EFFECT OF INSTRUCTIONAL GRAPHICS ON STUDENTS' ACADEMIC PERFORMANCE AND ATTITUDE TOWARDS BASIC SCIENCE IN DUTSIN-MA ZONAL INSPECTORATE OF EDUCATION, KATSINA STATE

BY

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M.ED/EDUC/07090/2010-2011

THESIS SUBMITTED TO
THE SCHOOL OF POSTGRADUATE STUDIES, AHMADU BELLO UNIVERSITY, ZARIA NIGERIA
IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF MASTERS IN INSTRUCTIONAL TECHNOLOGY

DEPARTMENT OF EDUCATIONAL FOUNDATIONS AND CURRICULUM
FACULTY OF EDUCATION
AHMADU BELLO UNIVERSITY, ZARIA NIGERIA

MAY, 2014

DECLARATION

I declare that the work in the thesis entitled "EFFECTS OF INSTRUCTIONAL GRAPHICS ON ACADEMIC PERFORMANCE AND ATTITUDE OF BASIC SCIENCE STUDENTS" has been written by me in the Department of Educational Foundations under the supervision of DR. SULEIMAN SALAU. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this thesis was previously presented for another degree or diploma at any university.

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CERTIFICATION

This thesis entitled "EFFECTS OF INSTRUCTIONAL GRAPHICS ON ACADEMIC PERFORMANCE AND ATTITUDE OF BASIC SCIENCE STUDENTS" by Siliki Mohammed Salisu meets the regulations governing the award of Masters Degree in Instructional Technology, Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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Date

DEDICATION

This piece of academic work is dedicated to the entire Sulikis' families whose encouragement and tolerance are highly appreciated.

ACKNOWLEDGEMENTS

All thanks go to Almighty Allah, the Beneficent the Merciful for sparing my life and giving me the courage and fortitude to withstand all the challenges that are normally confronted with in the course of scholarly research work.

The inadequacy of the appropriately literatures for correct application in divulging my profound affection, satisfaction and admiration with regard to the fatherly fondness bestowed to us by DR. SULEIMAN SALAU, who majorly, supervised my research process, is quite disheartening. A man with garment of excellent character symbolize by simplistic objective generosity coupled with genuine humbleness and willingness in guidance services. Your constructive and objective criticism, accessibility and promptness in reading and correcting the manuscripts, despite tight scheduled, metamorphoses in making this research work, a reality. May Allah (SAW), reward you abundantly, Sir.

Equally remarkable, is the scholarly contribution offered by my immediate supervisor, PROFESSOR, ABDULLAHI TUKUR KADAGE, a visiting but punctual and dedicated PROF, from Usmanu Danfodio University Sokoto, whose encouragement and promptness in reading and correcting the manuscript, is highly appreciated. Your authoritative but unbiased generosity has culminated into the manifestation of this great work. God shall intervene in all your endeavors.

Highly commendable, is the intelligent work of our Instructional Graphics teacher from the Department of Glass Technology, DR. J. I. AZI, whose instructional delivery, objective criticism and guidance excited the choice of the research title, related to his area of specialization. Due regard is once more acknowledge Sir.

The gentle but consistent work of M. Shitu from the Department of Mass Communication, who took us through Selection and Utilization of Instructional Material, is really considerable, remarkable and highly memorable.

Due regard is also given to DR. E.I. MAKOJA who was invited impromptu as a committee member during my internal defense. Your guidance, corrections and objective criticism, are highly reflected in this scholarly undertaking.

So grateful, are the entire academic staff of Curriculum and Instruction Section, Ahmadu Bello University Zaria, especially, Shehu Abubakar and Suleiman M. Zubairu for their tolerance, and scholarly contributions without which, the success for this study would have been a mirage.

My sincere gratitude also goes to Mr. Rotime Emanuel (a neighbour), who had been printing some of the manuscript on gratis and severally run errands at odd times when my computer developed a problem. He has never relents his efforts in encouraging and offering all possible assistance for the success of my study. God shall guide you all through your PhD study.

My sincere gratitude and appreciation are due to the entire staff of Dutsin-ma Zonal Inspectorate of Education and Education Resource Centre Katisna State for giving me the necessary data, pertinent for this research work. The Principals, Vice Principals, Basic Science Teachers and the students from the schools used for this study, would never be forgotten.

M.Ed students of 2010/2011 academic session need to be appraise for their encouragement and generative peaceful but competitive academic atmosphere without which, the compilation of this study report, would have been delayed.

Finally, the fiscal assistance, and generosity bestowed on to me by the entire Suliki's families, my wife, AMINA BADAMASI DAN IRO, my seven children, friends and well wishers, need to be acknowledged. May God spare our lives and guide us for more prosperous future. Thank you all. Thank you once more.

ABSTRACT

This study investigated the effects of Instructional Graphics on Academic Performance and Attitude of Basic Science students in Dutsin-ma Zonal Inspectorate of Educational, Katsina State. Quasi-experimental design involving pre-test and post-test was used for data collection. The population comprises of 15,555 students. A sample of 120 subjects of both males and females in the ratio of 60:60, were selected by stratified random sampling and assigned into the experimental and control groups with equal representation (i.e. 30 males and 30 females per group). The instruments used for data collection are; Basic Science Performance Test (BSPT) and Students' Attitude to Instructional Graphics Learning Strategy Questionnaire (SAIGLSQ) with reliability coefficient of 0.83 and 0.79 respectively. Five null hypotheses were stated in line with the research questions raised. The data collected were analyzed using simple percentage and t-test statistics and at a significant level of $p \leq 0.05$.

Findings from the analysis of the data showed that, there was significant difference in the mean scores of experimental and control group in favour of experimental group. There was no significant difference in the mean scores of male and female students exposed to instructional graphics learning strategy and there was significant difference on the attitude of students after being taught Basic Science using instructional graphics learning strategy. Hence, instructional graphics is positively related to Basic Science study. Based on these findings, it was recommended that Basic Science teachers should use instructional graphics in teaching Basic Science students especially at at JSS level.

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DEFINITIONS OF TERM

Attitude: Personal view of something, an opinion or general feeling about something

Analogy: A comparison between two things that are similar in some way, often used to help explain something or take it easier to understand

.

Arbitrary: based on whim: based solely on personal wishes, feelings, or perceptions, rather than on objective facts, reasons, or principles

Cognitive: concerned with acquisition of knowledge, relating to the process of acquiring knowledge by the use of reasoning, intuition, or perception.

Gender: Somebody's sex, the sex of a person or organism, or of a whole category of people or organisms.

Graphics: According to Microsoft® Encarta® 2009, graphics is;

1. The presentation of information in the form of diagrams and illustrations instead of as words or numbers.
2. The art and science of storing, manipulating, and displaying computer data in the form of pictures, diagrams, graphs, or symbols.
3. The science of drawing something in accordance with mathematical principles, e.g. in architecture and engineering.

Reiber, 1989 as cited in Bassey (2002) maintained that, the terms **graphic**, **image**, **visual**, and **picture** greatly overlap and are often used synonymously.

Hypothesis: Assumption**,** a statement that is assumed to be true for the sake of argument**.**

Representational: Relating to or characterized by representation**,** depicting something in a physically recognizable form, especially in art.

Schema: mental pattern, an organizational or conceptual pattern in the mind

LIST OF ABBREVIATION

1. BSPT; Basic Science Performance Test
2. CBI ; Computer Based Instruction
3. CPR: cardiopulmonary resuscitation
4. ERC; Education Resource Centre
5. FRN; Federal Republic of Nigeria
6. IGLP; Instructional Graphics Learning Package
7. JSS; Junior Secondary School
8. JSSS; Junior Secondary School Student
9. JSCE; Junior Secondary Certificate Examination
10. NERDC; Nigerian Educational Research and Development Council
11. LMLP, Lecture Method Learning Package
12. NSES; National Science Education Standards
13. NTI; National Teachers Institute
14. PPMC Pearson Product Moment Coefficient
15. PT, Pilot Testing
16. SAIGLSQ; Students Attitude to Instructional Graphics Learning Strategy Questionnaire
17. SD, Standard Deviation
18. SE, Standard Error
19. STAN: Science Teachers Association of Nigeria
20. UBE; Universal Basic Education
21. US; United States
22. UNESCO; United Nations Educational, Scientific and Cultural Organisations

CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Science is the foundation upon which the bulk of present day technological breakthrough is built. Nowadays, nations all over the world including Nigeria are striving hard to develop technologically and scientifically, since the world is turning scientific and all proper functioning of lives depend greatly on science.

Owolabi (2004) defined science as an integral part of human society. Its impact is felt in every sphere of human life, so much that it is intrinsically linked with a nation's development. Science as a field of study has done a lot for mankind. For instance, life has been made a lot easier for man as a result of the advancements in science. Through sciences, man has been able to better understand his environment and this has enabled him to manipulate the conditions of his environment to his own benefit. Science has also made it possible for man to acquire his desired needs easily. It has reduced human needs to the barest minimum.

Ogunleye (2000) observed that science is a dynamic human activity concerned with understanding the workings of our world. This understanding helps man to know more about the universe. Without the applications of science, it would have been impossible for man to explore other planets of the universe. Conversely, the awareness of the existence, of other planets would not have been realized without science.

The Basic Science curriculum is designed to enable students become literate in sciences and to lay a sound foundation for their subsequent study of Biology, Chemistry, Physics and Geography at the senior secondary school level (Federal Republic of Nigeria, 2004). Many studies have shown that students in Secondary schools are not interested in sciences (Esiobu, 2005; Okonkwo, 2000). Besides, Physics as a science subject has remained one of the most difficult subjects in the school curriculum Nigerian Educational Research and Development Council, 2005). A study by Owolabi (2004) revealed that the performance of Nigerian Students in ordinary level physics was generally poor. This was attributed to many factors of which teaching strategy itself was considered as an important factor.

Jegede, Okota and Eniayeju, (1992) reported factors responsible for students' general poor performance in science, technology and mathematics. These are poor laboratory facilities, inability of the Science teachers to make proper use of instructional materials to put across ideas clearly to the students and inadequate number of learning facilities in schools as against consistent increase in the number of students.

Jegede (1996) observed that in spite of the various innovations introduced into the educational system, the attainment of the desired goal remains an illusion. UNESCO (1995) reported that the poor performance in Basic Science has remained, despite all the efforts in terms of curriculum reforms on the part of Science Educators to see that a firm scientific base is developed. This under-performance of students in Basic Science is attributed to many factors such as the constant use of the lecture method of teaching, the attitude of students towards Basic Science, difficulty in managing large classes, among others (Mari, 1994 and Usman, 2002).

The use of a lecture method by science teachers has been criticized by many researchers (Abdullahi, 1982, James, 1991 and Usman 2002). This instructional method, according to them, is extremely didactic in approach, teacher-centered, and does not lead to meaningful learning. It only encourages the development of passivity, docile learning and over-dependence on the teacher and on textbooks. Basic Science is a subject designed based on the process teaching strategy. Therefore, using the lecture method solely to teach the subject is inappropriate.

Ogunniyi, (1993) ; Cosgrove and Osborne (1986), as cited in Dyel, (2011) observed that the kind of strategies for teaching and learning science which are capable of achieving the objectives of the school and society are those which emphasize the teaching of process skills of science and child-centered inquiry-based instruction. The search for improved strategies for teaching and learning of science is therefore a continuous process.

Attitude is another variable which affects learning Abdullahi, (1995) cited in (Dyel, 2011). Brown and Story (1978) reported that positive attitude enhances academic performance in science by 20-25%, while negative attitude, in contrast, could lead to low expectation of students' academic performance. Ogunlele (1993) in his research reported that many students developed negative attitude to science learning, probably due to the fact that teachers' mode of instruction is inadequate and ineffective. Teaching strategies, thus, appear to influence the attitude of students positively or negatively. Olorukooba (2001) reported that students taught using cooperative learning strategy had a positive attitude to the educational benefits derived from the group work among Chemistry students. Basic Science, which incorporates Biology, Chemistry and Physics, is a complex subject and students studying it have problems in learning it based on performance and negative attitude as observed by Mari (1994) and Usman (2002). Hence, there is a need to employ an activity-based teaching strategy, such as students-centred approach with the aid of instructional graphics, to see whether there will be an improvement in students attitude to the subject or not. Therefore, one of the aims of this study was to investigate the effects of instructional graphics on student's academic performance and attitude towards Basic Science.

On the issue of gender in science education, there is a number of conflicting conclusions about gender-related difference in performance in sciences (Anaso, 2006). Some view gender as a relevant factor in performance while others find that no difference exists between the sexes in terms of academic performance. Researchers such as Mullin, Jerkins and Indolp (1994) cited in Dyel, (2011) reported great concern that girls are not achieving as much as their male counterparts in science. Tobin, (1993) and Tallin, (1996) reported that there is no significant difference in performance of girls and boys in science subjects. In a situation, where instructional graphics is involved, what will be the interactive effect of gender among Basic Science students? In this study, the researcher would also investigate the interaction effect of students' gender when students are taught using instructional graphics in Basic Science.

Science subject is activity oriented and the suggested method for teaching it which is guided discovery method is resource based (National Teachers Institute, 2007). This suggests that the mastery of Basic Science concepts cannot be fully achieved without the use of instructional materials. The teaching of Basic Science without instructional materials will certainly result to poor performance in the course. Franzer, Okebukola and Jegede, (1992) stressed that, a professionally qualified science teacher no matter how well trained would be unable to put his ideas into practice if the school setting lacks the equipment and materials necessary for him or her to translate his competence into reality. The objectives of any educational process determine the contents, methods and materials needed for achieving such objectives. The materials used for enhancing instructional effectiveness are aspects of media employed for achieving the instructional objectives. Bassey (2002) described instructional media as system components that may be used as parts of instructional processes which are used to disseminate information, message and ideas or which make possible communicable in the teaching-learning process.

Onasanya (2004) gave various kinds of models used in educational instruction namely: Mental models, theoretical models, mathematical models, diagrams, concrete models and so on. These models are of special pedagogic significance in science and technology instruction due to the nature of knowledge and knowledge getting process in these disciplines.

Concrete models are materials objects which are likenesses of natural or man-made structures or systems which are intended to highlight and explain or describe structures, functional processes and relationships in the original. Concrete models are constructed in an effort to understand the behaviours of the physical world and the causes of such behaviours (Onasanya & Adegbija, 2007). They summarized the role of concrete models as: simplification of complex phenomena, concretization of complex phenomena, bridging of gaps in distance and time between phenomena and classroom events, enhancing of students ability to communicate in science.

According to Soetan, Iwokwagh, Shehu and Onasanya, (2010), graphics include charts, posters, sketches, cartoons, graphs and drawings. Graphics communicate facts and ideas clearly through combination of drawings, words and pictures. The use of graphics in teaching and learning creates definitiveness to the materials being studied. They help to visualize the whole concepts learned and their relationships with one another.

The role of graphic materials in visual communication is both unique and significant.

Historically, symbols, a basic part of graphics have made it possible, the whole range of written language used in the world today. The instructional value of graph generally is in their capacity to attract attention and convey certain types of information in condensed form (Onasanya & Adegbija, 2007).

Okpala, Ambali and Alpha, (1998), stated that graphical illustrations provide a common experience to a large group at the same time. They summarized the values of graphic for instructional design as follows: They require no special machine for projection, the teacher is confident in manipulating the material, their improvisation encourages more creativity and diversification of teaching methods, they are very easy to preserve and they could be produced within minimum cost and maximum efficiency.

Experience over the years has shown that teachers have been depending on excessive use of words to express, to convey ideas or facts in the teaching-learning process. This practice is termed the “chalk-talk” method. Today, advances in technology have made it possible to produce materials and devices that could be used to minimize the teachers talking and at the same time, make the message clearer, more interesting and easier for the learners to assimilate (Onasanya, 2004).

For meaningful learning to occur, the learner must actively construct new information on his/her existing mental framework. Conventional (lecture) method of teaching is the process of transmission of knowledge from teacher to student. It is essentially a one-way process. The inherited Nigerian teaching method , whether primary, secondary or tertiary institutions levels, tends to resemble a one-person show, with a captive but often comatose audiences. Classes are usually driven by “teacher-talk” and depend heavily on textbooks for the structure of the course. There is the idea that there is a fixed world of knowledge that the student must come to know. Information is divided into parts and built into a whole concept. Teachers serve as pipelines and seek to transfer their thoughts and meanings to the passive students. There is little room for student-initiated questions, independent thought or interaction between students. The goal of the learner is to regurgitate the accepted explanation or methodology expostulated by the teacher (Onasanya, 2004). This teaching method can hinder the development of individual student's active and creative abilities, and students who experience only this model of education may no longer be considered sufficient for the needs of a future educated citizenry (Zhao, 2003).

One proposed solution to the afore-mentioned problem is to prepare students to become good adaptive learners. That is, students should be able to apply what they learn in school to the various unpredictable situations that they might encounter in the course of their work lives. Obviously, the "chalk talk" method as instructional strategy has failed to bring about the desired outcome of producing thinking students (Young & Collin, 2003). A much heralded alternative is to change the focus of the classroom from teacher dominated to student-centered approach. The aim of the present study was to determine the effect of instructional graphics on the academic performances and attitude of students' in Basic Science on Katsina State Junior Secondary School students instructed with the aid of instructional graphics. To accomplish the afore-mentioned purpose, the following objective was established: Compare the academic performance and attitudes of students' instructed with the aid of instructional graphics with that of the students instructed without instructional graphics in basic science study in Katsina State.

1.2 Statement of the Problem

The problem of large classes in developing world including Nigeria is tied to two interrelated trends, global initiatives for universal education and rapid population growth. It has been observed that one of the problems arising from enhanced access to education is that of increased number of students and this has resulted to inadequacy of infrastructure, teaching and learning materials, insufficient teachers, and inadequate provision of classrooms leading to high teacher-student ratio.

One of the problems of increased number of students in the class is limited range of teaching method and inability of teachers to provide for the specific learning needs of the individual students and this has resulted into poor performance of students. It has been identified that persistent use of the lecture method and managing large classes as the major shortcomings affecting learning and higher performance in Basic Science. The search for improved strategies for teaching and learning of science in order to stem the tide of students under performance is a continuous process.

Despite several attempts by the government and other stakeholders in education to achieve the formulated objectives of basic science education, it seems that the huge amount of money that is being spent on the procurement of test books and instructional materials, organizing of workshops, seminars and even in-service training opportunities for the science teachers, are not yielding positive result at Junior Secondary Schools in Katsina State. The failure rate is increasing on regular basis as shown by available records from Dutsin-ma Zonal Inspectorate of Education (July, 2013). The records show that the total number of candidates who failed JSCE increases from 27% in 2007/08 to 39% in 2011/12 Academic year.

Though many causes are attributed to this, yet the relevance of instructional graphics in

teaching Basic Science in Junior Secondary Schools in Katsina State can be an area of investigation.

To the author's knowledge, no research finding appears to have examined the effects of instructional graphics on academic performance and attitude of Basic Science students. However, several studies conducted on the relevance of instructional graphics were mainly on students' academic performance compared to other teaching methods. However, while not much can be done by an individual regarding the poor performance of students in basic science especially in JSCE in Katsina State, one should ask the following pertinent questions regarding this poor performance;

What are the factors responsible for student's poor academic performance in Basic Science at JSCE level, in Katsina state? How can these factors be addressed towards improving the academic performance of students in Basic Science at JSCE level in the state?
Specifically, the study is therefore, conceived to find out whether or not the use of Instructional graphics in teaching and learning will enhance Students' academic performance of Basic Science at JSS level in Katsina State.

1.3 Objectives of the Study

The objectives of the study are to:

1. Determine the effect of instructional graphics on the academic performance of basic science students in the experimental group.

2. Find out about the effect of instructional graphics on academic performance of Male and Female Basic Science students in the experimental group.

3. Examine the effect of instructional graphics on students' attitude towards Basic Science.

4. Investigate the effect of instructional graphics on female students' attitude towards Basic Science.

1.4 Research Questions

To serve the afore-mentioned purposes, the study was conducted based on the following Research Questions:

1. What is the effect of instructional graphics on the academic performances of students in Basic Science at JSS level in Katsina State?
2. What is the effect of instructional graphics on the academic performance of male and female in Basic Science students in Katsina State?
3. What is the effect of instructional graphics on the attitude of students towards Basic Science study?
4. Male and Female Students differ in their attitude towards Basic Science after their experience?

1.5 Research Hypotheses

The following hypotheses guided the study.

Ho_1: There is no significant difference between the academic performance of Basic Science students who were exposed to instructional graphic learning strategy and their counterparts exposed to the lecture method

$Ho_{2:}$ There is no significant difference in the academic performance on Basic Science of male and female Basic Science students exposed to instructional graphic learning strategy.

$H_{O3:}$ There is no significant relationship in the attitude of Basic Science students before and after exposure to instructional graphics learning strategy.

$H_{O4;}$ There is no significant difference between Male and Female students in their attitude towards Basic Science when Instructional Graphics are used in Basic Science Instruction?

1.6 Significance of the Study

The study will provide information for teachers and would-be teachers, examiners, administrators and stakeholders on how to make proper utilization of instructional graphics.

As a result, students' academic performance and positive attitude towards basic science study especially at JSS in Katsina State would be enhanced.

Part and parcel of secondary schools' curriculum implementation are the administrators. However, they are not always in the schools to interact with teachers and students. The study could therefore, provide them with information on how to improve teaching and learning strategy in basic science course in the state. Similarly, students are part of the users of the library; the research work could serve as a reference point to readers in basic science and other related fields. This may inculcate the reading habit to the students thereby improving their perception and enhancing their academic achievement.

For the stakeholders (members of the society), the study could motivate them to appreciates the contribution of science education for national development and societal goals achievement. This may persuade them to provide all the necessary support and guidance that might be pertinent for the successful implementation of junior secondary schools' curriculum especially when it has to do with science based courses.

The essence of research is to correct the situation on ground. Considering the fact that many examiners have been complaining over the poor performance of JSS students in basic science, the study of this nature could help them to identify the causes of the problem and determine a way forward for addressing the issue.

Part of the problem might be lack of adequate and relevant instructional graphics in the schools. Provision of enough and relevant instructional graphics materials in schools could encourage teachers to make proper utilization of them. As a result, students' perception could be made easier and more permanent which could improve their academic performance in class test, end of term examination and JSCE summative evaluation in basic science course.

The findings of the study could guide the government in the provision of relevant instructional graphic and enhancement of Science Teachers' Allowance (STA) as to boast science teachers' morale in Katsina State. It could also guide the government to draw more realistic aims on junior secondary development programme.

Books writers and curriculum experts could be guided by this study to cope with the needs of the basic science instructional processes which might be necessary for improving students' academic performance. This could be achieved by identifying and guiding in developing relevant instruction graphics for effective instructional delivery. In addition, the result of the study could help policy makers and educationists to identify other related problems in order to improve effectiveness in teaching and learning of basic science in particular and other conventional courses in general, especially at JSS level in Katsina State.

Professional associations such as the Science Teachers Association of Nigeria (STAN) and Nigerian Educational Research and Development Council (NERDC) can carry out seminars, workshops and research activities to help implement and communicate the result of the study to teachers to use as part of their instructional package throughout Nigeria.

1.7 Basic Assumptions of the Study

The following are the basic assumptions of the researcher in respects of the problems of the effect of instructional graphics in Basic Science instruction in secondary schools:

1. That instructional graphics would improve students' academic performance in JSCE Basic Science, in secondary schools in Nigeria.
2. That instructional graphics could be used to reduce gender related problems in Basic Science instruction in secondary school in Nigeria.
3. That when instructional graphics are used in Basic Science instruction, both male and female students perform, equally.

4. That instructional graphics would improve students' positive attitude towards Basic Science and consequently towards other sciences at their senior secondary school level.

1.8 Scope of the Study

The study was limited to;

1. Junior Secondary School II Students of Basic Science selected from two Coeducational Secondary Schools in D/ma ZIE Katsina State Nigeria.

2. The topics used were limited to Human Skeletal System and Kinetic Energy drawn from Basic Science II UBE Edition (2008).

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

One of the vital aspects in a research of this nature is reviewing literature, for the fact that, it explores and sheds more lights on many areas of the problems under study. To examine related literature to the study, the review entails the following areas:

- Conceptual framework
- The concept of graphics
- Types of instructional graphics
- Application of instructional graphics
- Cognitive Theories Relating to Instructional Graphic
- Theoretical Basis of Science Education
- Science Content and Cognitive Capacity

- Developing and Acquiring Fundamental Scientific Concepts and Skills
- Gender Differences and Academic Performance in Science
- Attitude and Academic Performance in Science
- Science Teaching Methods
- Empirical Support for Instructional Graphics
- Summary

2.2 Conceptual framework

A major area of interest in science education research is the teaching of science through inquiry. Research findings and the national reform in science education overwhelmingly support this notion. The US Department of Education and the National Science Foundation (1992) endorse mathematics and science curricula that promote active learning, inquiry, problem solving, cooperative learning, demonstration, and other instructional methods that motivate students. The publication entitled *National Science Education Standards* (National Research Council 1996) states that science teaching must reflect science as it is practiced and that one goal of science education is to prepare children to understand and use the modes of reasoning of scientific inquiry. NSES presents inquiry as a step beyond process that involves learning, observing, and inferring.

Inquiry-oriented instruction engages students in the investigative nature of science. As Novak in Zhao, (2003) suggested, inquiry is a student behaviour that involves activity and skills, but the focus is on the active search for knowledge or understanding to satisfy students' curiosity. In inquiry, educators should not expect children to discover everything for themselves; rather, they should focus on relating new science knowledge both to previously learned knowledge and to experiential phenomena, so students can build a consistent picture of the physical world. Science teachers can facilitate this process in several ways. For example, when children show an interest in learning more about a bean plant or a nearby tree, the teacher should ask questions to determine what each student already knows. In this way, teachers can modify learning experiences and classroom settings to best meet individual needs.

One way to involve students in inquiry is through problem solving, which is not as much a teaching strategy as it is a child behaviour. As with inquiry, the driving force behind problem solving is curiosity-an interest in finding out. The challenge for the teacher is to create an environment in which problem solving can occur.

Problems should relate to, and include, the children's own experiences. From birth, children want to learn and they naturally seek out problems to solve. Problem solving in the pre-kindergarten years' focuses on naturalistic and informal learning: filling and emptying containers of water, sand, or other substances; observing ants; or racing toy cars down a ramp. In kindergarten and the primary grades, adults can institute a more structured approach to problem solving (Hurd, 1989).

Problem solving can be a powerful motivating factor to learn science. When students perceive the situations and problems they study in class as real, their curiosity is piqued and they are inspired to find an answer. Searching for a solution to a question or problem that is important to the student holds his or her attention and creates enthusiasm.

Sprenger (2005) admonishes educators to vary teaching styles and learning opportunities in order to embrace a variety of learning styles. "Our students have different ways of learning. Some of them are visual learners, some auditory, and some kinaesthetic or tactile. These learning preferences or learning strengths may influence what our students are paying special attention to" (p. 26).

Attitude plays a major role in students learning (Ajewole 1990). Simpson; Wilson; Soyibo, in Dyel (2011) reported that, student's positive attitude to science correlate highly with their science performance. He maintained that Attitude was found to have a direct effect on science performance among American high school students. In Nigeria,

Balogun (1975), reported that, in general, the attitude of Nigeria students towards the basic sciences tend to decrease in the order of Biology, Chemistry, Physic and mathematics. Oyedokun (1998) noted that attitude to science generally account for

between 20% to 25% variations in the academic performance in science. Although students differ in degree in their attitudes towards different subject taught in the school curriculum, a person generally perform better in any discipline to which favourably he/she is disposed.

Despite theorists' differences concerning the manner in which students acquire knowledge, instructional graphic can be utilized to foster learning no matter the learning style preferred by the student.

The role of graphic materials in visual communication is both unique and significant.

Historically, symbols, a basic part of graphics have made it possible, the whole range of written language used in the world today. The instructional value of graphical illustrations lies generally in their capacity to attract attention and convey certain types of information in condensed form (Onasanya & Adegbija, 2007). Okpala *et al*. (1998) started that graphical illustrations provide a common experience to a large group at the same time. They also summarized the values of graphic for instructional design as follows: They require no special machine for projection, the teacher is confident in manipulating the material, their improvisation encourages more creativity and diversification of teaching methods, they are very easy to preserve and they could be produced within minimum cost and maximum efficiency.

2.2.1 The Concept of Graphics

According to Reiber, (as cited in Bassey {2002}) the terms **graphic**, **image**, **visual**, and **picture** greatly overlap and are often used synonymously. Computer visuals refer to all possible computer output, including text. Computer graphics are considered a subset of computer visuals and involves the display of **nonverbal information**, or information that is conveyed spatially. Included in this definition are; the range of computer-generated pictures, with **pictures** being defined as graphics that share some physical resemblance to an actual person, place, or thing. The quality of these types of graphics ranges from near photographic to crude line drawings. Also included is the spectrum of nonrepresentational graphics, including, but not limited to, charts, diagrams, and schematics.

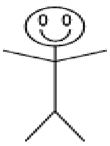
Besides its general meaning, the term **visualization** also describes an interdisciplinary field of study in which computer graphics techniques are used to display images that convey a wide range of information. In this sense, visualization differs from computer graphics in that visualization stresses the information that is conveyed in the resulting image (Brown & Cunningham, 1990). However, for simplicity's sake, **graphics** typically will be used throughout this study to denote all visual information conveyed through no textual ways.

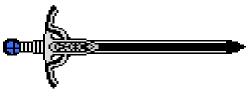
Reiber, (1990a) reported that, the first principle of the design of instructional graphics is this; There are times when pictures can aid learning, times when pictures do not aid learning but do no harm, and times when pictures do not aid learning and are distracting. This principle is an important one, however obvious it may seem. It speaks to an underlying philosophy of instructional graphics and instructional technology. It is important to understand this philosophy at the start, because it will guide every attempt at designing graphics when the purpose is to aid, enhance, or support learning. This study does not advocate or oppose the use of graphics. Instead, it supports the position that graphics, like most strategies and techniques, have their place in instruction. The problem is understanding when and how to design effective graphics, as well as when to avoid them altogether.

2.3 Types of Instructional Graphics

Given the popularity and flexibility of graphics in instruction, a way is needed to make sense out of how they can be used to improve instructional materials. First, there is a need to describe the types of graphics commonly used in instruction. Second, there is a need to describe the various functions of each type when applied in an instructional or training Setting. In general, there are three types of graphics which are classified as representational, analogical, and arbitrary (Reiber, 1990a), as shown in Figure 2.2

Representational graphics vary in detail from line drawings to photographs, but are alike in that they closely "resemble" the object(s) they depict. For example, a stick figure can represent a person.





Analogical graphics show one thing and by analogy imply something else. For example, a graphic of a sword might be shown to illustrate the concept of medieval warfare.

Arbitrary graphics include tables, charts, and cognitive maps that have no real-life counterpart that they are attempting to portray.

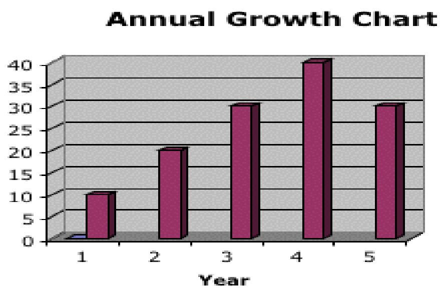


FIGURE 2.1 Three Types of Instructional Graphics. Source; Reiber, (1990a)

2.3.1 Representational Graphics

Representational graphics share a physical resemblance with the object they are supposed to represent. For example, a passage of text explaining the purpose and operation of a submarine probably would be accompanied by a picture of a submarine. Representational visuals, range somewhere between highly realistic and abstract (Rieber, 1990a). The most common examples of realistic representational visuals are photographs or richly detailed coloured drawings, the latter of which are currently the highest quality images that can be generated on microcomputers. Multimedia systems present opportunities to incorporate near-photographic images, such as composite video images taken from video disc or videotape recorders, or from computers. Although many would argue that the quality of these video images is much lower than photographs, the issue of representational integrity is largely a function of the context (Pauline & Hannafin, 1987).

An example of an abstract representational visual is a line drawing. These also range in quality from richly detailed to rudimentary drawings. For example, Figure 2.2 shows an example of a passage explaining the use and function of an astronaut's space suit. While it is clearly a line drawing, it was produced from a photographic original. On the other hand, Figure 2.3 shows a rather crude drawing of a submarine. This primitive drawing still captures the most salient features of a submarine. In fact, the lack of interesting details and background makes it easier to focus on the essential characteristics of a submarine and far less likely to get confused or distracted by extraneous details. For these reasons, simple line drawings are often considered better learning aids than realistic visuals, especially when the lesson is externally paced, such as in films and video (Dwyer, 1978).

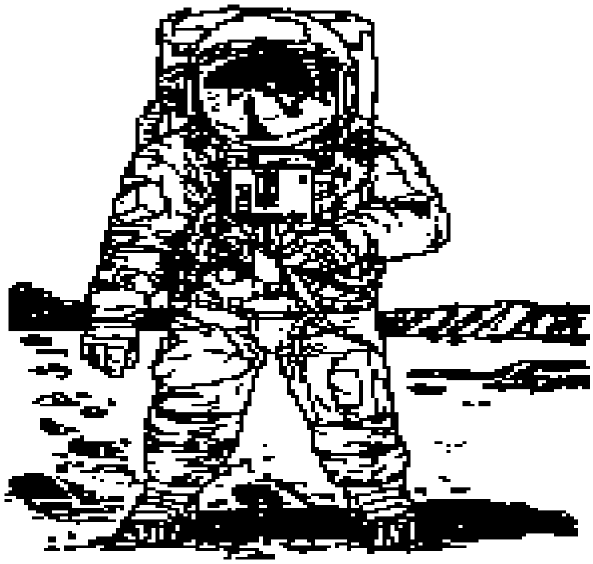


FIGURE 2.2 Snapshot of a CBI lesson using a presentation graphic consisting of a representational line drawing. Source; Reiber, (1990b)

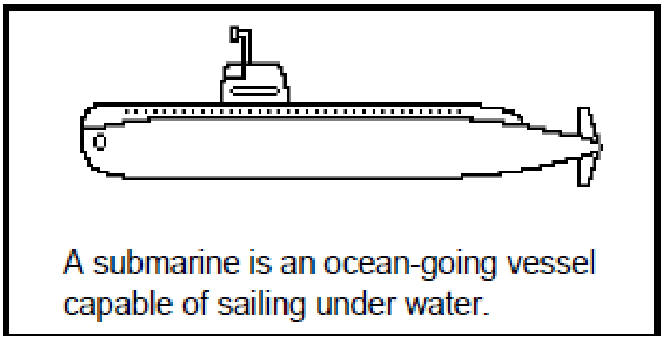


FIGURE 2.3 Example of an analogical graphic. Source; Reiber, (1990a)

2.3.2 Analogical Graphics

This range of representational visuals is probably the most common type of illustration used in instructional materials today, including computer environments. However, presenting students with an accurate representation of something may not always be the best learning tool. One such example is when students have absolutely no prior knowledge of the concept.

Instructional research indicates that analogies may be effective instructional strategies in such instances (Curtis & Reigeluth; Halpern; Hansen, & Riefer; in Reiber, 1990a).

For example, if students do not understand the idea that a submarine is able to dive under water, it might be more appropriate to first suggest that a submarine is analogous to a fish so students understand this characteristic. However, a better analogy would be a dolphin because it, like a submarine, must surface occasionally for air, or better yet, a whale, because of its size. Of course, a submarine is not a dolphin or a whale, so learners must understand that the analogy is being used only to represent similarities. Differences do exist, and it is important that students understand the analogy's limits.

Educational psychologists often describe learning as a process that goes from the known to the unknown (Reigeluth & Curtis, 1987). An analogy can act as a familiar "building block" on which a new concept is constructed (Tennyson & Cocchiarella, 1986). Of course, if the student does not understand the content of the analogy, then its use is meaningless and confusing. Worse yet, students may form misconceptions from an inadequate understanding of how the analogy and target system are alike and different (Zook & Di Vesta, 1991). The usefulness of the analogy, therefore, is largely dependent on the learner's prior knowledge. Graphics can help learner's see the necessary associations between parts of the analogy.

2.3.3 Arbitrary Graphics;

Do not offer any resemblance of real or imaginary objects, but yet contains visual or spatial characteristics that convey meaning. Examples range from the use of spatial orientations of text, such as outlines, to flowcharts, bar charts, and line graphs Rieber, (1990a).

All information can be represented as existing on a continuum. At one end are the most concrete representations — real objects. Nearby are highly realistic representational pictures. At the other end are spoken and written words that represent the most abstract form of communication. In the centre of this continuum would be arbitrary graphics Winn, (1989) in Rieber, (1990a).

Charts and graphs are probably the most common types of arbitrary graphics (Reiber, 1990a). Charts refer to tables or information contained in table-like formats. Examples include taxonomies, such as the classification of animal groups, language families, or baseball teams (see figure 2.4). The purpose of a chart is to organize and display information by one or more categories or fields. All of the information in a chart is discrete (categorical) data.

Holley and Dansereau, (1984) cited in Bassey, (2002) maintained that a "cognitive map" is an interesting example of a chart that has much support from research as a learning tool. Cognitive maps are part of an instructional technique called spatial mapping. The purpose of cognitive maps is to show the relationships and hierarchies of related ideas and concepts. Research has shown that these graphics tend to be most useful when the *student* constructs the map or when the map is constructed in front of the student, usually during the explanation of the ideas, rather than just providing a completed map to a student to study (Bassey (2002).

National League	
East	**West**
Chicago Cubs	Atlanta Braves
Florida Marlins	Cincinnati Reds
Montreal Expos	Colorado Rockies
New York Mets	Houston Astros
Philadelphia Phillies	Los Angeles Dodgers
Pittsburgh Pirates	San Diego Padres
St. Louis Cardinals	San Francisco Giants

American League	
East	**West**
Baltimore Orioles	California Angels
Boston Red Sox	Chicago White Sox
Cleveland Indians	Kansas City Royals
Detroit Tigers	Minnesota Twins
Milwaukee Brewers	Oakland A's
New York Yankees	Seattle Mariners
Toronto Blue Jays	Texas Rangers

FIGURE 2.4: Example of presenting categorical information in a table.

Source; Reiber, (1990a)

Similarly, graphs also logically represent information along one or more dimensions, but the main purpose of graphs is to show relationships among the variables in the graph, as shown in Figure 2.5. The most common types of graphs are line graphs and bar graphs, although many other types abound, such as pie graphs, scatter plots, etc.

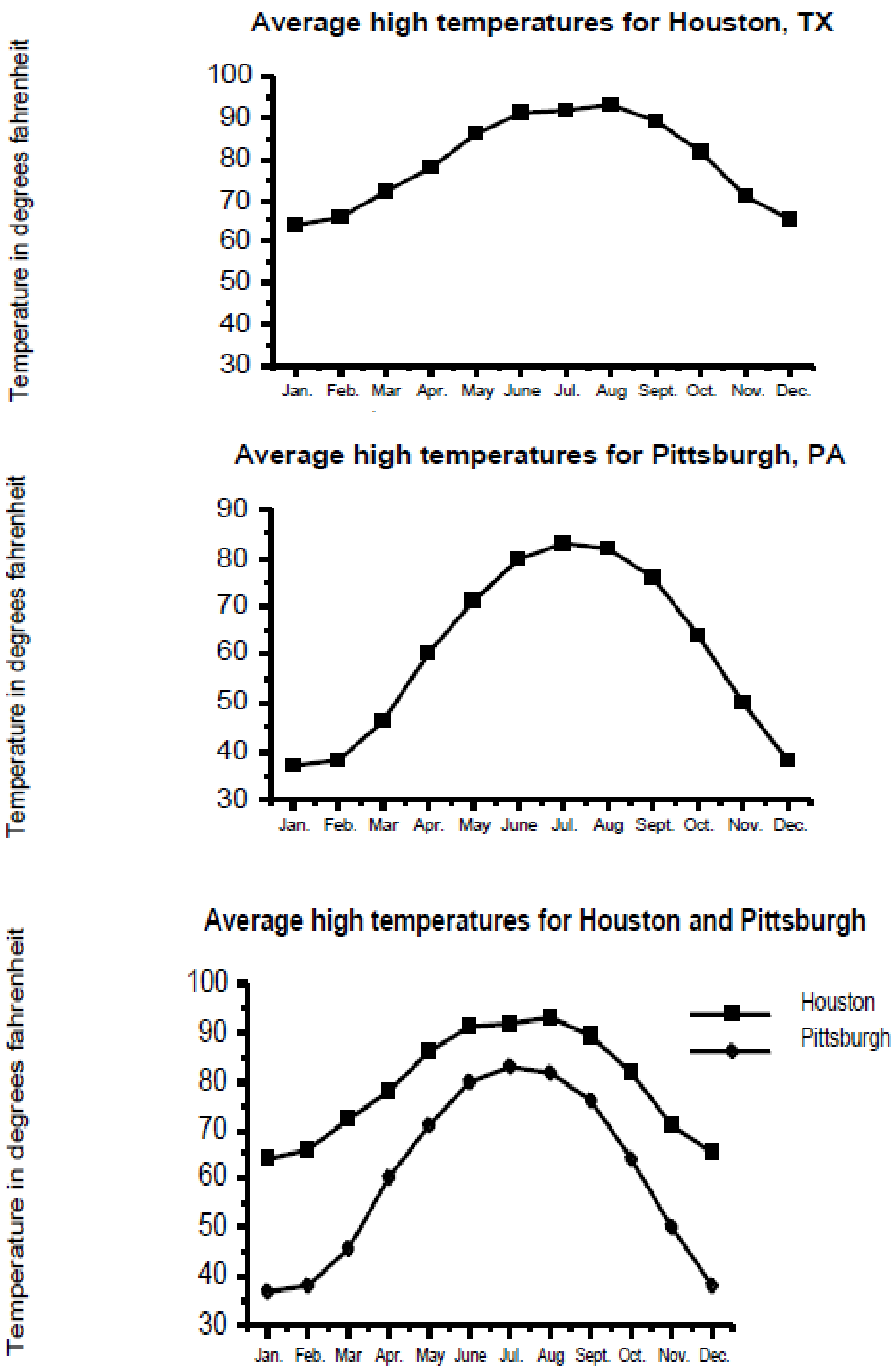


FIGURE 2.5

Examples of line graphs. Source; Reiber, (1990a)

Reiber , (1990a) cited in Bassey (2002) stressed that, the way space is used in a chart or graph to form sequences and patterns is very important. Research has shown that more rapid problem solving results from diagrams in which conceptual relationships are shown spatially, rather than by text.

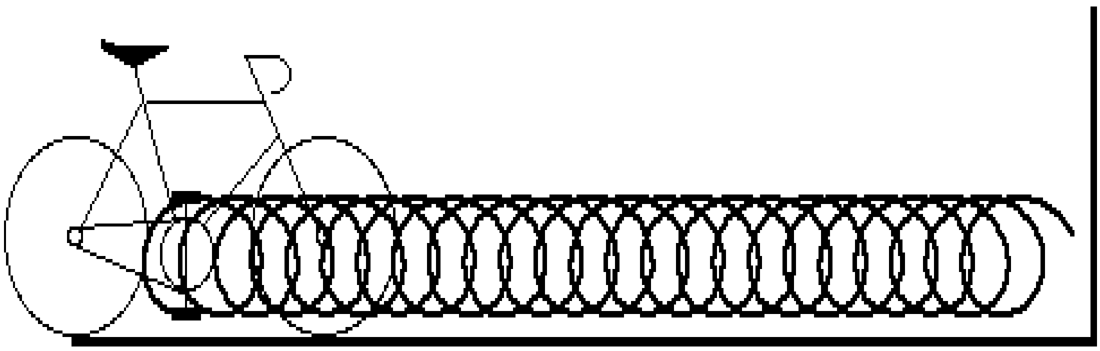
In charts, the sequence of information is usually not a critical feature. For example, there are many ways to sequence the various names and hometowns of major league baseball teams. It doesn't really matter if the American League or National League is listed first or second. The teams are listed alphabetically in Figure 2.4, but changing this order does not change how information in the chart is conveyed. The pattern of a chart is typically conveyed through row or column headings. The baseball chart is informational because of the primary and secondary groupings:

Also, the proximity of items to one another in a chart may also convey information. The sequence of a graph is crucial to understanding the information it contains. For example, the usefulness of a graph that describes average monthly temperatures, such as those shown in Figure 2.5, would be seriously curtailed if it were arranged alphabetically by month instead of chronologically. “Reading” the graph is easier when the graph displays information in a natural sequence. Also, the purpose of a graph is usually to compare information across parts of the graph, such as which times of the year are the hottest or the coldest. This also speaks to the importance of the pattern of information displayed in a graph. Consider Figure 2.5 containing three separate line graphs: one graph showing the monthly temperatures for both Houston and Pittsburgh, and then one superimposing the two graphs. Graphs such as these are meaningful if they convey trends and comparisons quickly at a glance. When superimposed, the line graphs quickly allow the reader to compare the climates of the two cities. Tufte, cited in Reiber (1990a) states that an effective and popular graph type is the **time-series plot**, where one axis is tied to some chronological variable, such as seconds, minutes, or years.

Scientists often use time-series plots to show how large and complicated data sets change over time. A simple example of the resulting motion of a bicycle's pedal as it turns while the bicycle moves forward at different speeds is shown in Figure 2.6.

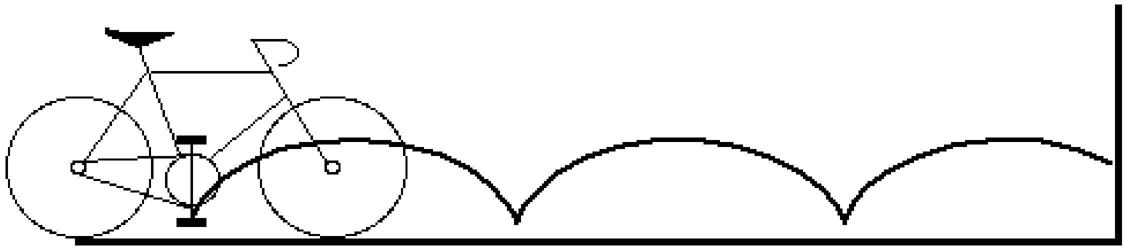
Reiber (1990a), further states that one of the most influential figures on how to visually display quantitative information has been Edward Tufte. His most fundamental principle of statistical graphics is simply “above all else show the data”. Yet, it is amazing how often this simple principle is violated, sometimes unintentionally and sometimes deliberately to distort the data (such as for political motives). For this reason, Tufte defines the “lie factor of graphs” as the size of the effect shown in the graph divided by the actual size of the effect in the data. A lie factor of 1 denotes no lie, but ±.05 constitutes a substantial distortion of the data. Tufte, (1990) also admonishes designers of graphs to keep “chart junk,” nonessential graphical decoration, to a minimum. Tufte feels that “the best designs are *intriguing* and *curiosity-providing*, drawing the viewer into the wonder of the data. . .” (p. 121).

Speed of bicycle (distance/time)

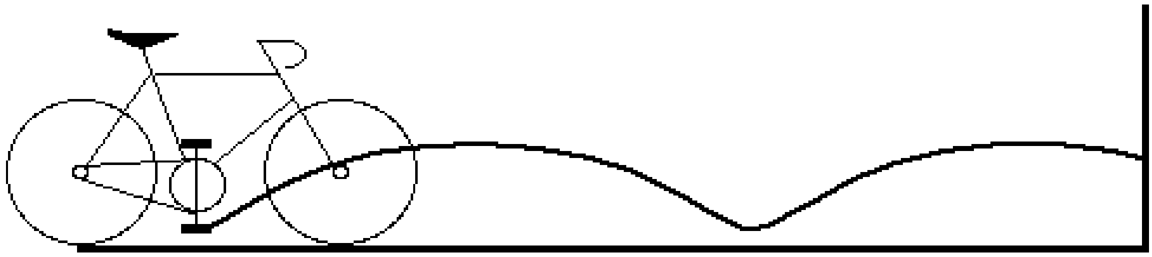


Lower Gear

Source; Reiber, (1990a)



Medium



High Gear

FIGURE 2.6: Three time-series plots showing the path that a bicycle's pedal follows as the bicycle moves forward, given different gear ratios. Source; Reiber, (1990a)

2.4 Applications of Instructional Graphics

The instructional value of graphical illustrations lies generally in their capacity to attract attention and convey certain types of information in condensed form (Onasanya & Adegbija, 2007). Okpala *et al*. (1998) started that graphical illustrations provide a common experience to a large group at the same time. Okpala *et al.* (1998) also summarized the values of graphic for instructional design as follows: They require no special machine for projection, the teacher is confident in manipulating the material, their improvisation encourages more creativity and diversification of teaching methods, they are very easy to preserve and they could be produced within minimum cost and maximum efficiency.

Reiber, (1990a) in Osa, (2005) maintained that, there are five instructional applications of graphics offered as an informal guide to the ways graphics can be used in instruction: cosmetic, motivation, attention-gaining, presentation, and practice. These five applications come as a direct result of the discussions of learning outcomes and the events of instruction. Their purpose is to describe instructional situations in which all the three graphic types can be applied. Even though these are listed in discrete fashion, their functions frequently overlap, making it possible for the instructional intent and result of any one graphic to be classified across more than one application. These applications are presented as easy-to-remember guideposts for the various uses of graphics in and out of CBI.

Three of the applications — attention-gaining, presentation, and practice — serve cognitive functions and two of the applications — cosmetic and motivation — serve affective functions (as shown in Figure 2.7). These functional categories should help you to design and evaluate instructional graphics based on whether the intent of a graphic is to contribute to learning or to the affective appeal of a lesson. All instructional graphic designers should ask themselves this all-important question each time they begin a project: “What function is my graphic going to serve in this lesson?

A guide to using graphics in instruction	
Instructional applications	**Function**
Cosmetic Motivation	Affective
Attention-gaining Presentation Practice	Cognitive

FIGURE 2.7Five Instructional application of Graphics. Source; Reiber, (1990a)

2.4.1 Affective Functions of cosmetic graphics and motivational graphics is to enhance the affective appeal of a lesson. Affective applications are designed to improve a student's attitude toward learning or to increase the incentive of a student to participate in the lesson.

2.4.2 Cosmetic Graphics are often used for purely cosmetic reasons. In a sense, it is a misnomer to call this an instructional function, because, by definition, no direct learning benefits are expected from cosmetic graphics. The purpose of a cosmetic graphic is to merely add to the polish or decoration of a package to make a program more attractive or aesthetically pleasing (Levin, Anglin, & Carney, 1987). There are too many examples to list them all, but a few common cosmetic graphics are fancy screen borders, some uses of colour, and the use of special effects (like animation at the start of a program to display a product's title and publisher). Cosmetic graphics often add a certain level of completeness or sophistication to a package. This may promote the feeling among students that the instruction is important, whether or not this is true.

At their best, cosmetic graphics help maintain student interest and perhaps regain student attention and would heavily overlap the attention-gaining and motivational functions described next. At their worst, cosmetic graphics distract student attention from other important material. An example of a cosmetic graphic is shown in Figure 2.14. Here the graphic is included in a lesson on the history of sports. Notice that the graphic has nothing to do directly with the lesson text, but merely adds visual appeal to the frame.

Unfortunately, students may get the impression that the graphic is directly relevant to the text and thereby might spend time looking for learning clues in the graphic. When this happens, the graphic poses the risk of distracting the student from the intended lesson goals. Distraction is the Nemesis of instructional graphic design (Willows, 1978).

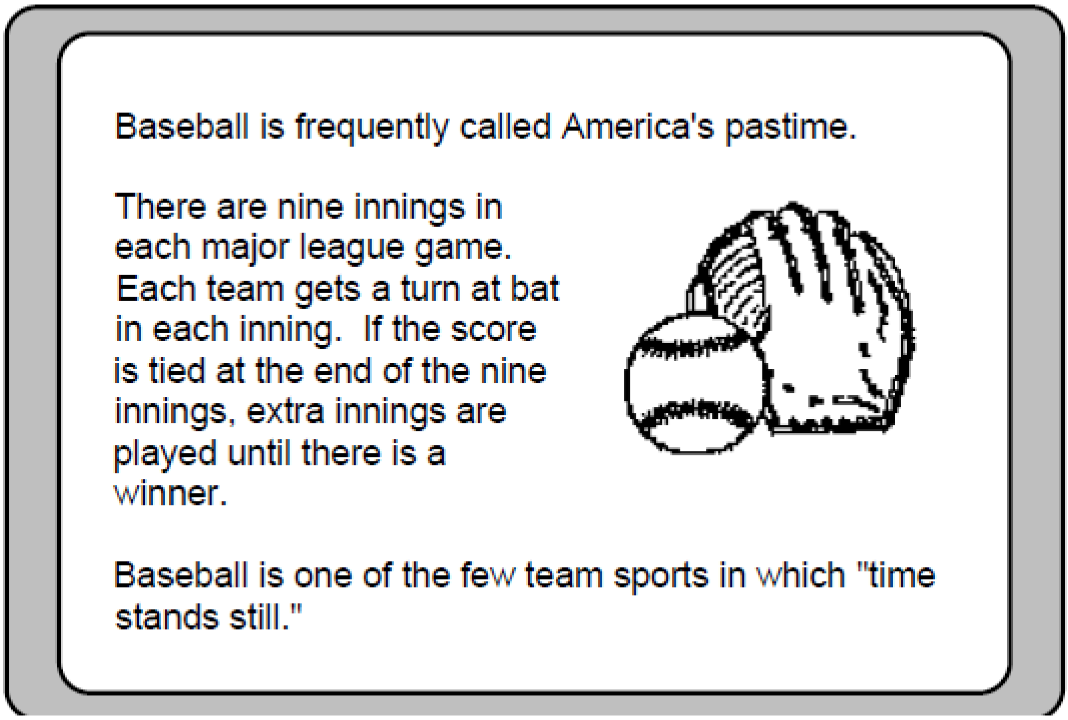


FIGURE 2.8 Snapshot of a CBI lesson using a cosmetic graphic.

Source; Reiber, (1990a)

Distraction effects pose threats to learning because of the severe processing limitations of short-term memory. The haphazard use of cosmetic graphics is an example of where good intent can lead to unfortunate outcomes. Steps must be taken to ensure that learners will not be misled into perceiving some underlying instructional value of a cosmetic graphic. The frequency and position of cosmetic graphics should be strictly controlled.

2.4.3 Motivational Graphics are often incorporated into instruction to raise the general motivational level of a lesson. Much of the motivating appeal of graphics is due to novelty. Unfortunately, novelty effects are temporary, gradually disappearing over time (Clark, 1985). A good example of failing to recognize novelty effects is the early history of microcomputers in the classroom. Many believed that students naturally learned more from microcomputers because they wanted to work on them and because it was so easy to keep them on task. However, comparative reviews of media research favouring the computer over traditional instructional media were often found to be based on novelty effects (Clark, 1985). There is nothing wrong with taking advantage of novelty effects so long as one understands that the opportunity to enhance learning solely because of novelty is short lived. As students become more familiar with computers, the prospect of interacting with one becomes less and less exciting, and hence the novelty effect disappears. The inherent instructional design of the materials delivered by computer is all that's left to influence the learner.

Using graphics to arouse general curiosity and interest is seen by many as a very superficial way to increase motivation. There are deeper ways to maintain attention and interest beyond the simple provision of interesting graphics. For example, if the nature of the learning task is satisfying, relevant, and challenging, students are more likely to participate in meaningful ways (Keller & Suzuki, 1988; Kinzie, 1990). Hence, their time on-task is not only increased, but the quality of this learning time is enhanced as well.

Motivational Graphics can be used as one strategy to maintain motivational appeal by constantly refreshing the lesson's level of novelty and curiosity. However, the power of computer graphics as a long-term motivational tool designed to increase student perseverance does not have much empirical support (Surber & Leeder, 1988).

2.4.4 Cognitive Functions; Graphics that serve cognitive functions are designed to directly enhance the ability of students to learn from instructional materials. These graphics should be designed to achieve, or help achieve, one or more of the events of instruction.

2.4.5 Attention-Gaining Graphics; of the three orienting events of instruction, graphics are used more often, by far, for attention-gaining — and for good reason Onasanya and Adegbija, (2007). There are many sources of stimuli that compete for a person's attention in and out of the classroom. Many, if not most of these sources are probably far more interesting than the instruction itself. Usually, these competing stimuli come from the student's environment, such as a buzzing light, sniffling nose, screeching chairs, music or laughter from down the hallway, a growling stomach, or an attractive member of the opposite sex sitting in the next row. Competing stimuli also can come from within the student's own mind, such as personal concerns like a home crisis or just general day dreaming.

For these reasons and many more, attention-gaining is an important initial event of instruction (Gagné, 1985). Attention-gaining applications are obvious, practical, and rational uses of graphics. As with cosmetic applications, graphics that purposely serve to gain attention should not subsequently distract attention from other important and salient lesson features.

Other examples include interesting special effects for transitions between instructional frames or lesson parts. Special screen washes, moving symbols or characters (cartoon or text), animated prompts, such as arrows that direct attention to key words, paragraphs, graphics, or other screen items are still other examples of animated attention-gaining devices (Hannafin & Peck, 1988). Interesting graphics contained throughout a CBI lesson can help maintain a student's attention. One reason that graphics seem to work is that they offer a degree of novelty. Attention is naturally drawn to what is new and different. Remember, however, the temporary nature of novelty effects.

Among the qualities of static graphics that increase the level of student interest is moderate to heavy richness of detail (Dwyer, 1978; Fleming, 1987). Some people may notice a contradiction with this and the principle, discussed in the last section, indicating that learning often results from representational graphics containing relatively low levels of realism. But there is a big difference between using a graphic to capture the attention of someone versus using that graphic to teach something. This is just one of many examples of the "form follows function" principle, where the type and design of a graphic must be determined by the function that the graphic is supposed to serve.

2.4.6 Presentation Graphics are frequently used to teach and can be used with or without accompanying text to demonstrate or elaborate a lesson concept, rule, or procedure (Alesandrini, 1987).The processing partnership between visual (e.g., static or animated graphics) and verbal (textual) information is the foundation of several theories of long-term memory (Bower, 1972; Paivio, 1986). The use of static and animated graphics as a presentation device has been called a "learning-by-viewing approach" to instructional graphics (Reed, 1985). Most instructional applications of this type use representational graphics to directly visually depict critical information and are probably the most common way pictures are used to help students learn from text (Levin, Anglin, & Carney, 1987).

Animated presentations can also aid a student's conceptual understanding of interrelated lesson variables. In this way, presentation graphics help students to interpret difficult-to-understand information. (Levin, Anglin & Carney, 1987).

Representational graphics are an effective presentation strategy when combined with text. These graphics help learners focus their attention on the explanative information in the text (Mayer, 1989). Instructional Graphics also help learners form visual mental models of the materials explained by the text. Mayer and Gallini, (1990) suggest that visuals are useful presentation strategies when they satisfy four conditions:

1. The text is *potentially* understandable by students;

2. The visuals are *designed* and evaluated in terms of learner understanding;

3. The visuals are used to *explain* information provided by text; and

4. Students have little or no previous *experience* with the content.

Finally, presentation graphics can also serve an organizational function (Levin, Anglin, & Carney, 1987) to help make relationships between ideas more apparent. The most common examples of these are “how-to-do-it” graphics that show a set of step-by-step procedures in visual form. Examples include how to assemble a household device or how to perform an emergency medical procedure, such as cardiopulmonary resuscitation (CPR). Such procedural applications of graphics are very relevant for many psychomotor tasks, as shown in Figure 2.9.

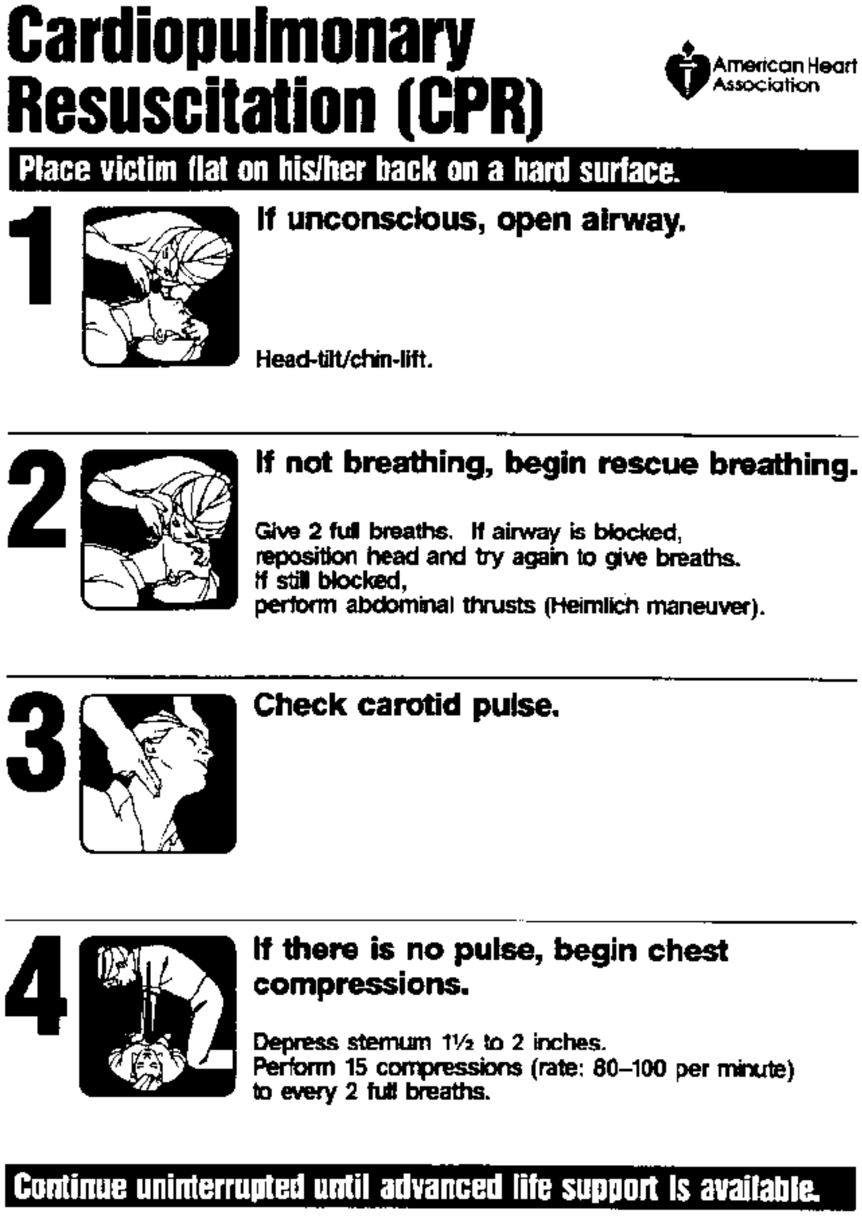


FIGURE 2.9 Examples of a procedural graphics that illustrates a step-by-step sequence of tasks, "Cardiopulmonary Resuscitation CPR", source; American Heart Association Wall Chart, 1986.

2.4.7. Graphics in Practice Activities; Graphics can be very useful in practice activities and can act as visual feedback to students as they interact with lesson ideas and concepts. This application of graphics is particularly suited to the computer medium, such as those involving visually based simulations. Real-time animated graphics in interactive learning displays are also known as "interactive dynamics" (Brown, 1983). Real-time animated graphics change continuously over time, depending on student input. Students learn in these highly interactive visual environments by discovery and informal hypothesis-testing. Graphics act as instantaneous feedback. Brown (1983) called this application of animation “learning by doing.” Examples of graphics include, real-time simulations, such as piloting an airplane as shown in Figure 2.9, interacting with a Newtonian particle in a gravity free/ frictionless environment (Rieber, 1990a), and graphic programs where students learn musical concepts (Lamb, 1982). Other examples include graphic programming procedures in (LOGO), where students drive an animated “turtle” (Papert, 1980). However, students must be able to perceive differences in the graphic feedback, ability that novices, especially, have a difficult time attaining (Brown, 1983). Interactive dynamics should be structured to offset this deficiency (Rieber, 1989) or to augment such interactions with coaching or other prompts (Reed, 1985). Learning from interactive dynamics appears very contextually bound. This use of animation is not easily replicated with media other than the computer.

Graphics are commonly used in more traditional practice activities in computer based instruction (CBI), such as question and answer. Often, the role of graphics is merely to reinforce correct responses, such a displaying a happy face for right answers. The danger is that attractive and interesting graphics may actually reinforce wrong responses or other behaviours. Some computer chess games, for example, visually personify the chess pieces. When one piece “takes” another, some programs actually show the “execution” of the captured piece. A person who finds such visuals motivating might *want* to lose the game just to witness the graphical results.

FIGURE 2.10 Snapshot of a computer flight simulator as the user tries to land the airplane.

Source; Reiber, (1990a)

In another perspective, Levier, in Bassey (2002), reported that, the purpose of most instructional graphics is to help explain something to the viewer in a manner that hopefully increases retention of the subject matter. He further maintained that, Instructional graphics have seven possible functions:

- ***Descriptive***, to show what an object looks like.
- ***Expressive***, to make an impact on the learner.
- ***Constructional***, to show how the parts fit together into the whole.
- ***Functional***, to show a process or the organization of a system in a simplified manner.

- ●***Logic-Mathematical***, to display a mathematical concept such as a curve graph, line graphs and charts with a scaled X and Y axis fall into this category.
- ●***Algorithmi***c, to show a holistic picture of the range of possibilities, Flow charts fall into this category.
- ●***Data Display***; illustrating textual data visually, Bar charts, pie charts, and histograms falls into this category.

2.5. Cognitive Theories Relating to Instructional Graphic

Knowledge gained about how the brain processes information has been instrumental in the development of teaching techniques and learning strategies. Several cognitive theories in particular lend support to the use of instructional graphic in helping students process and retain information. Schema theory, dual coding theory, and cognitive load theory provide the basis for explaining the characteristics of instructional graphic that support the learning process.

2.5.1 Schema Theory

According to schema theory, memory is composed of a network of schemas. A schema is a knowledge structure that accompanies or facilitates a mental process. According to Winn and Snider (1996), all of the definitions of schema theory contain the following characteristics:

1. A schema is an organized structure that exists in memory and combined with other schemas, contains the sum of an individual's knowledge.
2. Schema consists of nodes and links that describe relationships between node pairs.
3. Schema is formed through generalities, not specific information.
4. Schemas are dynamic. As new information is learned, it is assimilated into existing schemas or causes the formation of new schemas.

5. Schema provides contexts for how new experiences are interpreted. How information is interpreted is based on existing schemas (Winn & Snider, 1996).

According to Dye (2000), the instructional graphic has its roots in schema theory. When students learn something new, they must be able to retain the information for later use. Our knowledge is stored in a scaffold hierarchy as a way of organizing information. According to Slavin (1991), people encode, store, and retrieve learned information based on this hierarchy.

Information that fits into a student's existing schema is more easily understood learned and retained than information that does not. The teacher's task is to ensure that the student has prior knowledge related to the concept and to provide a means for helping the students make connections between prior knowledge and new concepts. Instructional Graphic make it easier to link new information to existing knowledge and help students build the schema they need to understand new concepts (Guastello, Beasley, & Sinatra, 2000). If prior knowledge is activated, the schema will be able to provide a framework to which new information can be attached and learning and comprehension will be improved.

2.5.2 Dual Coding Theory

Paivio (1986) published a dual coding that assumes that memory consists of two separate but interrelated systems for processing information. One system is specialized in processing non-verbal imagery and the other is specialized in dealing with language. While each system can be activated independently, there are connections between the systems that allow for the dual coding of information. The visual system specializes in processing and storing images.

The processed and stored images are termed imagens (Paivio, 1986). The verbal system processes linguistic information. The resulting stored linguistic informations are termed logogens (Paivio, 1986). Paivio describes both imagens and logogens as meaningful units of memory similar to "chunks" described by Miller (1956). According to Saavedra (1999), dual coded information is easier to retrieve and retain because of the availability of two mental representations, verbal and visual, instead of one. The more students use both forms, the better they are able to think about and recall information (Marzano, Pickering, & Pollock, 2001).

The theoretical foundations of dual coding theory have definite implications on the value and use of instructional graphic. Marzano, Pickering & Pollock (2001), state that instructional graphic “enhance the development of non-linguistic representations in students and therefore, enhance the development of that content”. The use of instructional graphic also helps students generate linguistic representations. As a visual tool, instructional graphic help students process and remember content by facilitating the development of imagens. As a linguistic tool, text based instructional graphic also facilitate the development of logogens thereby dual coding the information.

2.5.3 Cognitive Load Theory

According to Adcock (2000), Cognitive load is the amount of mental resources necessary for information processing, Cognitive load theory maintains that working memory can deal with a limited amount of information and if its capacity is exceeded, the information is likely to be lost. According to Cooper (1998), working memory has a capacity of between four to ten elements depending on the student’s existing schemas. Extraneous cognitive load refers to how much demand is placed on working memory to learn the new material. The level of extraneous cognitive load may be modified through different modes of instruction, thus facilitating student learning. Visual learning tools such as instructional graphic can reduce the cognitive load and as a result, allow more of the working memory to attend to learning new material (Adcock, 2000). As a result, content can be addressed at more sophisticated and complex levels through the use of instructional graphic

2.6 Theoretical Basis of Science Education

The young child's understanding of science grows from the fundamental concepts they develop during early childhood. Much of our understanding about how and when this development takes place comes from research that is based on theories of concept development as put forth by Jean Piaget (DeVries and Kohlberg 1987/1990; Driver et al. 1985; Kamii & DeVries 1978). These theories gave rise to the constructivist approach, which places the emphasis on individual children as intellectual explorers who make their own discoveries and construct knowledge. Constructivism has important implications for science education, especially in today's classrooms, where students are encouraged to engage in the inquiry process rather than memorize isolated science facts. Constructivism is a theory of learning based on the idea that knowledge or concept is constructed by the learner based on mental activity (Piaget, 1964; Vygotsky 1978). Science Educators such as (Yager 1993; Okebukola, {2002}) observed that many of the instructional strategies proposed to improve science instructions are those using the constructivist view. In the most general sense, it usually means encouraging learners to use active technique to create more knowledge and then to reflect on what they are doing and how their understanding is changing in such a way that they will be able to construct their own ideas. In this sense, instructional graphics learning strategy among other teaching strategies such as problem solving, inquiry approach, science-technology-society instructional strategy fit into the constructivists' framework.

It was assumed that science concepts would be learned by being good observer of the natural phenomena. Science Teaching that used discovery method was activity – based.

It encourages students to develop an active approach to learning. This mode of science presentation is supported by the psychological theory of Piaget, (1964) and Ausubel, (1968). In Nigeria, the guided discovery method was adopted and emphasised for instruction at secondary schools through the 6 – 3 – 3 – 4 curriculum. The guided discovery method is also activity – oriented. In this method, students are guided by the materials provided by teachers. The teacher using this method guides the students to discover some concept. Bruner, (1961) proposed the use of discovery method in teaching of scientific concepts and its importance to practical activities in science.

The main advantage of this method is that it promotes the development of creativity in students which is the primary objective of science teaching. The current interest in the study of science concept learning owes much to the work of Novak (1977), whose study explores children's explanations for natural phenomena. Since this text was published, numerous studies related to a wide range of topics in the science curriculum have been reported, reviewed, and summarized by many researchers.

In science, teaching for conceptual change, or "teaching for understanding," requires different strategies from those previously employed by educators. Many science education researchers agree that the key is to provide a developmentally appropriate content that progressively increases in conceptual depth and complexity as children advance through school and life. The assessment of prior knowledge is thought to be essential to this process. Von Glasserfeld, Resnick, and others, cited in Bassey (2002) caution that, if we as educators do not take students' prior knowledge into consideration, it is likely that the message we think we are sending will not be the message that students receive.

2.6.1 Science Content and Cognitive Capacity

Although Piaget's (1969) developmental stages of learning are considered a major contribution to the teaching and learning of science, educators and curriculum developers do not always take these stages into account when designing science curriculum and experiences for young children. If children are to learn science and become scientifically literate, educators must choose appropriate science content and experiences to match children's cognitive capacities at different stages of their development. As Covington and Berry (1976) found, the results of mismatched content and cognitive capacity are often cause teachers to resort to telling the information in a didactic manner because the child cannot conceptualize the content. Cowan (1978) underscores the importance of this alignment, stressing that mismatching content and developmental levels (e.g., expecting kindergarten children to understand the movements of the Earth's crust) leads to misconceptions and frustrations for teacher, parent, and child. The effects of mismatches are that;

(1) Children are not able to extend, apply, or interpret deeper meanings of the content

(2) Interest and positive attitudes toward science are likely to diminish.

Many other examples in the literature also emphasize the match between science contents and cognitive capacity as essential to learning science. The implication from the research is that the content must always be within the realm of possibility of comprehension.

A prominent feature of cognitive research is the study of student misconceptions in science. These misconceptions are not merely errors in calculations or the misapplication of strategies. They are ideas that are based on misperceptions or incorrect generalizations that are consistent with the student's general understanding of a phenomenon. For example, misconceptions can be seen in children's ideas about light and shadows, which have been studied by Feher and Rice (1987). Young children think of a shadow as an object. They think that light is the agent that causes the object to form or that allows people to see the shadow, even when it is dark. This example clearly shows that misconceptions are a very real and significant obstacle to learning, one that educators must overcome before broaching new science concepts.

In considering all of the preschool and primary developmental stages described by Piaget, keep in mind that a child's view of the world and of scientific and mathematical concepts is not the same as yours. Their perception of phenomena is formed from their own perspective and experiences. Misconceptions will arise. So, be ready to explore the world to expand their thinking, and be prepared for the next developmental stage. Teach children to observe with all of their senses and to classify, predict, and communicate, so they can discover other viewpoints.

2.6.2 Developing and Acquiring Fundamental Scientific Concepts and Skills

One of the strongest themes in the *National Science Education Standards* (*NSES*) (National Research Council 1996) and *Benchmarks for Science Literacy* (*Benchmarks*) (American Association for the Advancement of Science 1993) is that, all children can learn science and that all children should have the opportunity to become scientifically literate. In order for this learning to happen, the effort to introduce children to the essential experiences of science inquiry and explorations must begin at an early age (Bredekamp, 1997).

A national consensus has evolved around what constitutes effective science teaching and learning for young children. More than ever before, educators agree that preschool-level and primary-level science is an active enterprise. Science is understood to be a process of finding out and a system for organizing and reporting discoveries. Rather than being viewed as the memorization of facts, science is seen as a way of thinking and trying to understand the world. This agreement can be seen in the national reform documents *NSES*, *Benchmarks*, and Science for All Americans (American Association for the Advancement of Science 1989.) Both *NSES* and *Benchmarks* are aligned with the guidelines from the National Association for the Education of Young Children (Bredekamp 1997; Bredekamp & Rosegrant 1992; Bredekamp & Copple 1997).

The reform documents mentioned in the previous paragraph espouse the idea that active, hands-on, conceptual learning provides meaningful and relevant learning experiences. These documents also reinforce Bredekamp (1997) observation that all students, especially those in underrepresented groups, need to learn scientific skills such as observation and analysis at a very young age.

As any scientist knows, the best way to learn science is to do science. This is the only way to get to the real business of asking questions, conducting investigations, collecting data, and looking for answers. With young children, this learning strategy can best be accomplished by examining natural phenomena that can be studied over time. Children need to have a chance to ask and answer questions, do investigations, and learn to apply problem-solving skills (Usman, 2002). Active, hands-on, student-centered inquiry is at the core of good science education

According to the National Research Council, cited in Bassey (2002), concepts are the building blocks of knowledge; they allow people to organize and categorize information. During early childhood, children actively engage in acquiring fundamental concepts and in learning fundamental process skills. As we watch children in their everyday activities at various stages of development, we can observe them constructing and using concepts such as;
One-to-one correspondence—putting pegs in pegboard holes or passing one apple to each child at the table;

Counting—counting the pennies from the penny bank or the number of straws needed for every child at the table;

Classifying—placing square shapes in one pile and round shapes in another or putting cars in one garage and trucks in another; and

Measuring—pouring sand, water, rice, or other materials from one container to another.

Young children begin to construct many concepts during the pre-primary period, including mathematics and science concepts. They also develop the processes that enable them to apply their newly acquired concepts, expand existing concepts, and develop new ones. As they enter the primary period (grades one through three), children apply their early, basic concepts when exploring more abstract inquiries and concepts in science. Using these concepts also helps them understand more complex concepts in mathematics such as multiplication, division, and the use of standard units of measurement (Charlesworth & Lind 1995).

Concepts used in science grow and develop as early as infancy. Babies explore the world with their senses. They look, touch, smell, hear, and taste. Children are born curious and want to know all about their environment. As children learn to crawl, to stand, and to walk, they are free to discover more on their own and learn to think for themselves. They begin to learn ideas of size: As they look about, they sense their relative smallness. They go over, under, and into large objects and discover the size of these objects relative to their own size. They grasp things and find that some fit their tiny hands, and others do not. Infants learn about *weight* when they cannot always lift items of the same size. They learn about *shape*: Some things stay put while others roll away. They learn *time sequence*: When they wake up, they feel wet and hungry. They cry. The caretaker comes. They are changed and then fed. Next, they play, get tired, and go to sleep. As babies' first look and then move, they discover *space*: Some spaces are big and some spaces are small. With time, babies develop *spatial sense*: (Charlesworth & Lind 1995).

Toddlers sort things. They put them in piles—of the same colour, the same size, the same shape or with the same use. Young children pour sand and water into containers of different sizes. They pile blocks into tall structures and see them fall and become small parts again. The free exploring and experimentation of a child's first two years help to develop muscle coordination and the senses of taste, smell, sight, and hearing—skills and senses that serve as a basis for future learning.

As children enter preschool and kindergarten, exploration continues to be the first step in dealing with new situations. At this time, however, children also begin to apply basic concepts to *collecting and organizing data* to answer a question. Collecting data requires skills in observation, counting, recording, and organizing.

Children acquire fundamental concepts through active involvement with their environment. As they explore their surroundings, they actively construct their own knowledge. Charlesworth and Lind (1995) characterize specific learning experiences with young children as *naturalistic* (or spontaneous), *informal*, or *structured*. These experiences differ in terms of who controls the activity: the adult or the child.

2.6.2.1 ***Naturalistic learning experiences*** are those in which the child controls choice and action .They are the experiences that are initiated spontaneously by children as they go about their daily activities Rieber, (1990a). These experiences are the major mode of learning for children during the sensor motor period. Naturalistic experiences can also be a valuable mode of learning for older children. With naturalistic experiences, the adult's role is to provide an interesting and rich environment for the child. That is adults should offer many things for the child to look at, touch, taste, smell, and hear. The adult should observe the child's activity, note how it is progressing, and then respond with a glance, a nod, a smile, or a word of praise to encourage the child. The child needs to know when he or she is doing the appropriate things.

2.6.2.2 ***Informal learning experiences*,** the child chooses the activity and action, but adults intervene at some point. The adult initiates informal learning experiences as the child is engaged in naturalistic experiences. These experiences are not pre-planned. They occur when the adult's experience or intuition or both indicate that it is time to act (Charlesworth & Lind 1995). For example, the child might be on the right track in solving a problem but needs a cue or encouragement. In another situation, the adult might take advantage of a teachable moment to reinforce certain concepts.

2.6.2.3 ***Structured learning experiences,*** the adult choose the experience for the child and give some direction to the child's action. Structured experiences are pre-planned lessons or activities that can occur in many different ways.

There is a natural integration of fundamental concepts and process skills across content areas, including mathematics and science. When fundamental mathematics concepts—comparing, classifying, and measuring—are applied to science problems, they are referred to as *process skills*. These mathematical concepts are necessary to solve some science problems. The other science process skills—observing, communicating, inferring, hypothesizing, and defining and controlling variables—are equally important for solving problems in both science and mathematics (Charlesworth & Lind 1995).

Math and science concepts and skills can be acquired as children engage in traditional early childhood activities such as playing with blocks, water, sand, and manipulative materials, as well as during dramatic play, cooking, and outdoor activities. Providing young children with opportunities to see the math and science in their everyday activities helps them to build the basic understandings and interest for future learning (Charlesworth & Lind 1995). However, keep in mind that there are variations in learning styles among groups of children and among different cultural groups. Thus, science content should be introduced when it is appropriate to do so.

2.7 Gender Differences and Academic Performance in Science

Kelley, Erickson and Erickson, Welch, Mullis & Jenkins in Dyel (2011), stated that, in science education there is the concern that girls are not achieving as they ought to. Jegede and Inyang (1990) reported that gender differences are more pronounced in the physical sciences. Dix (1981) and Coe and Crawley, (1990) reported lack of representation of females in the sciences and engineering professions. Researchers have focused attention on gender differences in educational choices, as well as investigated gender differences in performance (Eccles 1987). Many studies have reported small but consistent differences between the performance of male and females in science performance test (Samba, 1998).

In a meta-analysis carried out on 100 investigations into gender differences in mathematics performance for widely varying groups of pupils and school types, Samba, (1998) in Dyel (2011) found that men in general perform slightly better than women in mathematics. The issue of under representation of girls in mathematics and science has recorded a great deal of attention (Eccles, Goh & Nizele, 1986). A number of researchers have come up with reasons for gender related differences in science performance. Becker (1981) noted that teachers spoke more frequently to boys, asked the boys more questions, praise boys for quality work and girls for neatness. Sadker and Sadker (1985) revealed that male students received more praise and criticism from teachers than the female students. Ormerod (1975) suggested that the differences in the performance of male and female subjects could be related to interest in content area.

Bajah (1979) noted that boys were superior to girls in school performance and that children's sex types affect their performance in science. A number of research findings have come up with explanation for the differential participation of boys and girls in the science.

Eta (2000) observed that female participation both in science and education in general have been observed to decline drastically between primary and secondary levels. According to Lee and Lockhead, (1989), differential participation borders in the maturation of female and marriage which leads to removal of girls from school. Sex related differences according to Samba (1998) therefore could be related to three areas, namely social, educational and personal.

Social factors include sex role model, sex role orientation and stereotyping.
Educational and personal factors include parents, teacher-peer expectation decision and extracurricular activities.

Maccoby and Jacklin (1974) explained that sex differences are not evident until age 12-13 but thereafter boys' mathematical skills increase faster than girls. Even though most researchers have reported gender differences in science performance there are few conflicting reports. Erickson and Erickson (1984) found no significant difference in science performance of boys and girls. Ajewole (1990) in his study on guided discovery and expository instructional methods effect on students' transfer of learning found no significant difference in the transfer of learning between male and female students exposed to guided discovery and expository method. Similarly, Samba, (1998) in a study on conceptual change instructional strategy in the teaching of biology found that the strategy appeared to be gender-friendly. Boys out performed girls in performance test, but the differences in performance were not much. What then could be the case of gender related issue in Basic Science when

Instructional graphics with text strategy is used to teach junior secondary school students?

2.8 Attitude and Academic Performance in Science

Attitude plays a major role in students learning (Ajewole 1990). Studies (including

Simpson; Wilson; Soyibo, in Dyel (2011) reported that, student's positive attitude to science correlate highly with their science performance. He maintained that Attitude was found to have a direct effect on science performance among American high school students. In Nigeria, Balogun (1975), reported that, in general, the attitude of Nigeria students towards the basic sciences tend to decrease in the order of Biology, Chemistry, Physic and mathematic. Oyedokun (1998) ascertain that attitude to science generally account for between 20% to 25% variations in the academic performance in science. Although students differ in degree in their attitudes towards different subject taught in the school curriculum, a person generally perform better in any discipline to which favourably he/she is disposed.

Defiana (1995) found that using Basic Science environment activity improved high school students' attitude towards awareness about the environment. Aiyelaegbe, (1998) also reported a more positive attitude of students after exposing them to self learning strategy. Similar results were obtained by Udousoro (2002) and Popoola (2002) when students were exposed to computer and text assisted programmed instruction.

Studies on instructional learning strategy have been shown to imbibe in the students' positive attitude towards the course. From the work of Sharan, Johnson & Johnson, Olumide, Okebukola & Odunbunmi, in Dyle (2011), students using instructional learning strategy have been known to display a positive attitude towards the course, just like they also show a favourable attitude towards the cooperative learning experience. According to Dyle (2011), Burron, James & Ambrosio in their study on effects of cooperative learning in a physical science course on the attitude of students concluded that positive attitude towards science did increase among the students. When students were requested to state their preference between demonstration (e.g. employing instructional graphics in teaching and learning) and competitive strategies for schools, they expressed a strong preference for demonstration learning strategy (Dyle (2011),). For example 65% of the students studied showed preference for demonstration over competition while in the science class, 90% of the students perceived demonstration strategy as against the competition group. In this study therefore, the researcher sought to explore the attitudinal changes that might be elicited to the students when exposed to activity based learning strategies with the aid of instructional graphics.

2.9 Science Teaching Methods

There are different science teaching methods but before the 1950s' the teaching of science was undertaken mainly as passive transmission of ideas to the learners. This view was called "bank view of learning" (Freire, 1985). According to Watson & Kopnicek, (as cited in Dyel (2011), the text and curricula of the 1950s did not allow for inquiry. Teaching of science was done as text book oriented. Today, the methods that teachers of science employ in the classroom to present scientific facts, information, principle, skill or concept to the students are many. Some are more frequently used than others. However, the methods that are frequently used as stated by Abdullahi, (as contained in Dyel (2011) include: -

- Discovery or Inquiry Method
- Demonstration Method
- Discussion Method
- Project Method
- Laboratory/Investigation Method
- Individualized Learning Method
- Lecture or Talk and Chalk Method

2.9.1 Discovery or Inquiry Method

With the launching of Sputnik I in 1957 by the Russians, there was a shift from transmission of information, which resulted in passive learning, to an active learning culture, which emphasized students “active participation in learning. This led to “discovery” teaching methods. It was assumed that science concepts would be learned by being good observers of the natural phenomena. Science Teaching that used discovery method was activity – based.

It encourages students to develop an active approach to learning. This mode of science presentation is supported by the psychological theory of Piaget, and Ausubel, (as cited in Dyel (2011).

In Nigeria, the guided discovery method was adopted and emphasised for instruction in secondary schools through the 6 – 3 – 3 – 4 curriculum. The guided discovery method is also activity – oriented. In this method, students are guided by the materials provided by teachers. The teacher using this method guides the students to discover some concept.

Dyel (2011) reported that Bruner, proposed the use of discovery method in teaching of scientific concepts and its importance to practical activities in science. The main advantage of this method is that it promotes the development of creativity in students which is the primary objective of science teaching.

The major drawback of the method is that it can become frustrating for both teachers and students because the students may not be discovering anything or may be discovery things outside the concept. It is equally capital-intensive, real equipment and materials will be required. Jegede (1987) reported that very little was achieved since the introduction of guided discovery in Nigeria. Ezenwa (1993) reported that guided discovery in Nigeria has not brought about identifiable significant changes in the teaching and learning of science. Soyibo (1991) observed that because the guided discovery method is not handled satisfactorily, it led to poor performance of students in senior secondary school examination. Students performance may be improved with appropriate teaching strategy hence an attempt to determine the effectiveness of instructional graphics learning strategy.

2.9.2 Demonstration Method

Another science teaching method is the demonstration. Demonstration method simply means to display something (Dyel, 2011). It involves the introduction of new skills or ability to learn better way of doing something; usually it is accompanied with a lot of explanation and showing how something works or is done. It is employed in finding facts; identifying problem and displaying materials. Under demonstration, a range of activities can be planned starting from showing the correct use of science apparatus, illustrating a technique to planning a manipulation equipment and material in order for pupils to observe a scientific phenomenon. Unfortunately, demonstrations are usually dominated by the teacher who is performing a predetermined routine designed to lead to a highly predictable result.

Shuaibu, (1979) stated that this method is often used by science teachers to make abstract concepts concrete. It is a 'one-man-show' as the teacher attempts to demonstrate and explain by example, a procedure or the expected outcome of an experiment.

The main advantage of this method is that it is considered to be a good way of motivating students to learn and believe to save time. Its bulk of disadvantage is that it does not allow pupils to develop manipulative skills, difficult for all pupils to see details of the demonstration or apparatus; pupils are not given enough time to become familiar with equipment and materials. It is however, felt that its effectiveness at making pupils learns to discover is questionable. Sorunke (1982) expatriating on the superiority of laboratory work over giving a demonstration, reported that laboratory method produces positive attitude towards science in students than demonstration and that demonstration should be less emphasized during instruction. In this study, teaching method that will allow for the active involvement of the students in teaching/learning process is what the study sought to find out to enhance academic performance.

2.9.3 Discussion Method

Discussion method is also a science teaching method. This method is mainly verbal as distinct from the other methods previously discussed. According to Abdullahi (1982b) it simply means talking over subjects from various points of view, with the teacher acting as the moderator. The main advantage of this method is that it builds up self confidence in students through frequent exchange of idea between each other and the teacher.

It bulk of disadvantage is that, a lot of time is consumed attending to every view and many questions, some of which are not relevant; it will not allow for coverage of syllabus and except handle carefully, the tendency is to leave behind slow and below average students leading to boredom and frustration.

2.9.4 Project Method

Project method is used mainly to individualize instruction. It aims at providing for the need of individual pupils or small groups or pupils with special abilities. This method requires some originality (Okebukola, 1992). While students are given the free hand to search for problems which interest them and find solutions to such problems, topics for the project are usually obtained from the teacher.

2.9.5 Laboratory/Investigation method

Another science teaching method is the laboratory/investigation method. This is an activity carried out by one or more persons through the exercise and experimental approaches. The laboratory exercises are activities carried out in order to provide, designing, operating and interpreting experiments. According to Collette, in Dyel (2011) all laboratory exercises are experiments but not all experiments can be regarded as laboratory work.

The main advantages are it affords students opportunity to develop manipulative skills; enhance the ability of students to transfer skills to solve other problems and gives students opportunities to gain exposure to facts of scientific phenomena which aid retention of information. The main problem with this method is the provision of adequate equipments/apparatus hence, some are expensive.

2.9.6 Individualized Learning Method

Individualized learning method is another science teaching method that could be a desirable method. Bruner (1966), arguing in favour of this method, stated that learning is an individual thing, no matter how many students there are to a teacher considering the type of educational system which we operate, this method is hardly realizable. Lagendijk (1980) reported some finding using individualized system of instruction through use of objective, learning materials, mastery learning, self – spacing, tutors and frequent tests. He found that there was a significant difference in performance between students in the personalized system of instruction and those in the conventional laboratory course. The problem today is that individual difference is hardly taken into consideration in our classroom.

According to Okebukola (1992) of all the science teaching method mentioned, the teaching method employed by science teachers to teach science in Nigeria mostly was the direct expository or lecture methods which impede performance.

2.9.7 The Lecture or Talk and Chalk Method

Lecture method traditionally referred to as “didactic approach” is a method of teaching that is teacher – centred, characterized by the teacher talking to the class most of the time while the students listen, take down note and occasionally ask questions. According to Dienye & Gbamanja, in this method, the teacher present spoken discourses on a particular subject (Dyle {2011}). In this method, the students’ roles are relegated to that of passive learners (Tawari, 1986). In passive learning students often sit quietly copying notes from the chalkboard or listening passively to a teacher telling, reading or demonstrating using science apparatus.

Students' minds are seen as empty reservoirs into which knowledge could be stored indiscriminately. The consequence of this is that students are encouraged to memorize scientific fact, principles and concepts leading to rote learning. Dyle (2011), reported that Joju recognized learning by rote as one of the factors militating against effective science learning in Nigeria. He further maintained that Mba & Abdullahi have attributed the low percentage passes in science to the use of the traditional teaching method. In this method, the emphasis is on the content.

Learning to students is seen principally for testing and retention is short-lived. Process skills are seen by students as skills scientist posses which are course requirements. This viewpoint affects the attitude of students in that it results in decline in interest and decrease in curiosity. Consequently, this leads to decline in students' ability to question phenomena which are not understood by them. It also results in students finding it difficult to see value in the science they learn as applicable to living. This is so even though they are able to recite and master the information/concept studied (Yager, 1993; Okebukola, 1992). This teaching method is also authoritarian in nature. Science concepts are taught as theories while teaching method that encourage pupil centered learning for developing reasoning skills and process through scientific approach are lacking.

Balogun, (1982) conducted a study on science teaching effectiveness in Nigeria. He found that many Nigerian teachers with up-to-date science programme continue to lecture. He concluded that one probable reason why many teachers avoid the newer approaches for the more individual method could be because they prefer to take the line of least resistance.

Olorukooba (1992) carried out a survey of different methods of teaching science in some selected secondary schools in Zaria and environs. The outcome of the survey showed that the most frequently used method of teaching by science teachers was traditional lecture method.

The main advantage of this method is its economical mode of instruction in which the teacher/lecturer presents in impersonalized, continuous and systematic manner, a large body of knowledge to his audience. It also facilitates early completion of the curriculum by the teacher. It is less expensive and it can accommodate a great number of students in a class at a time.

Despite these advantages, one major problem with the traditional method of teaching science is that it does not allow for students active participation in teaching and learning process meant to promote meaningful learning of science. As a result of this, students have to memorize what they are taught which leads to low retention of the science concepts learn.

Soyibo (1991) observed that because these previously described teaching methods are not satisfactory, more especially when used in large classes, science educators now, advocate for instructional strategies that enhance effective academic performance in relation to improving students' attitude and retention towards science despite their class-sizes. The instructional strategies proposed to improve science instruction are those that take into cognizance the students' active participation in the teaching/learning process. The role of students' personal experience in their construction of knowledge has been largely neglected in the previous learning methods. There is therefore the need to have shift from teaching which is teacher centered to students centered strategy which recognize the role of personal participation in the development of scientific knowledge. It is to this end that this study is being conducted to expose students to interactive mode of teaching and learning that is instructional graphics learning strategy which may probably bring about increase in students' participation and meaningful learning. Specifically, an attempt is made in this study to use both the lecture method and the instructional graphics learning strategy on different groups of students and compare the effects of the two teaching strategies on student's academic performance and attitude towards Basic Science instructions.

2.10 Empirical Support for Instructional Graphics

Since the late 1970s, many reviews of instructional visual research have been published that point to positive effects of pictures on learning. One of the earliest was a review by Levin and Lesgold (1978), which described "abundant empirical evidence to document the positive value of pictures". They reported that consistent learning gains were to be expected by the addition of pictures.

One example of the supportive research cited by Levin and Lesgold (1978) is a study by Guttmann, Levin, and Pressley. In their study, children correctly responded to about 80% of the short-answer questions when pictures accompanied oral narratives, whereas children in a no-picture condition only answered about 57% correctly.

Research and classroom practice, however, has shown that instructional graphic are equally useful as assimilation or follow-up activities (Dishner, Bean, & Readence; Simmons, Griffin & Kameenui, in Ellis (2001).

Other research, although supporting the claim that children depend less on outside images as they grow older, demonstrated that pictures can decrease the difficulty of prose material for older children. Levin & Divine-Hawkins as contained in Ellis (2001) demonstrated that fourth-grade children do not automatically construct images, although they are capable of doing so.

Ellis (2001) identifies three benefits of using instructional graphic. First, instructional graphics make content easier to understand and learn. Second, instructional graphic also help students separate important information from what might be interesting but not essential information. Thirdly, instructional graphic decrease the necessary semantic information processing skills required to learn the material. By making the organization of content information easier to understand, instructional graphic allow material to be addressed at more sophisticated levels. Finally, students who use instructional graphic may become more strategic learners. An individual’s approach to a task is called a strategy (Bulgren & Lenz, in Ellis , (2001). Strategies include how a person thinks and acts when planning, executing, and evaluating a task and its subsequent outcomes (Usman, (2002). When the organization of a topic becomes apparent, reading and writing skill, communication skills, analytical skills as well as creative skills are subject to improve with the use of instructional graphic (Ellis, 2002).

The use of instructional graphic has been shown to develop students’ thinking and learning skills in a variety of content areas (Pruitt, 1993).

Analogical pictures offer potential to help people understand abstract concepts (Tennyson & Park, 1980). Analogies that are visually based seem to facilitate learning by helping to make abstract information more concrete and salient (Mayer, 1989).

There are many stories of famous philosophers and scientists arriving at ingenious solutions to a problem by having the solution come to them in a vision. Einstein is said to have thought of the theory of relativity by imagining what it would be like to ride on a beam of light (Burke, 1985).

There is little research to suggest that pictures necessarily promote stronger emotional feelings than words in the long-term, there is convincing evidence that pictures offer much more emotional impact in the short-term. One might refer to this as "shock value," and research suggests that pictures can arouse strong feelings in less than a second (Cupchik & Berlyne, as cited in Usman, (2002).

Dwyer (1972) has noted that "aesthetically pleasing visuals may be deceptive in their instructional value" (p. 90). Again, this serves as an important reminder from previous discussions that graphics can serve different functions, such as affective or cognitive. It is important that the intent of the graphics be defined. There is nothing wrong with adding visuals simply for aesthetic appeal, so long as these graphics do not undermine other instructional goals, such as those in the cognitive domain.

2.11 Summary

The review of related literature shows that the terms **graphic**, **image**, **visual**, and **picture** greatly overlap and are often used synonymously. Graphics are of three types which are classified as representational, analogical, and arbitrary and hence serve cosmetic, motivation, attention-gaining, presentation, and practice functions. It further explores the fact that our students have different ways of learning such as visual learners, auditory, kinaesthetic or tactile.

It was also reported that, student's positive attitude to science education correlate highly with their science performance. Children should therefore be taught to observe with all of their senses and to classify, predict, and communicate, so they can discover other viewpoints. Despite theorists' differences concerning the manner in which students acquire knowledge, instructional graphic can be utilized to foster learning no matter the learning style preferred by the student. This study does not advocate or oppose the use of graphics. Instead, it supports the position that graphics, like most strategies and techniques, have their place in instruction.

The problem is understanding when and how to design effective graphics, as well as when to avoid them altogether.

Eta (2000) observed that female participation both in science and education in general have been observed to decline drastically between primary and secondary levels. According to Lee and Lockhead, (1989), differential participation borders in the maturation of female and marriage which leads to removal of girls from school. Sex related differences according to Samba (1998) therefore could be related to three areas, namely social, educational and personal.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The description of the methodology that was employed for the study is presented under the following subheadings:

- Research Design
- Population of the study
- Sample and Sampling Technique
- Topics Selected for the Study
- Instrumentation
- Pilot Testing
- Procedure for Data Collection
- Procedure for Data Analysis

3.2 Research Design

The design for this study is quasi experimental involving pre-test and Post-test control type (Dyel 2011). The design of the study is represented as follows;

$$E \Longrightarrow O_1{}^P{}_A \Longrightarrow X_1 \Longrightarrow O_2{}^P{}_A$$

$$C \Longrightarrow O_1{}^P \Longrightarrow X_0 \Longrightarrow O_2{}^P$$

Where:

E = Experiment group (Exposure to Instructional Graphics during Instruction)

C = Control group (Exposure to Lecture Method)

O_1 = Pre-test

O_2 = Post-test

Xo = Control

X1 = Treatment

A = Attitude

P = Performance

Figure 3.1: Research Design Illustration

3.3 Population of the Study

The Population for the study comprises of all the 25 Junior Secondary Schools Students (JSSS) in Dutsin-ma Zonal Inspectorate of Education Katsina State of Nigeria that study Basic Science during the 2012/2013 academic year. Current records show that there are 15,145 JSS in this Educational Zone. Students' enrolments and their distributions in each of the JSS in D/ma ZIE up to February, 2013, are depicted in table 3.1.

Table 3.1: Total Enrolment of Students of all JSS under D/ma ZIE

S/NO	Names of Schools	Students
1.	Government Day Junior Secondary School, Tamawa	345
2.	Govt. Pilot Junior Secondary school, D/ma	1025
3.	Govt. Day Junior Secondary School, D/ma	770
4.	Govt. Pilot Junior Secondary School, Safana	800
5.	Govt. Day Junior Secondary School, Makera	554
6.	Govt. Day Junior Secondary School, Gora II	455
7.	Govt. Day Junior Secondary School, Mara	350
8.	Govt. Day Junior Secondary School, Marina	180
9.	Govt. Day Junior Secondary School, Ruma	753
10.	Govt. Day Junior Secondary School, Batsari	1270
11.	Govt. Day Junior Secondary School, Bagagadi	209
12.	Govt. Day Junior Secondary School, Karofi	785
13.	Govt. Day Junior Secondary School, Yantumaki	678
14.	Govt. Day Junior Secondary School, Babban Duhu	140
15.	Govt. Day Junior Secondary School, Zakka	362
16.	Govt. Day Junior Secondary School, Dan'ali	372
17.	Govt. Day Junior Secondary School, Rawayau	180
18.	Govt. Day Junior Secondary School, Yanruma	678
19.	Govt. Day Junior Secondary School, Wurma	372
20.	Govt. Day Junior Secondary School, Birchi	523
21.	Govt. Day Junior Secondary School, Dabawa	200
22	Govt. Day Junior Secondary School, Danmusa	1225
22.	Govt. Girls Junior Secondary School, Dutsin-ma	1079
23.	Govt. Day Junior Secondary School, Kurfi	1113
24.	Govt. Day Junior Secondary School, Tsauri	490
25.	Govt. Day Junior Secondary School, Kuki	237
	TOTAL	**15,145**

Source: D/ma ZIE, Katsina State Ministry of Education Nigeria (February, 2013)

3.4 Sample and Sampling Technique

This study adopted a simple random sampling technique using balloting method involving picking out ‘YES’ or ‘NO’ from a bucket to select the two samples schools. Two ‘YES’ and twenty three ‘NO’ were written on separate pieces of paper which were then folded and dropped into a bucket. Each of the twenty five schools in D/ma ZIE was assigned with a representative from members of staff of the Zone. All the representatives were asked to pick out one of the folded paper from the bucket one after the other. The school’s representative who picked out ‘YES’, the name of the school he represents was recorded among the sample schools. On the other hand, the school’s representative that picked out ‘NO’, the school he represented was not included in the sample schools. This process continues until the two required sample schools were obtained.

The subjects for the study were selected by the use of stratified random sampling because of the gender effect. This was done by first grouping the students into two different strata, i.e. males and females. Simple random sampling involving picking ‘YES’ or ‘NO’ with replacement, from a bucket was then used in selecting 30 males and 30 females students from each of the sampled schools. The number of the subjects was selected based on Gay (1987) who states that for causal-comparative studies and many of the experimental studies, a minimum of 30 subjects per group is generally recommended.

According to Kerlinger, in Usman, (2000), simple random sampling was adopted because of its capacity to reduce the chance of sampling error, and the subjects within the population would be equally represented. Shuaibu; Abah; as cited in Usman, {2000}), observed that simple random sampling techniques ensure that differences in subjects, such as level of intelligence, social background and sex, among others, are evenly distributed. In addition, the proportional representation of the students in terms of gender disparity is essential in testing hypotheses of section 1.5 in chapter 1.

Table 3.2: Sample Size for the Study

School		Sample based on sex		
Designation	Grouping	Male	Female	**Total**
A	Exp. Group	30	30	**60**
B	Control Group	30	30	**60**
	Total	**60**	**60**	**120**

3.5 Topics Selected for the Study

Basic Science for Junior Secondary Schools 2 (UBE Edition, 2008) was carefully studied. Relevant topics were selected from the book for the purpose of teaching and learning and as a guide for the design of instruments for data collection. Based on these, the topics that were found to be more relevant are shown in Table 3.3

Table 3.3: Topics Selected for the Study

Chapter	Topics	Page
15	Human Reproductive System	71 - 76
24	Kinetic Energy	109 - 111

These topics were selected for the following reasons: -

1. The topics form a good representation of the major areas of Basic Science, i.e. Physics, Chemistry and Biology.
2. These topics contain several illustrations that could be taught with the aid of instructional graphics.

Thus, it is assumed that any significant difference in academic performance and attitude between the experimental and control groups can be attributed to the effect of the treatment administered

3.6 Instrumentation;

Four instruments were used for data collection. These are;

1. Basic Science Performance Test (BSPT)

2. Students' Attitude to Instructional Graphics Strategy Questionnaire (SAIGSQ).

3. Instructional Graphics Learning Package (IGLP)

4. Lecture Method Learning Group (IGLG)

3.6.1 Basic Science Performance Test (BSPT)

The Basic Science Performance Test items was constructed from the past JSCE questions papers of five years (2008-2012) that are within the syllabus of JSS II), and some revision questions from Basic Science for Junior Secondary Schools 2 (UBE Edition, 2008) (see Appendix A).

A total of 20 test items were constructed based on the objectives of Human Reproductive System and Kinetic Energy instructions. The test instrument covered all the topics that were treated for this study.

The answer sheet and marking scheme for the twenty test items were constructed as shown in Appendix B and C respectively). In ascertaining the reliability of this instrument, it was pilot tested at and the r value obtained is, 0.85. Specification of the test items, that reflect the six (6) cognitive levels of Blooms (1968) Taxonomy for cognitive domains, is presented in table 3.4.

Table 3.4: Test Blue Print for the (BSPT) based on Bloom's Taxonomy of Cognitive Domains.

S/N	Content	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation
1.	Human Rep. System	1, 3, 4, 7, 12, 13, 14, 16, 17	9, 10	18	5	2, 15	___
2.	Kinetic Energy	6, 8	11	20	___	___	19

3.6.2.1 Validation of Basic Science Performance Test (BSPT*)*

The face and content validity of the Basic Science Performance Test was done by a panel of:

(a) Two Sciences Examiners/Educators from Education Resource Centre (ERC), Katsina State.

(b) Three staff from Department of Educational Foundations and Curriculum Faculty of Education Ahmadu Bello University, Zaria. The panel estimate of the validity of the BSPT is 0.78.

3.6.2.2 Reliability Coefficient of Basic Science Performance Test (BSPT)

To obtain the reliability coefficient of the (BSPT), a test-retest method was adopted using sample size of 60 subjects (30 males and 30 females). By using Pearson Product

Moment Coefficient (PPMC), the reliability coefficient for the test was 0.83. The reliability coefficient of a test is the consistency with which the test repeatedly measures what it is intended to measure (Thorndike, (1977).

3.6.3 Students' Attitude to Instructional Graphics Strategy Questionnaire

SAIGSQ was constructed by the researcher to assess the students' change in attitude towards the instructional graphic learning strategy. This instrument was administered to the experimental group before and after the instructions.

In constructing the instrument, the researcher used the adapted Likert scale by removing the undecided response from the option items on the scale. Babatunde, (as cited in Olorukooba (2001) stated that the "undecided" was removed from the option on the scale because it did not have any relevance during computing the data generated from the instrument. The only options are on the items of the scale are:- "Strongly Agree" (SA=5), "Agree" (A=4), "Disagree" (D=2), "Strongly Disagree" (SD=1). (see Appendix D).

3.6.3.1 Validation of Students' Attitude to Instructional Graphics Strategy Questionnaire (SAIGSQ)

Face and content validity of the instrument was established by,

(a) Two Sciences Examiners/Educators from Katsina State, Education Resource Centre (ERC).

(b) Three staff from Department of Educational Foundations and Curriculum Faculty of Education Ahmadu Bello University, Zaria. The panel estimate of the validity of the BSPT is 0.78.

3.6.3.2 Reliability Coefficient of Students' Attitude to Instructional Graphics Learning Strategy Questionnaire (SAIGSQ)

The pre-test scores on Students' Attitude to Instructional Graphics Learning Strategy questionnaire (SAIGLSQ) was analyzed using Guttmann Split-half method. K. Richardson Correlation Coefficient statistics of r-value was found to be 0.79, which shows that the instrument is reliable and can be used for the study.

3.6.4 Instructional Graphics Learning Package (IGLP)

The Instructional Graphics Learning Package was developed by the researcher in the process of Basic Science Instruction that was undertaken in this study. The models consists of unlabeled but numbered human reproductive system, puberty and secondary sexual characters, and structure of solids, liquids and gases (see Appendix E).

3.6.4.1 Validation of Instructional Graphics Learning Package (IGLP)

Face and content validity of the instrument was established by,

(a) Two Science Examiners/Educators from Education Resource Centre (ERC), Katsina State.

(b) Three staff from Department of Educational Foundations and Curriculum Faculty of Education Ahmadu Bello University, Zaria. The panel estimate of the validity of the BSPT is 0.72.

3.6.4.2 Reliability Coefficient of Instructional Graphics Learning Package (IGLP)

In this study, the test-retest reliability co-efficient was used. By using Pearson Product Moment Coefficient (PPMC) formula, the reliability coefficient obtained from the pilot testing of the (IGLP), is 0.77.

3.7 Development and Validation of Instructional Graphics Learning Package (IGLP)

The researcher developed an IGLP which contains the entire instructional process and some activities on “Human Reproductive System” and “Kinetic Energy”, during the study. Most of the activities required the aid of instructional graphics for easy and clear understanding of the content. Examples include:-

Activity 1: Identifying the male reproductive system.

Activity 2: Identifying structure of particles of different state of matter particles.

The behavioural objectives and students activities were developed with reference to the Basic Science Text Book for Junior Secondary Schools 2 (UBE Edition, 2008) (see Appendix F). The face and content validities of the IGLP were undertaken by, two senior Science

Educators from D/ma Zonal Inspectorate of Education, Katsina State and three Basic Science Secondary School teachers with a minimum qualification of first degree and minimum of 5 years teaching experience.

3.8 Pre-Test

A pre-test on BSPT was conducted in the two sample schools namely; Government Pilot Junior Secondary School Safana and Government Pilot Junior Secondary School Dutsin-ma. One hundred and twenty Junior Secondary School (JSS) II students consisting mixed sexes, different ability level, varied socio-cultural background studying Basic Science, were used. The test was administered to both the experimental and the control groups to determine the comparable entry ability of the sampled schools. The BSPT instruments consists of twenty multiple choice test items. Instruction on how to answer the questions were read and explained to the students by the researcher. This was done to ensure that the students attempted the questions carefully.

Based on the t-test analysis on the pre-test scores of the Basic Science Performance Test

(BSPT), there was no significant difference at $P \leq 0.05$, in the ability level of the sample schools.

3.8.1 Training of Research Assistants

Before the commencement of the lessons, the researcher trained two Basic Science Teachers as the research assistants, on how to make proper use of relevant instructional materials in teaching and learning process. Similarly, they were briefed on the types of activities that were expected from the students during the instruction. These included:

1. Encouraging the students to participate actively in activities and discussion
2. Urge the students to be attentive and observe any details that may be graphically displayed during the lessons.
3. Students in the experimental group were encouraged to form mental imagery.

Each of the research assistants was selected from and assigned to his respective school under the supervision of the researcher. This was aimed at reducing teacher effect variables since the students were familiar to their teachers.

3.8.2 Procedure for data collection

A pre-test on BSPT was administered to both the experimental and the control group before the commencement of the lessons. This was aimed at determining their comparable entry ability and testing the hypothesis accordingly.

The BSPT instrument contains 20 multiple choice test items, and each of the test item have four response options. Subjects were provided with answer sheets and pencils and instructed to shade only the correct alternatives on the answer sheet.

At the expiration of the 40 minutes which was allocated for answering the test, the answer scripts were collected, marked and scored using a marking scheme which was developed by the researcher. Each correct response attracts one mark. This makes a total marks for the total correct responses of the 20 test items.

Pre-tests on SAIGLSQ instrument was administered to the experimental group. The SAIGLSQ consist of 20 questions, four alternative responses and the subjects were instructed to choose the best alternatives that describe their feelings about Basic Science instruction.

The experimental group was appraised on the kinds of activities they would be exposed to and what was expected of them in the course of the lessons. Some of these activities include:

(i) Change of state of matter

(ii) Identification of human reproductive organs etc.

The instructional method for the experimental group was based on the application of Instructional graphics developed by the researcher as shown in appendix E.

A total of 60 subjects of different heterogeneous academic ability level were assigned to the experimental group. The group comprised 30 boys and 30 girls to allow for better interaction among the students within the group. The Instructional Graphics Learning Package (IGLP) containing detailed explanation of the instructional process, behavioural objectives and activities that helped in enhancing the academic performance of the subjects was provided to the research assistant. This served as a guide to the research assistant throughout the instructional delivery.

Equally, 60 subjects of different heterogeneous academic ability level were assigned to the control group. The group comprised 30 boys and 30 girls to allow for better interaction among the students within the group. The research assistant in the control group was provided with a Lecture Method Learning Package Learning Package (LMLG) (see appendix H). The research assistant delivered his lessons by the traditional lecture method which is of course, a teacher-centered method. Verbal presentations and notes giving strategy were adopted during each of the instructional delivery. Any relevant information that would enhance the academic performance of the subjects, were written down on the chalkboard and the students were instructed to copy in their note books. Assignments were also given to the students after each lesson.

Post-tests were administered by the researcher after the treatment. The subjects in both the experimental and control group attempted the post-test on the BSPT but, only the experimental group wrote on the SAIGLSQ.

3.8.3 Procedure for data analysis

The data collected for this study were used to test the hypotheses stated in section 1.5 of 'Chapter One'. T-test tools were used to analyse the data and the level of significance for rejection or retention of the stated hypotheses was set at $P \leq 0.05$.

CHAPTER FOUR

DATA PRESENTATION AND ANALYSIS

4.1 Introduction

This chapter presents the statistical analysis of the data collected based on the research questions and hypothesis. The chapter is presented under the following subheadings:

- Data Analysis and Result Presentation
- Summary of Findings
- Discussion

4.2 Data Analysis and Result Presentation

The data collected for this study were used to analyze the hypotheses stated in chapter one Section 1.5. Each hypothesis was analysed as follows:

4.2.1 Hypotheses Testing

Hypothesis 1

Ho_1**:** There is no significant difference between the academic performance of Basic Science students who were exposed to instructional graphic learning strategy and their counterparts exposed to the lecture method.

To test this hypothesis, the post-test scores of the subjects on BSPT of the experimental and control group were collated. These were then analyzed using t-test statistical technique to find out if there is any significant differences in the mean scores at $P \leq 0.05$. The result is presented in Table 4.1.

Table 4.1: t-test Analysis of Mean Scores on BSPT of the Experimental and Control Group after the Instruction

Variable	N	$\bar{X}$	SD	SE	t-value	df	p	Remark
Experimental	60	13.7300	3.3707	0.7262	4.0467	118	0.001	*Significant
Control	60	9.6833	4.5037					

* Significant at $P \leq 0.05$

As can be deduced from table 4.1, the experimental group had mean score ($\bar{X} = 13.73$, SD =3.37 or 13.73 +3.37) than the control group ($\bar{X}$ = 9.68, SD =4.51 or 9.63 ± 4.51). The t-test statistics revealed significant different, t (118) = 4.05, p<0.05j. Therefore the null hypothesis which stated that there is no significance difference between the academic performance of Basic Science students who were exposed to instructional graphic learning strategy and their counterparts exposed to the lecture method is rejected.

Hypothesis 2

$Ho_{2:}$ There is no significant difference in the academic performance on Basic Science of male and female Basic Science students exposed to instructional graphic learning strategy.

To test this hypothesis, the post-test scores on BSPT of the male and the female subjects in the experimental group were compared accordingly. The mean scores of the subjects were tested using t-test statistics. The results are presented in Table 4.2.

Table 4.2: t-test Analysis of Mean Scores on BSPT of Male and Female Students of the experimental group

Variable	N	$\bar{X}$	SD	SE	t-value	df	p-value	Remark
Male	30	13.87	3.27					
				0.8885	0.3039	58	0.661	Not significant
Female	30	13.60	3.63					

Not significant at P≤ 0.05

From table 4.2, the experimental group had mean score ($\bar{X}$ =13.83, SD =3.27 or 13.83 +3.27) than the control group ($\bar{X}$ = 13.60, SD =3.63 or 13. 60 + 3.63). The t-test statistics revealed no significant different, t (58) = 3.63, p<0.05j. The null hypothesis which stated that, there is no significance difference between the academic performances of male and female Basic

Science Students when exposed to instructional graphic learning strategy is retained. Therefore, instructional graphics learning strategy is gender-friendly.

Hypothesis 3

$H_{O3:}$ There is no significant relationship in the attitude of Basic Science students before and after exposure to instructional graphics learning strategy.

To test this hypothesis, the scores on the response of Students' Attitude to Instructional Graphics Learning Strategy Questionnaire (SAIGLSQ) of the experimental group before and after the instruction was analyzed using t-test Statistical tool. The results are presented in Table 4.3.

Table 4.3: t-test Analysis on mean scores of Students' Attitude to Basic Science before and after exposure to Instructional Graphics Learning Strategy

Variable	N	$\overline{X}$	SD	SE	t-value	p-value	Remark
Before	60	31.12	5.023				
				0.508	6112.0	0.0013	*Significant
After	60	70.10	3.312				

*Significant at $P \leq 0.05$

As can be concluded from table 4.3, the experimental group had mean score ($\overline{X}$ =31.12, SD =5.02 or 31.12 +5.02) before the instruction and, mean score of ($\overline{X}$ = 70.10, SD =3.31 or 70.10 + 3.31) after the instruction. This indicated that there was a significant difference in the attitudinal change of the subjects after exposure to instructional graphics learning strategy. This implies that the teaching strategy had a positive effect on the attitude of the subjects. Thus, the null hypothesis which stated there is no significant difference is rejected.

Hypothesis 4

$H_{O4;}$ There is no significant difference between the attitude of male and male students towards Basic Science when Instructional Graphics are used in Basic Science Instruction?

To test this hypothesis, the post-test scores on the response of Students' Attitude to Instructional Graphics Learning Strategy Questionnaire of male and female experimental group was analyzed using t-test statistics. The result is presented in Table 4.4.

Table 4.4: t-test Analysis on Mean Score on Students Attitude towards Basic Science of Male and Female Students' after the treatment.

Variable	N	$\bar{X}$	SD	SE	t-value	df	p-value	Remark
Male	30	67.50	3.32					
				0.8885	0.3039	58	0.661	Not significant
Female	30	70.18	3.12					

Not significant at $P \leq 0.05$

As can be deduced from table 4.2, the experimental group had mean score ($\bar{X}$ =67.50, SD =3.32 or 67.50 $\pm$3.32) than the control group ($\bar{X}$ = 70.18, SD =3.12 or 70.18 + 3.12). The null hypothesis which stated that, there is no significance difference between the attitude of male and female students towards basic science, after treatment, is retained.

4.3 Summary of Major Findings

The following are the summary of the major findings;

1. There is significant difference in the mean scores of the experimental group and the control group in Basic Science in favour of the experimental group. Subjects in the experimental group achieved better than those in the Control group.
2. There is no significant difference in the mean scores of male and female Basic Science Students when exposed to instructional graphics learning strategy.

3. There is a significant difference in the attitudinal change of Basic Science students before and after exposure to instructional graphics learning strategy. More positive attitude was shown by the subjects after being exposed to the instructional graphics learning strategy.
4. There is no significant difference between the attitude of male and male students

towards Basic Science when Instructional Graphics are used in Basic Science

Instruction

4.4 Discussion

The data collection and analysis were based on the academic performance of the subjects in the Basic Science Performance Test and the responses obtained from the Student's Attitude to Instructional Graphics Learning Strategy Questionnaire. The discussions of the results are as follows;

The result from Table 4.1 shows that there is significant difference between the mean scores of students in the experimental group and the control group. It further indicates that the experimental group which was exposed to instructional graphics learning strategy performed significantly better than their counterparts in the control group who were taught using lecture method. The higher performance in favour of the experimental group suggests that the instructional graphics learning strategy is more effective over the lecture method of instruction in teaching and learning of Basic Science.

The finding of this study is in conformity with other studies conducted on instructional graphics learning strategy. In other words, results from such studies have shown that the use of instructional graphics learning strategy improved the performance of students (Bower, 1972; Paivio, 1986; Reed, 1985; Dwyer, 1978; Fleming, 1987; Mayer, 1989; Anglin, & Carney, 1987; Bassey, 2002). Bower, 1972; Paivio, 1986; maintained that, the processing partnership between visual (e.g. static or animated graphics) and verbal (textual) information is the foundation of several theories of long-term memory. The use of static and animated graphics as a presentation device has been called a "learning-by-viewing approach" to instructional graphics (Reed, 1985). Among the qualities of static graphics that increase the level of student interest is moderate to heavy richness of detail (Dwyer, 1978; Fleming, 1987). Representational graphics are an effective presentation strategy when combined with text. These graphics help learners focus their attention on the explanative information in the text (Mayer, 1989).

Presentation graphics can also serve an organizational function (Levin, Anglin, & Carney, 1987) to help make relationships between ideas more apparent. Levier, (as cited in Bassey, (2002), reported that, the purpose of most instructional graphics is to help explain something to the viewer in a manner that hopefully increases retention of the subject matter.

The result obtained from Table 4.2 by comparing the academic performance of male and female basic science students, indicates that there was no significant difference in their mean scores, when exposed to instructional graphics learning strategy. This shows that the use of instructional graphics learning strategy is gender-friendly, meaning that both male and female benefit equally when exposed to instructional graphics learning strategy. This conforms to the finding of Erickson and Erickson (1984) who found no significant difference in science performance of boys and girls.

Ajewole (1990) in his study on guided discovery and expository instructional methods effect on students' transfer of learning, equally found no significant difference in the transfer of learning between male and female students exposed to guided discovery and expository method. Similarly, Samba, (1998) in a study on conceptual change instructional strategy in the teaching of biology found that the strategy appeared to be gender-friendly.

On the other hand, this result was in contradiction with the finding of Dyel (2011) who stated that, in science education there is the concern that girls are not achieving as they ought to (Erickson and Erickson 1984; Welch 1985; Mullis and Jenkins 1988). Jegede and Inyang (1990) reported that gender differences are more pronounced in the physical sciences. Dix (1981) and Coe and Crawley, (1990) reported lack of representation of females in the sciences and engineering professions.

In addition, Adcock, (2000) reported that, boys achieved significantly than girls in sciences, technical and mathematics subjects. This might have been attributed to the method of instruction used in teaching such subjects.

The result from the analysis of Table 4.3 on students attitude to instructional graphics learning strategy questionnaire, revealed a significant difference in the attitude of Basic Science students before and after treatment. These favourable attitudes demonstrated by the students towards Basic Science might be attributed to the teaching strategy. These advantages might include; simplification of ideas, concretisation of knowledge and attitude towards the difficulty level of Basic Science

Attitude plays a major role in students learning (Ajewole 1990). Studies (including Simpson, 1978, Wilson, 1983, Balogun (1975) reported that, in general, the attitude of Nigeria students towards the basic sciences, tend to decrease in the order of Biology, Chemistry, Physic and mathematic. Oyedokun (1998) ascertain that attitude to science generally account for between 20% to 25% variations in the academic performance in science.

In addition, the finding indicates that instructional graphics learning strategy relate well with Basic Science instruction. Okpala, Ambali and Alpha, (1998), stated that graphical illustrations provide a common experience to a large group at the same time. Okpala *et al*. (1998) also summarized the values of graphic for instructional design as follows: They require no special machine for projection, the teacher is confident in manipulating the material, their improvisation encourages more creativity and diversification of teaching methods, they are very easy to preserve and they could be produced within minimum cost and maximum efficiency.

Findings of the study in table 4.4 shows that, there is no significant difference between the attitude of male and female students towards Basic Science instructional. Instructional graphics learning strategy generate positive attitudinal change to both male and female Basic Science. Attitude plays a major role in students learning (Ajewole, 1990). Studies (including Simpson; Wilson; Soyibo; in Dyel (2011) reported that, student's positive attitude to science correlate highly with their science performance. Attitude was found to have a direct effect on science performance among American high school students (Schibeci & Billey, 1986).

The materials used for enhancing instructional effectiveness are aspects of media employed for achieving the instructional objectives. Bassey (2002) described instructional media as system components that may be used as parts of instructional processes which are used to disseminate information, message and ideas or which make possible communicable in the teaching-learning process. Onasanya (2004) gave various kinds of models used in educational instruction namely: Mental models, theoretical models, mathematical models, diagrams, concrete models etc. These types of models are of special pedagogic significance in science and technology instruction due to the nature of knowledge and knowledge getting process in these disciplines.

CHAPTER FIVE

Summary, Conclusion and Recommendations

5.1 Introduction

This chapter focuses on the highlights of the purpose of the study, the finding and the recommendations to students, teachers, education administrators, curriculum developers and ministry of education with the hope of bringing lots of improvements in the teaching and learning of Basic Science at JSS level. It is also hoped that research students and teachers in related discipline will take interest to select some related topics for further research work.

5.2 Summary of the Study

The purpose of this study is to determine the effect of instructional graphics on academic performance and attitude of Basic Science Students in the selected Secondary Schools in Dutsin-ma Zonal Inspectorate of Education Katsina State, with the view to offer recommendation where it is necessary. This summary chapter describes the highlights of this research work, the general introduction, which is the background of the study, the objectives of the study significance of the study, research questions, hypotheses, and the scope and delimitation of the study.

Chapter two of this study entailed the literature review on the concept of graphics, types and application of instructional graphics, cognitive theories relating to instructional graphics, theoretical basis of Science Education, science content and cognitive capacity, gender differences and academic performance in science, attitude and academic performance in science and empirical support for instructional graphics.

In chapter three, descriptions were made on the methodology adopted in the course of this study. As a consequence, research design, population of the study, sample and sampling technique, Basic Science topics selected for the study, instrumentation, pilot testing, as well procedure for data collection and data analysis were elicited. Chapter four also contains data and result presentation, hypotheses testing and summary of the findings and discussion.

5.3 Conclusion

The following conclusions are drawn based on the findings from this study. Students exposed to instructional graphics learning strategy performed significantly better in Basic Science than those exposed to the lecture method of learning instruction. Also, instructional graphics learning strategy is gender-friendly in enhancing the performance of male and female students in Basic Science. Male and Female Students' attitudes are positively affected as well as positively related by the instructional graphics learning strategy.

Generally, instructional graphics learning strategy has the potential of enhancing Basic Science students' performance and attitude. Using this teaching strategy for the improvement of Science Education at the JS level is therefore a welcome idea.

5.4 Recommendations

From the findings of this research work, the following recommendations were made for the purpose of improving positive attitude of students towards basic science instruction, reducing gender related problems to basic science and enhancing student's academic performance in basic science test as well as providing a framework for further research work.

1. Basic Science Teachers should make all efforts, where necessary, to deliver their lessons with the available but relevant instructional graphics. This will improve student's positive attitude towards basic science and consequently, improve the academic performance of Basic Science Students.

2. When instructional graphics are developed by a researcher, there is the need to evaluate the model by testing the ability of the students.

3. The state ministry of education should train and retrain Basic Science teachers on how to developed and apply instructional graphics in Basic Science instructions.

Suggestion for further studies

1 Similar study can be conducted on the effects of instructional graphics on the attitude and academic performance of students on other sciences related courses such as biology, chemistry, physics etc.

2 A similar study may also be conducted in tertiary institutions to find out the effect of Instructional graphics on the academic performance and attitude of students at higher levels of education.

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APPENDIX A

EFFECTS OF INSTRUCTIONAL GRAPHICS ON ACADEMIC PERFORMANCE OF BASIC SCIENCE STUDENTS IN KATSINA STATE, NIGFRIA

BASIC SCIENCE PERFORMANCE TEST (BSPT) FOR JUNIOR SECONDARY SCHOOL (JSS) STUDENTS II

Instruction: **TIME: 40 mins.**

Read each question carefully and the four possible answers provided after each question. Select one from the four options as your answer to the question and enter it on the answer sheet by shading the letter A, B, C or D that corresponds to your choice.

Example: The main objective of science is to;

A. Create some machines.
B. Draw diagrams and label them.
C. Keep rearing animals for food production.
D. Provide some solutions to human problems.

Supposing you choose option D for the above question, then you should cross letter D on your answer sheet as shown; =A= =B=X =C= =D=

1. In science lessons, experiments are carried out in a specific place called……….

A. Library.
B. laboratory
C. workshop
D. garage

2. Solid, Liquid and gas are the three states of;

A. Mixture
B. Matter
C. Element
D. Compound

3. The organ of the female reproductive system that sets the egg ready for fertilization is called a……………………..

A. fallopian tube.

B. ovaries

C. uterus

D. vagina

4. The organs of the body which work together to produce young ones, are called ……

A. excretory system.

B. circulatory system.

C. digestive system.

D. reproductive system.

5. The main organs of the male reproductive system are the …………….

A. penis, testes and the uterus

B. penis, testes and the sperm ducts.

C. penis, testes and the ovaries

D. penis, testes and the fallopian tube.

6. One of the basic assumptions of kinetic theory is that ………….

A. matter is made up of tiny indivisible particles that are static and therefore possess no energy.

B. matter is made up of tiny indivisible particles that possess mechanical energy.

C. matter is made up of tiny indivisible particles that are in constant motion and therefore possess kinetic energy.

D, matter is made up of tiny indivisible particles that posses heat energy.

7. The onset of sexual maturity which is characterized by the secondary sexual changes is called ………………………

A. puberty.

B. maturity.

C. maternity.

D. menstruation.

8. The famous scientist that proposed atomic theory was…………

A. John Dalton

B. Sir Isaac Newton

C. Archimedes

D. Galileo Galilee

9. Enlargement of the female breast with potentials of producing milk for feeding the young one, is one of the characteristics of ………………………

A. primary sexual changes

B. secondary sexual changes.

C. normal changes.

D. abnormal changes.

10. The process of bringing a new offspring to life is known as…………….

A. fertilization

B. gestation

C. reproduction

D. ovulation

11. The structure of solids, liquids and gases and such physical process as boiling and evaporation are explained by …………………..

A. random motion

B. kinetic energy.

C. law of motion.

D. kinetic theory

12. Spermatozoa or sperm is produce by the ………………

A. fallopian tube

B. uterus.

C. testes.

D. ovaries.

13. In the human reproductive system fertilisation takes place in the…….

A. uterus

B. oviduct

C. ovary

D. testis

14. Reproduction is necessary because it

A. makes growth possible

B. brings about continuation of animal and plant existence

C. promotes the production of food

D. helps in the increase of plant population.

15. Male and female gametes units to form……

A. baby

B. embryo

C. sex cell

D. zygote

16. The cohesive force between individual particles is highest for substances in the…………………………state

A. liquid

B .gaseous

C. solid

D. vapour

17. The particles in solid are closely packed and held together by strong……………..

A. magnetic force.

B. electromagnetic force.

C. forces of cohesion.

D. forces of repulsion.

18. The act of fertilization is best described as the……..

A. Union of the male sex cell with the nucleus of the female sex cell.

B. acts of the male mating with the female.

C. division of an egg into an embryo

D. release of egg from the ovary of the female

19. One of the differences between evaporation and boiling is that, evaporation occurs at all temperature while boiling occurs at the ……………….

A. freezing point of the liquid.

B. condensation point of the liquid.

C. humidity of the air,

D. boiling point of the liquid.

20. When liquid particles gain sufficient energy to break through the surface tension and escape as gas,……………..is said to have occurred.

A. crystallization.

B. boiling.

C. evaporation.

D. separation.

APPENDIX B

EFFECT OF INSTRUCTIONAL GRAPHICS ON STUDENTS' ACADEMIC PERFORMANCE TOWARDS BASIC SCIENCE IN KATSINA STATE, NIGERIA

BASIC SCIENCE PERFORMANCE TEST (BSPT) ANSWER SHEET FOR
JUNIOR SECONDARY SCHOOL (JSS) STUDENTS II

School___________________________

Gender____________________________

1. =A= =B= =C= =D=
2. =A= =B= =C= =D=
3. =A= =B= =C= =D=
4. =A= =B= =C= =D=
5. =A= =B= =C= =D=
6. =A= =B= =C= =D=
7. =A= =B= =C= =D=
8. =A= =B= =C= =D=
9. =A= =B= =C= =D=
10. =A= =B= =C= =D=
11. =A= =B= =C= =D=
12. =A= =B= =C= =D=
13. =A= =B= =C= =D=
14. =A= =B= =C= =D=
15. =A= =B= =C= =D=
16. =A= =B= =C= =D=
17. =A= =B= =C= =D=
18. =A= =B= =C= =D=
19. =A= =B= =C= =D=
20. =A= =B= =C= =D=

APPENDIX C

BASIC SCIENCE PERFORMANCE TEST (BSPT) MAKING SCHEME FOR JUNIOR SECONDARY SCHOOL (JSS) STUDENTS II

1. = = = = B
2. = = = = B
3. = = = = A
4. = = = = D
5. = = = = B
6. = = = = C
7. = = = = A
8. = = = = A
9. = = = = B
10. = = = = C
11. = = = = D
12. = = = = C
13. = = = =A
14. = = = = B
15. = = = =D
16. = = = = C
17. = = = = C
18. = = = = A
19. = = = = D
20. = = = = A

APPENDIX D

STUDENTS' ATTITUDE TO INSTRUCTIONAL GRAPHICS LEARNING STRATEGY QUESTIONNAIRE (SAIGLSQ) FOR

JUNIOR SECONDARY SCHOOL STUDENTS (JSS) II

School____________ Gender _____

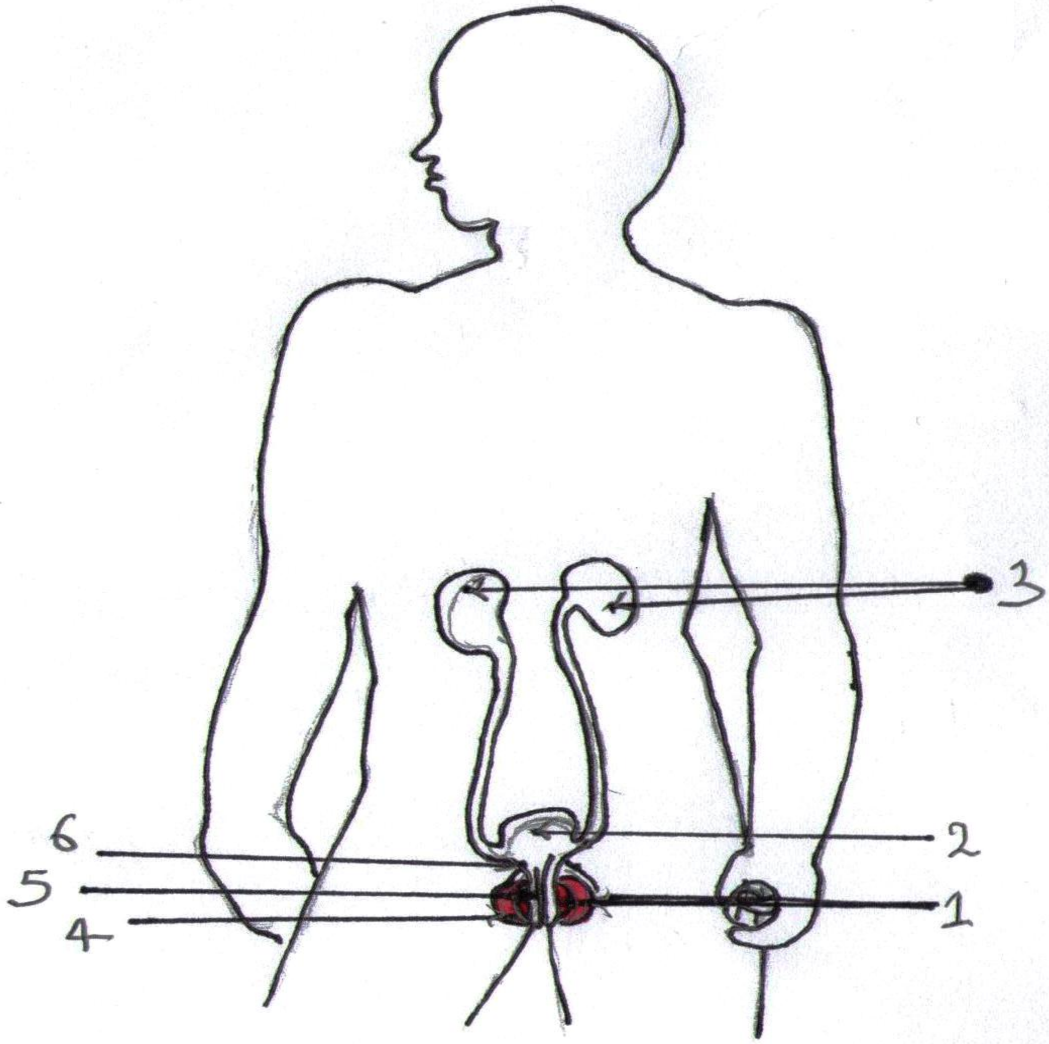
You are free to express your feelings about instructional graphics teaching and learning strategy in relation to the Basic Science course you have been taking.

Tick [√] the response which best describe your feeling, personal attitude and motivation towards the instructional strategy used in teaching Basic Science during the past six weeks. The responses are: Strongly Agree = SA; Agree = A; Disagree = D and Strongly Disagree = SD

		RESPONSES			
S/N	STATEMENT	SA	A	D	SD
1.	Instructional Graphics teaching and learning strategy has helped me to be more active in the class.				
2.	The teaching and learning strategy helps to show relationship between different parts of a system.				
3.	I find it difficult to interpret graphical representation.				
4.	The materials covered in Basic Science are uninteresting because of the use of Instructional Graphics teaching strategy.				
5.	The strategy has simplified more complex concepts.				
6.	The strategy has enabled me to score more marks in Basic Science than I used to score.				
7.	I learn more when I saw information graphically.				
8.	Graphical representations distract attention of the learner during the lesson.				
9.	The strategy has improved the frequency and quality of my interaction with the classmates.				
10.	I feel more comfortable in the class than before.				
11.	My view of the Basic Science lessons has been positively improved				
12.	The strategy is more of activity based				
13.	The strategy gives more clear information about abstract concepts.				
14.	My approach towards solving problem is greatly enhanced				
15.	The strategy enable me to apply the knowledge gained in my daily activities				
16.	It made the lesson boring				
17.	It has increases my reasoning ability				
18.	It has increases my creative ability.				
19.	It encouraged me to be more punctual to the class.				
20.	It has made the lessons more lively and interesting				

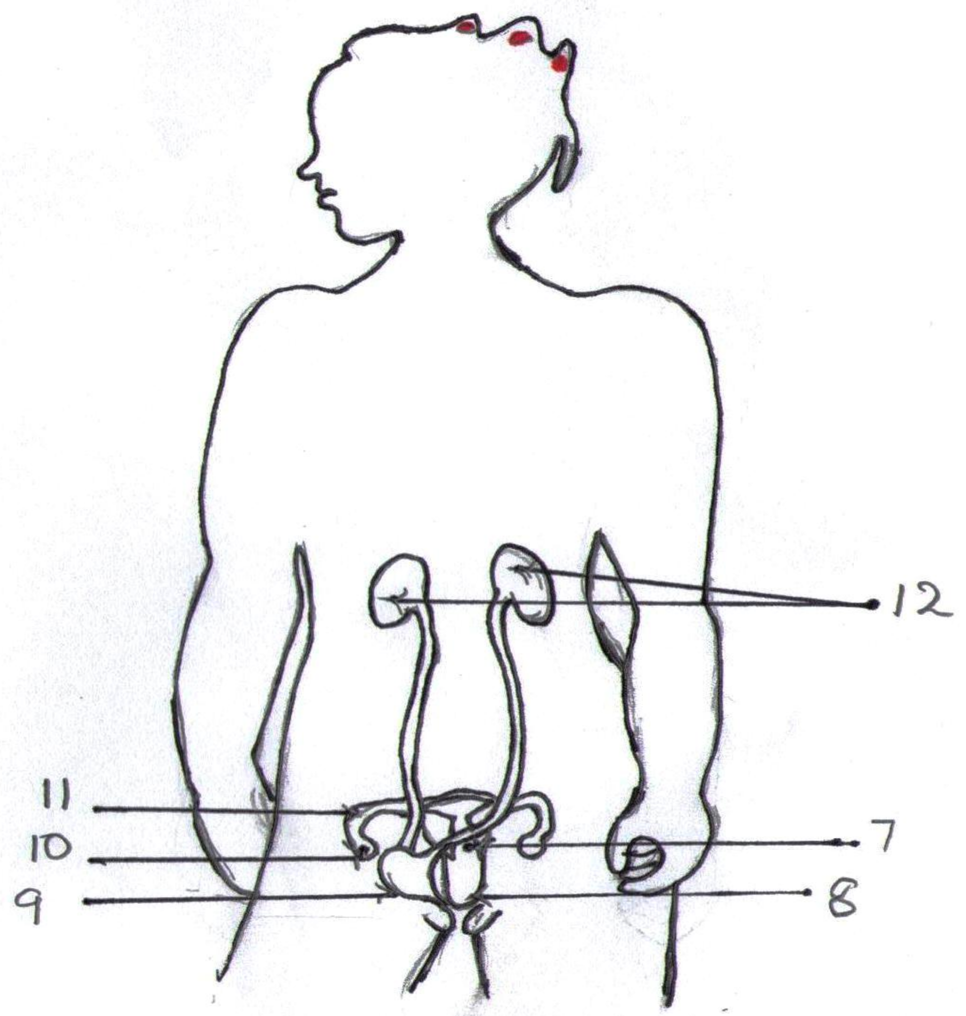
APPENDIX E

INSTRUCTIONAL GRAPHICS MODEL INSTRUMENT



1. Testis
2. Bladder
3. Kidneys
4. Scrotum
5. Penis
6. Sperm duct

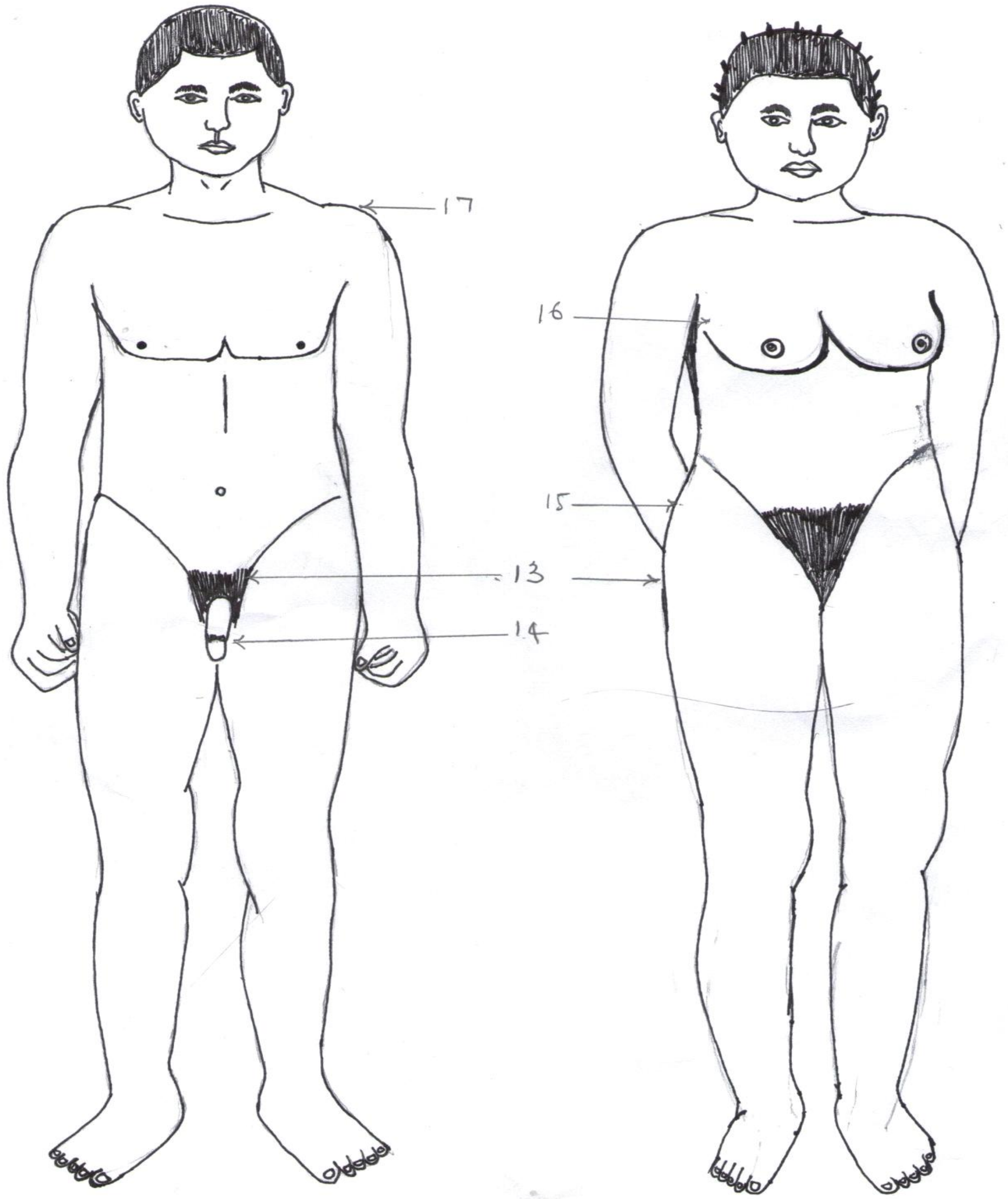
Human Male Reproductive System



7. Uterus 8. Virginia 9. Bladder

10. Ovaries 11. Oviduct 12. Kidneys

Human Female Reproductive System

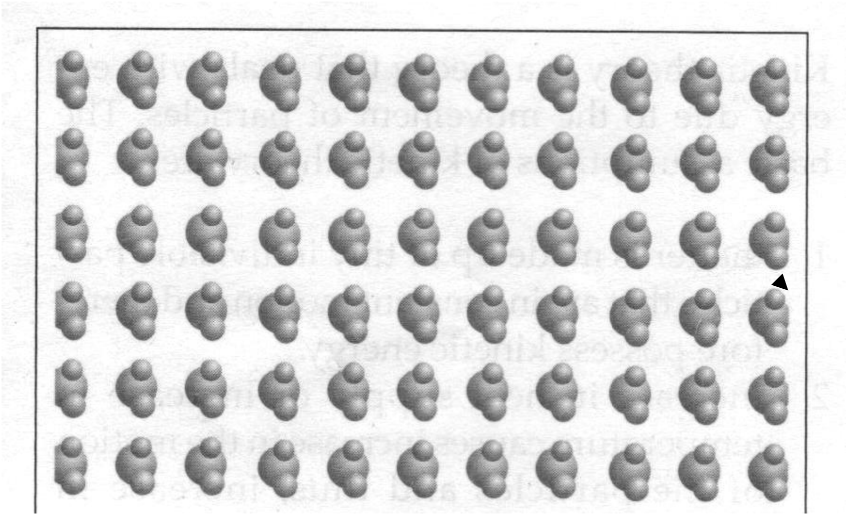


(a) (b)

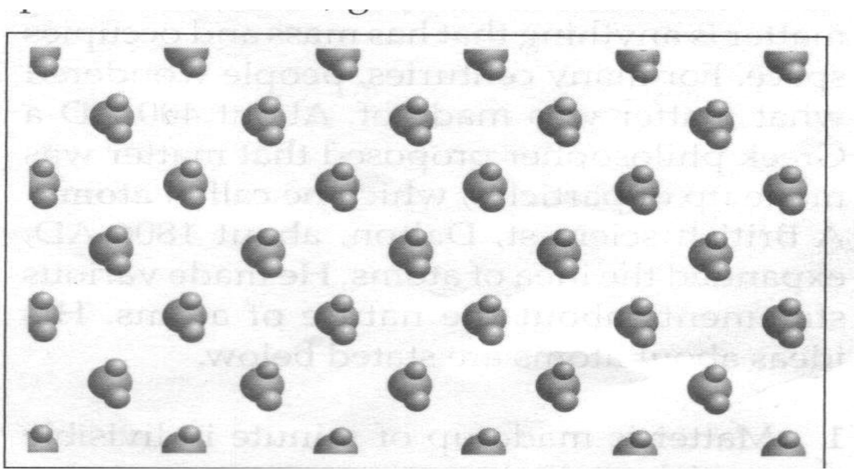
13. Pubic hair 14. Larger genitals 15. Wider hips

16. Larger breast and nipple 17. Wider shoulder

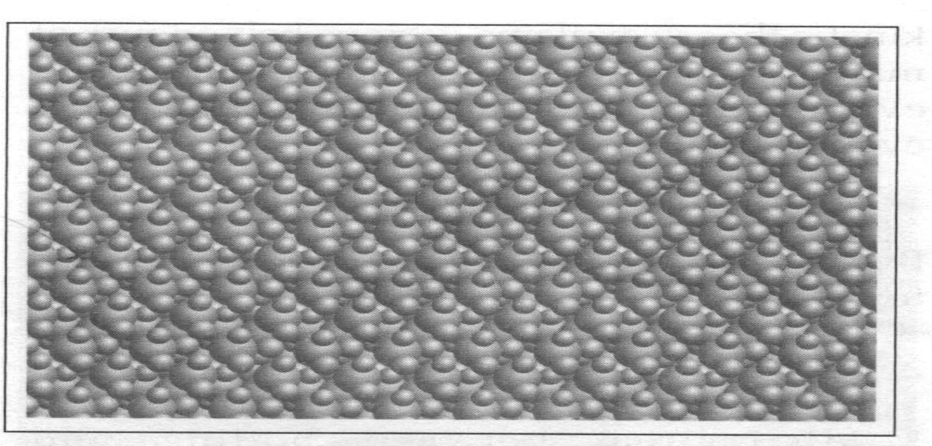
Secondary Sexual Changes in (a) Male and (b) Female



18. Structure of Liquid Particles



19. Structure of Gas Particles



20. Structure of Solid Particles

Structure of Matter Particles

APPENDIX F

INSTRUCTIONAL GRAPHICS LEARNING PACKAGE (IGLP)

EXPERIMENTAL GROUP: **LESSON NOTE ONE**

METHOD OF TEACHING: **INSTRUCTIONAL GRAPHICS LEARNING STRATEGY**

SUBJECT: **BASIC SCIENCE**

LESSON 1: **UNIT 1**

GROUP: **EXPERIMENTAL**

CLASS: **JSS II**

UNIT TITLE: **HUMAN REPRODUCTIVE SYSTEM**

NO. OF STUDENTS INN THE CLASS: **60**

TIME: DOUBLE PERIOD **(1:20 MIN.)**

TOPIC: **PARTS OF HUMAN REPRODUCTIVE SYSTEM AND THEIR FUNCTIONS**

INSTRUCTIONAL MATERIALS: Charts on human male and female reproductive system.

BEHAVIOURAL OBJECTIVES: By the end of the lesson students should be able to:

(1) Identify the parts of human male and female reproductive system;

(2) Explain the functions of the different organs in the human male and female reproductive system;

(3) Define reproduction.

PREVIOUS KNOWLEDGE: Students have learnt that reproduction is a process by which parent organism(s) brings new organism of their kind to life.

PRESENTATION: STEP 1: Define reproduction and reproductive System.

STEP 2: Display and explain well labelled chart of human male reproductive system.

STEP 3: Draw out a table of the functions of the main organs of the human male reproductive system on the chalk board.

STEP 4: Display and explain well labelled chart of human female reproductive system.

STEP 5: Draw out a table of the functions of the main organs of the human female reproductive system on the chalk board.

ACTIVITY 1: IDENTIFYING THE MALE REPRODUCTIVE ORGANS

You are provided with model of human male reproductive system.

1. Observe the model of human male reproductive system presented by your teacher.
2. Identify the main organs of the reproductive system by their names.
3. Make a table showing organs and their functions as follows:

S/N	Male organ	Functions

ACTIVITY 2: IDENTIFYING THE FEMALE REPRODUCTIVE ORGANS.

You are provided with model of human female reproductive system.

1. Observe the model of human female reproductive system presented by your teacher.
2. Identify the main organs of the reproductive system by their names.
3. Make a table showing organs and their functions as follows:

S/N	Female organ	Functions

EVALUATION: The teacher asked the students the following questions: e.g.

(i) What is the difference between reproduction and the reproductive system?

(ii) Mention two organs of male reproductive system and their functions.

(iii) Mention three organs of female reproductive system and their functions.

CONCLUSION: The teacher would conclude the lesson by explaining to the students briefly the main points in the lesson such as, reproductive system, functions of some main organs of the human reproductive system,

ASSIGNMENT: Students would be assigned to find out the meaning of puberty its associated periods.

INSTRUCTIONAL GRAPHICS LEARNING PACKAGE (IGLP)

EXPERIMENTAL GROUP: LESSON NOTE TWO

METHOD OF TEACHING: **INSTRUCTIONAL GRAPHICS LEARNING STRATEGY**

SUBJECT: **BASIC SCIENCE**

LESSON 2: **UNIT 1**

GROUP: **EXPERIMENTAL**

CLASS: **JSS II**

UNIT TITLE: **HUMAN REPRODUCTIVE SYSTEM**

NO. OF STUDENTS INN THE CLASS: **60**

TIME: DOUBLE PERIOD **(1:20 MIN.)**

TOPIC: **PUBERTY AND SECONDARY SEXUAL CHARACTERS**

INSTRUCTIONAL MATERIALS: An animation on the process of fertilization and a chart on secondary sexual changes in (a) male and (b) female

BEHAVIOURAL OBJECTIVES: By the end of the lesson students should be able to:

(1) identify some peculiar changes that accompany human stages of development;

(2) distinguish between the changes that are specific to a particular sex;

(3) define puberty and explain what is mean by secondary sexual changes.

(4) Understand the relationship between fertilization and pregnancy.

PREVIOUS KNOWLEDGE: Students have identified the main organs of human reproductive system and their functions.

PRESENTATION: STEP 1: Explain what is mean by fertilization.

STEP 2: Project a computer animation on the process of fertilization.

STEP 3: Display and explain a well labelled chat on secondary sexual changes in male.

STEP 4: Display and explain a well labelled chat on secondary sexual changes in female.

STEP 5: Point out the secondary sexual changes that are peculiar to both male and female and those that are specific to a particular sex.

ACTIVITY 3: IDENTIFYING SECONDARY SEXUAL CHANGES

You are provided with unlabelled charts on features of secondary sexual changes in male and female.

1. Observe the charts carefully and identify these features

3. Make a table of these features indicate whether it common or specific as exemplified below.

S/N	Features	Common	Specific
1.	Development of masculine muscle		Male
2.	Hair in the arm pit	Male & Female	

EVALUATION: The teacher would ask the students to;

(i) Define fertilization.

(ii) Explain what they understood by the term puberty.

(iii) Mention thee features in secondary sexual changes that are specific.

CONCLUSION: The teacher would terminate the lesson with a brief discussing on puberty period and its associated features.

ASSIGNMENT: Students would be assigned to find out the importance of reproduction.

INSTRUCTIONAL GRAPHICS LEARNING PACKAGE (IGLP)

EXPERIMENTAL GROUP: LESSON NOTE THREE

METHOD OF TEACHING: INSTRUCTIONAL GRAPHICS LEARNING STRATEGY

SUBJECT: BASIC SCIENCE

LESSON 3: UNIT 1

GROUP: EXPERIMENTAL

CLASS: JSS II

UNIT TITLE: HUMAN REPRODUCTIVE SYSTEM

NO. OF STUDENTS INN THE CLASS: 60

TIME: DOUBLE PERIOD (1:20 MIN.)

TOPIC: IMPORTANCE OF REPRODUCTION

INSTRUCTIONAL MATERIALS: (1) A diagram of a female cat with a pregnancy, given birth and then died leaving the offspring.

(2) Diagrams of male and female cats kept separately without matting but growing better, bigger and older until death takes place without any young one to leave behind.

BEHAVIORAL OBJECTIVES: By the end of the lesson students should be able to:

(1) Understand that all living things die due to old age, disease or even accident.

(2) Reproduction is the process that makes continuity of living things possible.

(3) Reproduction is also important for building up population.

PREVIOUS KNOWLEDGE: Students have learnt about the secondary sexual changes and the process of fertilization.

PRESENTATION: **STEP 1:** Explain some of the causes of death such as old age, diseases or accident.

STEP 2: Discuss the process that makes continuity of living things possible.

STEP 3: Display and explain a diagram of a female cat.

STEP 4: Display and explain diagrams of a male and female cat kept separately.

STEP 5: Explain the causes of population growth.

EVALUATION: The teacher would ask the students to;

(i) explain what happens when sexual intercourse results in fertilization.

(ii) outlines the importance of reproduction in their community.

CONCLUSION: The lesson would be concluded by emphasizing the important of population growth within a family.

ASSIGNMENT: Students would be assigned to write 3 major causes of death and 4 factors that may have impact on any 2 of the major causes.

INSTRUCTIONAL GRAPHICS LEARNING PACKAGE (IGLP)

EXPERIMENTAL GROUP: LESSON NOTE FOUR

METHOD OF TEACHING: INSTRUCTIONAL GRAPHICS LEARNING STRATEGY

SUBJECT: BASIC SCIENCE

LESSON 4: UNIT 2

GROUP: EXPERIMENTAL

CLASS: JSS II

UNIT TITLE: KINETIC ENERGY

NO. OF STUDENTS INN THE CLASS: 60

TIME: DOUBLE PERIOD (1:20 MIN.)

TOPIC: ASSUMPTIONS OF THE KINETIC THEORY

INSTRUCTIONAL MATERIALS: Chats of structure of solids, liquids and gases.

BEHAVIORAL OBJECTIVES: By the end of the lesson students should be able to:

(1) State the assumptions of the kinetic theory;

(2) Explain the structure of solid, liquid and gas particles using the kinetic theory.

PREVIOUS KNOWLEDGE: Students have already learnt that matter is anything that has mass and occupies space.

PRESENTATION: STEP 1: Explain what is mean by kinetic energy and kinetic theory.

STEP 2: state the basic assumptions of the kinetic theory.

STEP 3: Display and explain the structure of solid particles.

STEP 4: Display and explain the structure of liquid particles.

STEP 5: Display and explain the structure of gas particles.

EVALUATION: The teacher would ask the students to use kinetic theory and explain why a solid has a definite shape and a liquid has no definite shape.

ACTIVITY 4: OBSERVING CHANGE OF STATE OF MATTER

You are provided with ice block, a beaker and sources of heat.

1. Put the ice block in the beaker and heat it slowly maintaining a low temperature. Observe what happens to the ice and record your observations.

3. Increase the heating until the boiling point of water. Write down your observations.

4. Continue heating after the boiling point is reached and stop heating after a while. Write down your observations.

5. Based on your understanding of molecular structure of solids, liquids and gases, use kinetic theory to explain your observations.

Based on the observations that would be made from activity 4, boiling, evaporation and factors affecting evaporation would be explained to the students.

CONCLUSION: The lesson would be concluded by restating the basic assumption of kinetic theory

ASSIGNMENT: Students would be asked to differentiate between the kinetic energy and kinetic theory.

APPENDIX G

LECTURE METHOD LEARNING PACKAGE (LMLP)

CONTROL GROUP: LESSON NOTE ONE

METHOD OF TEACHING: LECTURE METHOD

SUBJECT: BASIC SCIENCE

LESSON 1: UNIT 1

GROUP: CONTROL

CLASS: JSS II

UNIT TITLE: HUMAN REPRODUCTIVE SYSTEM

NO. OF STUDENTS INN THE CLASS: 60

TIME: DOUBLE PERIOD (1:20 MIN.)

TOPIC: PARTS OF HUMAN REPRODUCTIVE SYSTEM AND THEIR FUNCTIONS

INSTRUCTIONAL MATERIALS: Basic Science for Junior Secondary Schools Book 2, Chalk, chalk board and a cleaner.

BEHAVIORAL OBJECTIVES: By the end of the lesson students should be able to:

1. List down the parts of human male and female reproductive system;

2. Explain the functions of the different organs in the human male and female reproductive system;

3. Define reproduction.

PREVIOUS KNOWLEDGE: Students have learnt that reproduction is a process by which parent organism(s) brings new organism of their kind to life.

PRESENTATION: STEP 1: Define reproduction and reproductive System.

STEP 2: List down all organs of human male reproductive system.

STEP 3: Explain the functions of the main organs of the human male reproductive system .

STEP 4: List down all organs of human female reproductive system.

STEP 5: Explain the functions of the main organs of the human female reproductive system.

ACTIVITY 1: MALE REPRODUCTIVE SYSTEM

1. Write down any 4 organs of human male reproductive system
2. Explain the functions of any 2 of the organs mentioned above.

ACTIVITY 2: FEMALE REPRODUCTIVE SYSTEM.

1. Write down any 3 organs of human female reproductive system
2. Explain the functions of any 2 of the organs mentioned above.

EVALUATION: The teacher asked the students the following questions: e.g.

(i) What is the difference between reproduction and the reproductive system?

(ii) Mention two organs of male reproductive system and their functions.

(iii) Mention three organs of female reproductive system and their functions.

CONCLUSION: The teacher would conclude the lesson by explaining to the students briefly the main points in the lesson such as, reproductive system, functions of some main organs of the human reproductive system, etc.

ASSIGNMENT: Students would be assigned to find out the meaning of puberty and its associated periods.

LECTURE METHOD LEARNING PACKAGE (LMLP)

CONTROL GROUP: **LESSON NOTE TWO**

METHOD OF TEACHING: **LECTURE METHOD**

SUBJECT: **BASIC SCIENCE**

LESSON 2: **UNIT 1**

GROUP: **CONTROL**

CLASS: **JSS II**

UNIT TITLE: **HUMAN REPRODUCTIVE SYSTEM**

NO. OF STUDENTS INN THE CLASS: 60

TIME: DOUBLE PERIOD **(1:20 MIN.)**

TOPIC: **PUBERTY AND SECONDARY SEXUAL CHARACTERS**

INSTRUCTIONAL MATERIALS: Basic Science for Junior Secondary Schools Book 2, Chalk, chalk board and a cleaner.

BEHAVIOURAL OBJECTIVES: By the end of the lesson students should be able to:

1. State some peculiar changes that accompany human stages of development;

2. Distinguish between the changes that are specific to a particular sex;

3. Define puberty and explain what is mean by secondary sexual changes.

4. Understand the relationship between fertilization and pregnancy.

PREVIOUS KNOWLEDGE: Students were taught the main organs of human reproductive system and their functions.

PRESENTATION: STEP 1: Explain what is mean by fertilization.

STEP 2: Explain all the secondary sexual changes in male.

STEP 3: Explain all the secondary sexual changes in female.

STEP 4: List down all the secondary sexual changes that are common to both male and female and those that are specific to a particular sex.

ACTIVITY 3: RECORDING SECONDARY SEXUAL CHANGES

1. Write down all the secondary sexual changes

3. Differentiate between the secondary sexual changes which are common and those that are specific to either male or female.

EVALUATION: The teacher would ask the students to;

(i) define fertilization.

(ii) explain what they understood by the term puberty.

(iii) mention thee features in secondary sexual changes that are specific.

CONCLUSION: The teacher would terminate the lesson with a brief discussing on puberty period and its associated features.

ASSIGNMENT: Students would be assigned to find out the importance of reproduction.

LECTURE METHOD LEARNING PACKAGE (LMLP)

CONTROL GROUP: **LESSON NOTE THREE**

METHOD OF TEACHING: CONTROL GROUP

SUBJECT: BASIC SCIENCE

LESSON 3: UNIT 1

GROUP: CONTROL GROUP

CLASS: JSS II

UNIT TITLE: HUMAN REPRODUCTIVE SYSTEM

NO. OF STUDENTS INN THE CLASS: 60

TIME: DOUBLE PERIOD (1:20 MIN.)

TOPIC: IMPORTANCE OF REPRODUCTION

INSTRUCTIONAL MATERIALS: Basic Science for Junior Secondary Schools Book 2, Chalk, chalk board and a cleaner.

BEHAVIOURAL OBJECTIVES: By the end of the lesson students should be able to understand that;

1. all living things die due to old age, disease or even accident.

2. reproduction is the process that makes continuity of living things possible.

3. reproduction is also important for building up population.

PREVIOUS KNOWLEDGE: Students have learnt about the secondary sexual changes and the process of fertilization.

PRESENTATION: STEP 1: Explain some of the causes of death such as old age, diseases or accident.

STEP 2: Discuss the process that makes continuity of living things possible.

STEP 3: Explain the causes of population growth.

STEP 4: Explain what is mean by pregnancy and giving birth.

EVALUATION: The teacher would ask the students to;

(i) explain what happens when sexual intercourse results in fertilization.

(ii) outlines the importance of reproduction in their community.

ASSIGNMENT: Students would be assigned to write 3 major causes of death and 4 factors that may have impact on any 2 of the major causes.

LECTURE METHOD LEARNING PACKAGE (LMLP)

CONTROL GROUP: **LESSON NOTE FOUR**

METHOD OF TEACHING: **LECTURE METHOD**

SUBJECT: **BASIC SCIENCE**

LESSON 4: **UNIT 2**

GROUP: **CONTROL**

CLASS: **JSS II**

UNIT TITLE: **KINETIC ENERGY**

NO. OF STUDENTS INN THE CLASS: **60**

TIME: DOUBLE PERIOD **(1:20 MIN.)**

TOPIC: **ASSUMPTIONS OF THE KINETIC THEORY**

INSTRUCTIONAL MATERIALS: Basic Science for Junior Secondary Schools Book 2, Chalk, chalk board and a cleaner.

BEHAVIORAL OBJECTIVES: By the end of the lesson students should be able to:

1. state the assumptions of the kinetic theory;

2. explain the structure of solid, liquid and gas particles using the kinetic theory.

PREVIOUS KNOWLEDGE: Students have already learnt that matter is anything that has mass and occupies space.

PRESENTATION: STEP 1: Explain what is mean by kinetic energy and kinetic theory.

STEP 2: State the basic assumptions of the kinetic theory.

STEP 3: Explain the structure of solid particles.

STEP 4: Explain the structure of liquid particles.

STEP 5: Explain the structure of gas particles.

EVALUATION: The teacher would ask the students to use kinetic theory and explain why a solid has a definite shape and a liquid has no definite shape.

CONCLUSION: The lesson would be concluded by stating the differences between evaporation and boiling and some of the factors that affect evaporation.

ASSIGNMENT: Students would be asked to differentiate between the kinetic energy and the kinetic theory.

ACTIVITY 4: THE THREE STATE OF MATTER

1. Using atomic theory, explain the nature of the structure of liquid particles,

2. Differentiate between the structures of solid and that of liquid particles.