1 =2

Oxygen 2.67/16= 0.17

Students Activities

The students will be asked to divide by the smallest value.

0.17/0.17 =1 2/0.7=2 0.17/0.17 = 1

The empirical formula of the compound is CH_20

The teacher will guide in calculating the molecular formula.

(CH_20) X =60

30X=60

X=60/30=2

The formula therefore

Is (CH_20) 2

C_2 H_4 0_2

Step IV: Teacher Activities

The teacher will ask the students to look back on what they have solved to find out if the answer is correct.

Student Activities

The Student will look back and see if they have gotten the correct answer and to see if they can use the methods any time.

Evaluation

The teacher evaluate the lesson by giving the

Students class activity on calculating

The empirical formula of a compound

1. Determine the empirical formula of an oxide of nitrogen 33% containing 70% of oxygen
2. What do you understand by empirical formula.

Summary/Conclusion

The teacher summaries the lesson by restating the steps of calculating empirical and molecular formula.

Assignment

The teacher will give the students the following activities.

1. Calculate the molecular formula of a compound which on analysis yield 2.00g of carbon, 0.34 hydrogen and 2.67 oxygen if the relative molecular mass of the compound is 60.
   (C=12, H=1,0=16).
2. What is the empirical formula of the compound

   N=26.17%

   H=7.48%

   CL= 66.35%

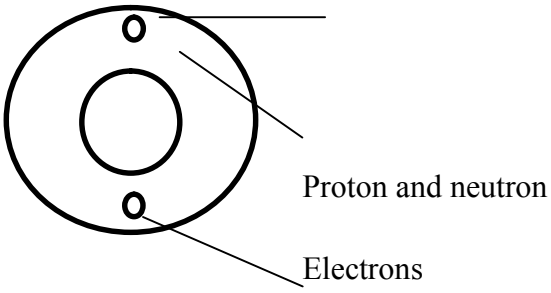
   (N=14,H=1,, CL=35.5).

LESSON PLAN FOR TEACHNG THE EXPERIMENTAL GROUP USING PROBLEM SOLVING STRATEGY

LESSON IV

Subject	Chemistry
Topic	Chemical Combination
Class	SSII
Date	
Duration	40 Minute
Gender	Male & Female
Average Age	15-17
Instructional Material	Election transfer charts
Behavioral Objective	At the end of the lesson the Students should be able to. 1. Describe the atomic structure 2. Define atomic number and mass number. 3. Explain electrovalent combination
Previous Knowledge	The student have been taught atoms and molecules.
Introduction	The teacher introduces the lesson by linking the previous knowledge with existing new topic.
Presentation	**Step 1 : Teacher Activities** The teacher will describe the atomic structure which

Contains the protons, neutron, electrons and nucleus.



He will define atomic number and mass number.

- Atomic number Z, of an element is the number of protons and electron is one atom of at element.
- Mass number A of an atom of an element is the sum of the proton and neutron in it.

The teacher will describe the electrovalent combination of an element which involves the transfer of electrons from one atom usually metal to another atom usually non -metal to ensure that the element have reach their octet or duplet state.

Student Activities.

The student will observe the words and the method carefully and see if they understand the concept very well.

Step II: Teacher Activities

The teacher at this point will present

a problem which the student will suggest a plan of solving it.

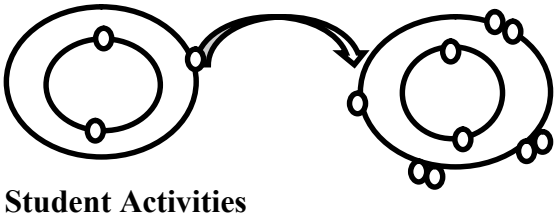
Q; an atom has 1 electron in it outer most shell and the other atom have 7 electron. Describe the combination of the element.

Student Activities

The students will observe the question and devices a plan of solving it.

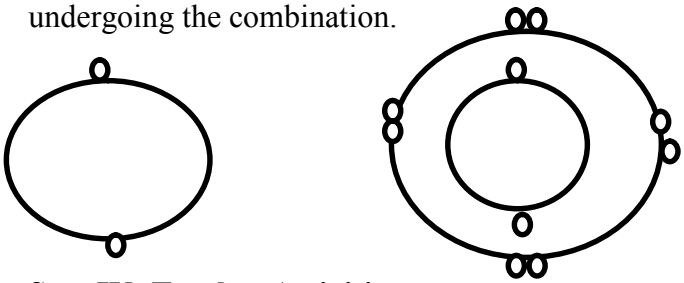
Step III: Teacher Activities

The teacher will guide them in using the device plan to solve the problem.



Student Activities

The students will use the device plan by drawing the diagram of the atomic structure of the atoms undergoing the combination.



Step IV: Teacher Activities

The teacher will ask the student to look back on what they have done to see if the understand the concept of electron transfer very well.

Student Activities

The students will look back to see what they have done so far and to see if they can use the method to solve several problems.

Evaluate

The teacher evaluate lesson by

giving the student element to use

electrovalent combination in forming the bond between them.

1. Hydrogen= 1 and chlorine =17
2. Sodium 11 and chlorine 17

Summary/Conclusion	The teacher conclude the lesson By revising the learned problems
Assignment	1. How do you form Magnesium Oxide Mgo. 2. Show clearly how you can Combine magnesium and chlorine.

APPENDIX III

LESSON PLAN FOR TEACHING THE CONTROL GROUP USING TRADITIONAL METHOD OF TEACHING

LESSON 1

Subject	Chemistry
Topic	Separation Techniques
Class	SS II
Date	
Duration	40 Minute
Gender	Male and Female
Average of Age	15-17
Instructional Material	Salt, Water, Chalkboard, Chalk Color mixtures, sand
Behavioral Objectives	At the end of the lesson, the Students should be able to. a. Explain what the meaning and properties of Matter is. b. Identify matter around them. c. Describe the separation of mixture. d. Explain the change of state in matter.
Previous Knowledge:	The student have learnt about matter in Senior secondary 1
Introduction	The teacher will introduce the topic by linking

	The new topic with previously learnt topic
Presentation	The teacher will present the topic in steps
	Steps 1
	The teacher will define matter and give
	Examples of matter.
	Matter is anything that has mass and occupies space for example
	Stone, sand, wood etc.
	Step II
	The teacher will described the change of state
	In matter.
	- From solid to liquid ice- to water - From liquid + gaseous slate evaporation - From solid to gaseous state combination - From liquid to solid – water to ice
	Step III
	The teacher describe the separation of immisible liquid
	- Separation of sand from water using decantation method. - Separation of salt from water using evaporation method.
Evaluation	The teacher will evaluate the lesson by asking
	The student.
	1. What is matter 2. Give example of one state of matter
Summary/Conclusion	The teacher will summarize by going through

The concept of matter and its properties.

Assignment

The teacher gives the students the following.

1. How do you separate the mixture of petrol and water.
2. Explain the solid to liquid state of matter.

LESSON PLAN FOR TEACHING THE CONTROL GROUP USING TRADITIONAL METHOD OF TEACHING

LESSON II

Subject	Chemistry
Topic	Atoms Molecule Formula and Equation
Class	SS II
Date	
Duration	40 Minute
Gender	Male and Female
Average of Age	15-17
Instructional Material	
Behavioral Objective	At the end of the lesson, the Students should be able to. 1. Define atom, molecule, relative atomic mass and relative molecule mass of a substance. 2. Calculate the empirical formula of a substance. 3. Calculate the molecule and atomic mass of a substance.
Previous Knowledge	The student have a hint on atoms and molecules in the previous lesson.
Introduction	The teacher introduces the topic by defining Atoms , molecule, relative atomic an molecule Mass of a substance.

Presentation

Step 1

An atom is a smallest particular of an element

This can take part in a chemical reaction.

A molecule is the smallest particle of a

Substance that normally exist alone and still

Retain the chemical properties of that chemical

Properties of that substance, be it element or

Compound.

- The relative atomic mass of an element is the number of times the average mass of one atom of that element is heavier than one twelfth the mass of one atom of carbon 12.
  Average mass of 1 atom of oxygen
  ½ mass of a atom of carbon 12.
- The relatives molecular mass M of an element or a compound is the number of times the average mass of one molecule of it I heavier than one twelfth the mass of one atom of carbon 12.

  Step II

  The teacher solve a problem of molecular mass of substance.

  Q. What is the relatives molecule mass of limestone CaC03 given (Ca=40,C=12,0=16)

  One role of CaC03 has I Ca IC any 30 atoms

  1x40+1x12+3x16

  =100.

Evaluation

The teacher will evaluate the by asking the

student to.

1. Define atom, molecule
2. Calculate the percentage by mass of nitrogen in trioxinate (v) acid where (=1,N=14,0=16). The molecule formula of trioxinate (v) acid is HN0 3

Summary

The teacher will summaries the lesson by going through the main point.

Assignment

The teacher will assign students the following activities.

1. What is the mass of 3 mole of oxygen, 02?
2. How many atoms are there in 6g of carbon C?.

LESSON PLAN FOR THE TEACHING OF CONTROL GROUP USING TRADITIONAL METHOD OF TEACHING CHEMISTRY

LESSON III

Subject	Chemistry
Topic	Calculate of Empirical Formula
Class	SS II
Date	
Duration	40 Minute
Gender	Male and Female
Average of Age	15-17
Instructional Material	
Behavioral Objective	At the end of the lesson, the Students should be able to. 1. Define empirical formula 2. Define molecule formula 3. Determine the empirical and molecule formula of a compound
Previous Knowledge:	The student have leant about molecule atoms
Introduction:	The teacher introduces the lesson by linking the Previous knowledge with the existing topic.
	Step 1
Presentation	The teacher define empirical formula as Empirical formula of a compound is the simplest Formula that is that tells us the.

- Component element in a molecule of the compound.
- Ration in which these element are combination together that is the mole ratio.

Step II

The teacher solves problems of empirical and molecular formula.

Q What is the empirical formula of a compound which on analysis yield the following as reacting masses carbon=2.0g, hydrogen =0.34g oxygen=2.67g from your result molecule formula of the compound if its relative molecular mass is 60.

(C=12.H=1, 0= 16).

Carbon	Hydrogen
2.0/12 =0.17	0.34/0.17=2

Divided by the smallest value.

0.17/0.17=1 2/0.17=2

0.17/0.17=1

The empirical formula of the compound is CH_20

The molecule formula is

(CH_20) X =60

30X=60

X=60/30=2

The molecule formula is (CH_20) 2= $C_2H_40_2$

Evaluation: The teacher evaluate the lesson by giving the

Students class activities to do.

1. Determine the empirical formula of an oxide of nitrogen 30% containing 70% of oxygen.
2. Define empirical formula.

Summary

The teacher summarizes the lesson by

Restating the steps in calculating empirical and molecular mass of a compound.

Assignment

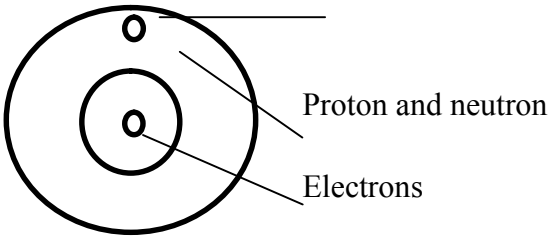
The teacher will give the students the following activities.

1. Calculate the molecule formula of a compound which on analysis yield 2.00g of carbon , 0.34 hydrogen and 2.67g oxygen if the relative molecular mass of the compound is 60.
   (C=12,H=1, 0=16).
   What is the empirical formula of the compound N=26.17%
   H=7.48%
   CL=66.35%
   (N=14,H=CL=35.5)

LESSON PLAN FOR TEACHING THE CONTROL GROUP USING TRADITIONAL METHOD OF TEACHING CHEMISTRY

LESSON IV

Subject	Chemistry
Topic	Chemical Combination
Class	SS II
Date	
Duration	40 Minute
Gender	Male and Female
Average of Age	15-17 Years
Instructional Material	
Behavioral Objective	At the end of the lesson, the Students should be able to. 1. Describe the atomic structure 2. Define atomic number and mass number 3. Explain electrovalent combination.
Previous Knowledge	the student have been taught about atom And molecules.
Introduction	the teacher introduces the lesson by linking the Previous knowledge with new topic.
Presentation	**Step 1** The teacher describe the atomic structure which Contains protons neutron, electron and nucleus.



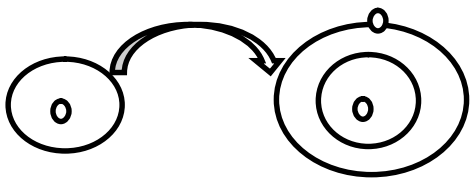
Step II:

The teacher defines atomic number, mass number and electrovalent combination

- Atomic number Z, of an element is the number of protons and electron in one atom of the element.
- Mass number A, of an atom of an element is the sum of the proto and neutrons in it.
- Electrovalent combination of an element involves the transfer of electron from one atom usually metal. To another atom usually non -metal to ensure that the element reaches its octate or duplet state.

Step III

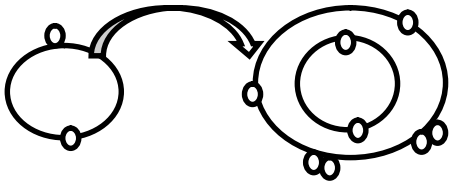
The teacher describes the example of electrovalent combination.

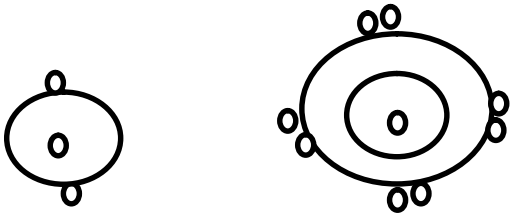


Q= an atom has I electron in it outermost shell

And the other atom have 7 electron described

The combination of the element.





Evaluation

The teacher evaluate the lesson by given the Student element to use electrovalent Combination in solving them.

1. Hydrogen 1 and chlorine 17
2. Sodium =11 and chlorinate 17

Summary/Conclusion

the teacher conclude the lesson by revising the Learnt problems.

Assignment

the teacher will give the student the following activities.

1. How do you for magnesium oxide mgo
2. Show clearly how you can combine magnesium and chlorine

APPENDIX IV

COMPUTATAION OF MEAN, STANDARD DEVIATION AND T-TEST OF THE POST TEST FOR BOYS AND GIRLS IN THE EXPERIMENTAL GROUP.

MALE STUDENT X	$(X-\overline{X})^2$	FEMALE STUDENT X^2	$(X-\overline{X})^2$
32	6.76	30	9
41	40.96	41	64
28	43.26	36	9
36	1.96	28	25
18	275.56	26	49
48	268.96	22	121
51	129.96	36	4
46	21.16	35	4
30	2.56	35	16
33	57.76	35	25
27	57.76	29	81
39	19.36	38	1
36	57.76	29	16
37	5.76	42	81
28	43.56	34	49
25	92.16	26	64
41	40.96	41	64
37	5.76	35	4
30	2.16	31	4
29	31.36	29	16

$\sum x = 692$

$\overline{x} = \frac{692}{20}$

$= 34.6$

$\sum(x = \overline{x})^2$

$SD = \sqrt{\sum(x \quad \overline{x}2)}$ / n

$SD = \sqrt{\frac{1290.5}{20}}$

$SD = \sqrt{64.525}$

SD= 8.03

$\sum x = 660$

$x \sum\overline{x} = \frac{x}{n}$

$= \frac{660}{20}$

$\overline{X} = 33$

682 $\sum(x-\overline{x})^2$

$SD = \frac{\sqrt{\sum(x \quad X)2}}{n}$

$Sd = \frac{\sqrt{682}}{20}$

Sd=5.83

CALCULATION OF T- TEST

H_0 $\bar{x}_1 = \bar{x}_2$ (0.05)

$t = \frac{x1 - x_2}{SE}$

$SE = \sqrt{\frac{sdx12}{n1} + \frac{Sdx_2\ 2}{n2}}$

sinq

$\bar{x}_1 =$ 34.6

$x_2 =$ 33

$Sdx_1 =$ 8.03

$Sdx_2 =$ 5.83

n1= 20

n2= 20

$SE = \sqrt{\frac{(8.03)\ 2 + (5.83)^2}{20 \qquad 20}}$

$SE = \sqrt{3.2 + 1.682}$

SE= 2.2095

$t = \frac{\bar{x}_1 - \bar{x}_2}{SE}$

$t = \frac{34.6-33}{2.2095}$

$t = \frac{1.6}{2.2095}$

t= 0.75.

APPENDIX V

ILLUSTRATION OF THE COMPUTATION OF PILOT STUDY CUNDUCTED ON 10 STUDENTS OF GOVERNMENT SCIENCE SECONDARY SCHOOL BILLIRI TO ESTABLISH THE RELIABILITY OF THE RESEARCH INSTRUMENT USING PERSON PRODUCT MOMENT CORRELATION COEFFICIENT

Subject	First Test	Second Test	X^2	Y^2	XY
A	20	18	400	324	360
B	18	22	324	484	396
C	26	30	676	900	780
D	20	24	400	576	480
E	25	24	625	576	600
F	30	32	900	1024	96
G	34	30	1156	900	102
H	24	35	576	1225	840
I	35	36	1225	1296	1620
J	40	42	1600	1764	1680

$10 \sum X = 272 \quad \sum X = 293 \quad \sum X = 7882 \quad \sum X = 9069 \quad \sum Xy = 8376$

Using the formula

n= 10

$$\sum x = 272$$

$$\sum X = 293$$

$$\sum X = 7882$$

$$\sum y2 = 9069$$

$$\sum Xy = 8376$$

$$\frac{\sum Xy \quad \sum X) \ \sum y)}{\sqrt{\sum x2 \quad (\sum x)\ 2\ (\sum y2 \quad (\sum y)\ 2}}$$
nx ny

$$\frac{8376- \ \underline{(272)\ (293)}}{\sqrt{7882 \quad (73984)(9069(85849)}}$$
10

10 10

$$\frac{\underline{8376\text{-}79696}}{\sqrt{483.6x484.1}}$$

$$\frac{\underline{406.4}}{\sqrt{234110.76\ .}}$$

$$\frac{\underline{406.4}}{483.8}$$

= 0.84

APPENDIX VI

ILLUSTRATION OF COMPUTING STUDENTS POST TEST MEAN SCORES, STANDARD DEVIATION AND THE T-TEST VALUE

Experimental Grp x	$(X-\bar{X})^2$	Control Grp	$(x-\bar{x})^2$
30	34.81	20	36
32	15.21	28	4
40	16.81	17	81
41	26.01	24	4
39	9.61	18	64
28	62.41	31	25
30	84.81	16	100
36	0.01	25	1
34	3.61	27	1
18	320.41	34	64
45	82.81	22	16
50	82.81	22	16
52	259.21	21	25
51	228.01	40	196
44	65.61	32	36
46	102.01	18	64
42	37.21	19	49
30	0.01	24	4
36	4.41	26	0
38	62.41	36	100
28	79.21	32	36
27	285.61	23	9
19	488.41	27	1
58	9.61	30	16
39	102.01	21	25
46	16.81	34	64
40	37.21	36	100
37	62.41	41	225
28	62.41	19	49
28	0.81	24	4
35	0.81	32	36

Experimental GRP x	$(x-\bar{x})^2$	Control GRP	$(x-\bar{x})^2$
25	118.81	22	16
26	98.81	15	121
41	26.01	30	16
41	26.01	31	25
37	1.21	26	0
28	62.41	23	9
30	34.81	20	36
19	285.61	16	100

$\bar{x} = \frac{\sum x}{n}$ $\frac{1436}{40}$ = 35.9

$\bar{x} = \frac{\sum X}{n}$ $\frac{1040}{40}$ $\bar{x} = 26$

$\sum(X - \bar{x})^2 = 1918$

$Sd = \sqrt{\frac{\sum(x - \bar{x})2}{n}}$

$Sd = \sqrt{\frac{1918}{40}}$

Sd= 6.92

$Sd = \sqrt{\frac{\sum(x - \bar{x})2}{n}}$

$Sd = \sqrt{\frac{3447.6}{40}}$

Sd= 9.28

CALCULATION OF T- TEST

Nr=40

$N_{2=}$ 40

$\overline{x}_1 = 35.9$

$\overline{x}_2 = 26$

$sdx_1=9.3$

$sdx_2 = 6.9$

$$t= \frac{\overline{x}_1 - \overline{x}_2}{SE}$$

$$SE= \sqrt{\frac{SDX1\ 2}{n} + \frac{SDX_2\ ^2}{n}}$$

$$SE= \sqrt{\frac{(9.3)^2}{40} + \frac{(6.9)^2}{40}}$$

$$= \sqrt{\frac{86.49}{40} + \frac{47.61}{40}}$$

$$\sqrt{2.16225 + 1.19025}$$

$$SE= \sqrt{3.3525}$$

SE= 1.8309

$$t = \frac{\overline{x} - \overline{x}_2}{SE}$$

$$t= \frac{35.9-26}{1.8309} \qquad \frac{9.9}{1.8309} = 5.407$$

APPENDIX VII

ILLUSTRATION OF COMPUTING THE PRE TEST MEAN SCORES, STANDARD DEVIATION OF THE EXPERIMENTAL AND CONTROL GROUP.

Experiment GRP X	$(X-\bar{X})^2$	Control	$(x-\bar{x})^2$
19	30.25	18	40.96
20	20.25	21	11.56
20	20.25	15	88.36
17	56.25	25	0.36
28	12.25	24	0.16
18	42.25	18	40.96
27	6.25	27	6.76
16	72.25	21	11.56
20	30.25	22	5.76
22	6.25	23	1.96
31	42.25	34	92.16
18	42.25	16	70.56
24	0.25	25	0.36
20	20.25	19	29.16
38	12.25	27	134.56
28	12.25	27	6.36
18	42.25	14	108.16
34	90.25	35	112.36
25	0.25	25	6.36
32	56.25	30	31.36
14	110.25	16	70.56
24	0.25	20	19.36
30	30.25	40	57.76
38	182.25	37	243.36
40	240.25	39	158.76
36	132.25	41	213.16
38	182.25	22	5.76
25	0.25	18	40.96
16	72.25	20	19.36
21	12.25	15	88.36
15	90.25	23	1.96
24	0.25	17	54.76
19	30.25	25	0.36
25	90.25	18	40.96
15	90.25	17	54.76
20	2.25	24	0.16
22	6.23	25	0.16
22	6.25		

$\sum X = 978$ $\sum(X \quad x)2$ $\sum X = 974$ Sd= $\sqrt{\sum X(x \quad x \quad)^2}$

n

$\bar{x}$ = 978 = 2043.95 $\bar{x} = \sum X$

40 n

$\bar{x}$ =24.5 Sd= $\sqrt{\sum X(x \quad x \quad)^2}$ $\bar{x}$ = 974 Sd= $\sqrt{\frac{2142.64}{40}}$

40

Sd= $\sqrt{\frac{2043.95}{40}}$ $\bar{x}$ = 24.4 $\sqrt{53.566}$

Sd= 7.15

Sd= $\sqrt{51.098}$

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Sd= 7.31