EFFECT OF SCIENCE, TECHNOLOGY AND SOCIETY APPROACH ON JUNIOR SECONDARY SCHOOL ACQUISITION OF SCIENCE PROCESS SKILLS IN BASIC SCIENCE IN ENUGU NIGERIA

BY

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TITLE PAGE

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A RESEARCH PROJECT
PRESENTED TO THE DEPARTMENT OF SCIENCE EDUCATION, UNIVERSITY OF NIGERIA, NSUKKA IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE EDUCATION.

SUPERVISOR: PROF. D.N. EZEH

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CERTIFICATION

Chibueze Mary-Belinda Adaora a postgraduate student of the department of Science Education University of Nigeria Nsukka with Registration Number PG/M.Ed/12/61851 has satisfactorily completed the requirements for the award of Masters Degree in Science Education. The work contained in this thesis is original and has not been submitted in part or full for any other diploma or degree of this or any other university.

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Prof. D.N. Ezeh
Supervisor

APPROVAL PAGE

This project has been approved for the Department of Science Education, University of Nigeria, Nsukka.

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DEDICATION

This work is dedicated to our Mother of Perpetual help.

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ABSTRACT

This study investigated the effect of Science, Technology and Society – Approach (STS-A), on Junior Secondary School Students' Acquisition of Science Process Skills (SPS) in Basic Science in Enugu Education Zone of Enugu State. A pre-test-Post-test quasi experimental design was used for the study. Three research questions and three null hypotheses tested at 0.05 level of significant guided the study. The sample consists of ninety-five Basic Science Students randomly selected from two out of the ten co-educational secondary schools in Enugu Educational Zone. In each of the schools sampled, a stream of JS 2 was randomly sampled for experimental treatment and control respectively. Students in the experimental group were taught using STS-A while students in the control group were taught using Traditional approach (lecture method). Both groups were taught the same STS-topics for four weeks at the end of which data was collected. The instrument used for data collection is a 40-item Science Process Skill Acquisition Rating Scale (SPSARS) developed by the researcher. The instrument was validated by experts in Science Education. The reliability of the instrument was determined using Cronbach alpha reliability index and Kendall's coefficient of concordance (W). Mean and Standard deviation was used to answer the research questions while ANCOVA was employed to test the null hypotheses. It was found that STS-Approach proved a more effective approach to the acquisition of Science Process Skills than the Traditional approach. Gender has no influence on the mean acquisition of Science Process Skill of students taught using STS-A. The researcher therefore, recommended the use of STS-A to enhance Science Process Skill Acquisition in Basic Science.

CHAPTER ONE

INTRODUCTION

Background of the Study

Science has been defined as the knowledge about the world, especially based on examining, testing and proving facts while Technology are the ways of doing things that are based on modern knowledge about science. These two inseparable tools play vital roles in national development such that no nation can be judged as developed where it has nothing to show scientifically and technologically. These roles of science and technology cut across all facets of national development and include: Agriculture, health and medicine, transportation, communication, comfort, entertainment and welfare, automation, building and construction to mention but a few.

Little wonder then Nwaigwe (2001) and Umoren (2001) described Science and Technology as the bedrock of the development of any nation, since according to them, the nation's level of science and technology forms the strongest link between its socio-economic development and civilization.

Considering these crucial roles of science and technology in the lives of the individuals and the development of the nation, it becomes imperative that every well-meaning country should endeavour to create opportunities for every individual to develop both scientifically and technologically so as to face the global challenges of science and technology. Nigeria is not an exception and so, the Federal Republic of Nigeria (FRN) as stipulated in the NPE (2005-2012 updated) included science and technology education at all levels of school system.

Since the introduction of science and technology Education into the school system, the government has continued to support the programme through different ways. For instance, the 6-3-3-4 system of Education which has been restructured into 9-3-4 system of Education by the NERDC Draft of 2006 was introduced to enable the learner learn science through the acquisition of skills so as to be equipped to live effectively in this modern age of science and technology. The government also came up with a policy that 60% of the students seeking admission into the nation's Universities, Polytechnics and Colleges of Education should be admitted for science-oriented courses while 40% of the students should be considered for Arts and Social Sciences.

Several other supports have come from professional associations such as Science Teachers Association of Nigeria (STAN), Mathematics Association of Nigeria (MAN), Nigerian Academy of Education (NAE), Nigerian Academy of Science (NAS) etc through the organization of conferences, workshops and seminars. Some NGOs have from time to time organized science fair and quiz competition programmes such as Junior Engineers, Technicians and Scientists (JETS). Scholarship awards were also given to students in order to encourage them study science, technology and mathematics in the school system. Still in line with the government effort to improve science and technology education, the Federal Government of Nigeria has also revisited the structure of science, technology and mathematic curricula through bodies like NERDC and STAN. The restructuring was done in areas like philosophy, objectives, content, methodology, evaluation and the implementation (Ivowi 1997). This effort was geared towards making science, technology and mathematics education in Nigeria meet up with the changing philosophy and objectives of the nation as contained in the NPE (1981) which among other things is to make the country self-reliant and egalitarian.

Unfortunately, despite all these support from the government, professional associations and NGOs to improve the teaching and learning of science and technology at all levels of education, research reports revealed a decline in students' interest, attitude and performance in science-related courses as more students have continued to seek admission into Social Sciences and Arts than in science courses on yearly basis. In other words, according to Achor (2011) and Oludipe (2011), all these government efforts have not yielded the much needed result. They therefore suggested that further attention should be given to teaching and learning of science especially in Nigeria as a developing country.

Disturbed by this ugly development, researchers in the field of Science Education in Nigeria embarked on series of studies to find out the logic behind this ugly development. They found that the problem stemmed from the first form of science a child comes in contact with at the Junior Secondary School level, that is, Integrated Science (Basic Science).

To this, Osuala, Ogoamaka (2005) and Duru (2007) have this to say; "Despite the workshops and annual conferences, studies continue to reveal that students' result in the sciences remained persistently poor because of poor teaching methods used at the foundation science courses, that is, Integrated Science".

Integrated science is a core subject in the Junior Secondary School Certificate Curriculum which provides the students with basic and fundamental knowledge necessary for understanding of scientific principles and concepts. This course integrates students into the world of science after their exposure to the rudiments of science called primary science at primary school level (Adetoyinbo, 2004). Integrated Science also prepares the students for the study of core subjects like Biology, Chemistry, Physics, etc. at the Senior Secondary School level which in turn brings about students' interest in science and technology-related courses at the Tertiary Institutions.

The skills which integrated science is supposed to develop in the students as listed by Bajah (1988) includes:

- Observing carefully and thoroughly
- Reporting completely and accurately what is observed.
- Organizing information acquired.
- Generalizing on the basis of acquired information
- Predicting as a result of generalization
- Designing experiment (including controls where necessary) to check predictions.
- Using models to explain phenomena where appropriate.
- Continuing the process of inquiry when new data do not conform to prediction

According to NERDC report (2007), integrated science also teaches the students the simple process of science and will also enable them to;

- Develop interest in science and technology
- Acquire basic knowledge and skills in science and technology
- Apply their scientific and technological knowledge and skills to meet societal needs.
- Take advantage of the numerous career opportunities offered by science and technology.
- Become prepared for the further studies in science and technology.

Considering the above stated objectives of Integrated Science, therefore it may not be wrong to say that Integrated Science forms the basis of Science, Technology and Mathematics Education. And since there can be nothing like development without a sound Science, Technology and Mathematics Education which is crucial to the attainment of the laudable vision 20:2020 objectives, any society which aspires to be scientifically and technologically developed must have an adequate level of Integrated Science Education as a foundation course for other sciences (Adeyegbe, 1998; Ojerinde, 1998; Okebukola, 2002).

Despite all Government efforts to ensure that these laudable objectives of Integrated Science are actualized, research reports have continued to reveal a persistent students' poor performance in integrated Science at the Junior Secondary School Certificate Examination with a consequent students poor performance in science subjects at the Senior Secondary School Certificate Examination. Duguryil, Duguryil, Profi (2011), reported that students did not attain up to 30% credit level and above pass in integrated science between 2004 and 2008. Ojerinde (1998), also observed that students' performance in Integrated Science at the JSSCE still leaves much to be desired. This consistent students' poor performance in science at the JSSCE and SSCE has continued to have a negative effect on students' enrolment as well as their performance in the sciences at the tertiary institution. Again, many graduates of science lack the skills to actualize wealth creation or become self-reliant. What this potends is that the objectives of integrated science have not been fully actualized. This situation is very disturbing when viewed against the nation's aspiration for scientific and technological advancement as contained in the vision 20:2020. Duguryil et al therefore suggested that this problem of students' poor performance in Integrated Science should be given an urgent and serious attention if our aspiration to be one of the top 20 most developed nations as enshrined in the vision 20:2020 blue print must not elude us. Many reasons account for this students poor performance in Integrated Science. Researchers blame this ugly situation on teaching strategies used by teachers among other factors (Adepitan, 2003; Ivowi and Oludotun, 2001).

Afuwape and Olatoye (2004), identified lack of qualified teachers, teaching methods, lack of equipment and facilities for teaching, lack of practical works, and insufficient allotment of time for integrated science on the school time-table as the major factors militating against the successful implementation of the core curriculum in Integrated Science. To this end, records suggested that further classroom based research studies on integrated science teaching and learning problems should be vigorously pursued. Hence, the need to search for an approach that will enhance the implementation of the objectives of teaching integrated science led to this study.

Integrated Science like every other science subjects is by its nature dynamic and activity oriented. It has its processes and products. The processes of science are the approaches used by scientists in carrying out investigations. These approaches involve process or inquiry skills also referred to as science process skills. Science process skills are mental and physical ability and competences which serve as tools needed for the effective study of science and technology as well as for problem-solving, individual and societal development (Nwosu, 2011). Harlen (1984), defined Science process skills as the abilities that can be developed by experience and which are used in carrying out material operations and physical actions.

Ango (1992), Collette and Chappetta (2004), classified science process skills into Basic Science process skills and Integrated Science process skills. According to them, the Basic Science process skills include: observing, communicating, measuring, inferring, classifying and predicting while the Integrated Science process skills include such skills as identifying variables, formulating hypotheses, describing relationship between variables, designing experiment and interpreting data, formulating models, defining variables operationally, understanding cause and effect relationship. The Basic Science Process Skills are simpler and provide the foundation for learning the Integrated Science Process Skills which are more complex. Basic Science Process Skills are vital for science learning and concept formation at Primary and Junior Secondary School-levels. More difficult and complex integrated science process skills are more appropriate at Secondary and Tertiary School levels for formation of models, experimenting and inferring. Botherton and Preece (1995) noted that scientists can only use integrated science process skills effectively once they have mastered the basic skills.

Moreover, the 1997 American Association for the Advancement of Science (AAAS) cited in Nwosu (1991) identified fifteen process skills as follows; observing measuring, classifying, communicating, predicting, inferring, using number, using space and time relationship, questioning, controlling variable, defining operationally, formulating model, hypothesizing, designing experiment, interpreting data. Research studies focusing on the science curriculum improvement studies and Science – A Process Approach (SAPA) indicate that students, if taught process skill abilities, not only learn to use those processes but also retain them for future use (Okebukola, 2002). The acquisition of science process skills will help the students to explore their environment, solve certain scientific problems by transferring classroom experience to real life situations. The qualities inherent in these skills will contribute to the students abilities to answer questions and solve problem even when the information base of science and technology changes.

It is in line with the realization of these important roles of science process skills in solution to scientific problem, that the Federal Government of Nigeria among other things state as one of the national goal of education in Nigeria that “education should aim at helping the child in the acquisition of appropriate skills, abilities and competences, both mental and physical as equipment for the individual to live with and contribute to the development of the society". Ibe and Nwosu (2003) and Okoli (2006) are of the opinion that the acquisition of science process skills of observing, measuring, questioning, designing, experiment, interpreting data, etc enables one to become specially equipped with the tools required for scientific inquiry or problem-solving as well as ability to use these skills in the laboratory for a variety of investigation. But unfortunately, studies showed that students at all levels of education exhibit very poor acquisition of these important skills (Igboegwu, 2006; Nwosu, 2006). Researchers attributed this poor acquisition of science process skills to a number of factors such as teaching methods employed by teachers among others. Researchers regretted that science teachers have continued to lay extreme emphasis on content and teacher-centered approach (Lecture method) neglecting the practical activity approach which enhances teaching and learning of science. This present method used in teaching science especially in Secondary Schools do not augur well for the acquisition of Science Process Skills by Students (Ibe, 2004; Madu, 2004). According to Okebukola (2002), students learn the basic skills better if they are considered an important object of instruction and if proven teaching methods are used. Therefore, it is relevant to select appropriate teaching strategy that can facilitate the acquisition of science process skills as this will enable the students to use science information in daily life both personal, social and global.

Hence, the need to teach science in the context of human experience to match the increasing rate of science and technological advancement in our society led to Science, Technology and Society-Approach (STS – Approach) world wide. This paradigm shift in teaching method was first adopted in the USA in 1960. STS-Approach is recognized as a reform in Science Education across the world. The change in societal values prompted the proponents of STS-Approach to advocate for a change in the objectives of science teaching. They suggested that science should be considered from the societal view point rather than that of a scientist. Therefore, STS-Approach is designed to bridge the gap between academic work and everyday activities. The curriculum of STS-Approach is geared towards child-centered or activity-centred design, which puts more emphasis on learning science as a process rather than a body of knowledge (product) STAN (2001).

STS – Approach according to Yager (1992) means involving learners in experiences, questions and issues which are related to their lives. In a STS – Approach Classroom, the teacher creates situations where students will need the basic concepts of Science and Technology and Process Skill that allow them to become active and responsible citizens by responding to issues that influence their lives.

Ajeyalemi (1983) is of the opinion that the essence of STS class is that students come to acquire and use the processes of science which are appropriate to the solution of particular problem. This view is in line with the aim of STS which includes, among other things; the production of scientifically and technologically literate citizenry that is capable of taking responsible decisions about crucial problems and issues, and taking personal actions that can bring about development in the society. STS – Approach is needed to bring out attitudinal changes as we imbibe scientific and technological ways of doing things referred to as processes or skills. It is also needed to enhance meaningful learning, provide opportunity for skill acquisition, decision-making and problem-solving, as well as overall improvement or the draw back of the conventional approach in science teaching. An investigation of students accomplishment in science experience through the STS – Approach have been extensively documented (Yager, 1990, 1993b, 1998; Kellerman and Liu, 1996; Liu, 1992 & Negedum, 2008). Collectively, their reports revealed a measurable improvement in students' achievement with respect to mastery of science concept and processes; the ability to apply science concepts and processes in new situation particularly those in real-life setting; an understanding and use of the basic feature of science (i.e. nature of science). The report further indicates significant increase in students curiosity about natural and human-made world, significant improvement in students interest and attitude toward science and science-related careers and significant growth in students creative abilities relevant to science (such as the quality and quantity of student-generated questions, proposed explanation and methods of testing the validity of those explanations). The above citation clearly attests to the effectiveness of STS – Approach in accomplishing the reform vision of National Science Education Standard (NSES). Thus, this study will contribute to the attestation of the effectiveness of STS – approach in acquisition of science process skills and actualization of the objectives of the existing Integrated Science Programme.

Furthermore, a meaningful development should involve all citizens irrespective of gender, tribe or religion. Apart from teaching method, gender is another factor that has impacted on science education and interplays in the acquisition of Science Process Skills. However, studies have shown a contradiction on the acquisition of Science Process Skills in relation to gender. For instance, Raimi, (2002), reported that the effect of gender on students' performance in chemistry practical skill acquisition was not significant. The result also revealed a no significant interaction effect of treatment and gender on students' acquisition of practical skills in chemistry but remarks that female students performed better than their male counterparts in computational skills. Nwagbo and Chukelu (2011) and Ogunleye and Babajide

(2011) have similar reports. According to them, gender has no significant effect on acquisition of Science Process Skills. Reporting further, Ogunleye et al noted that the era of male dominance and supremacy in science learning is fast winding up. With scores of male and female students not significantly different both in achievement and practical skills, gender stereotyping as well as the view of science career being for male students are fast disappearing. The trends of boys having greater natural aptitude than girls has been disproved by the finding of this study.

Contrary to these studies are the reports of Nwosu (2001) and Okoh, Iwuzor and Odinma (2011). While Nwosu noted that boys generally perform better than girls, Okoh et al. reported that boys failed to achieve higher in computational problems in chemistry than their female counterparts. Shaibu and Maris (1997) study on gender difference in acquisition of science practical skills among Junior Secondary school students in Nigeria showed that there was a significant difference in the practical skills of boys and girls but no significant difference was observed in the application of practical skills acquired. Thus, with this contradicting reports and lack of clear trend in gender influence in students' acquisition of science process skills, there is need for further investigation. Again, none of these researchers employed the STS – Approach in their study, hence the need for this study.

Statement of the Problem

Research evidence have revealed a persistence in students' poor performance and lack of interest in science at the secondary school level resulting to low enrolment in science related courses in tertiary institution. This trend was blamed on the instructional methods used by teachers of science. Moreover, researchers have noted the relationship between instructional method and acquisition of science process skills. According to them, certain instructional methods (lecture, chalk-talk method, etc) do not augur well for the acquisition of science process skills. Findings in these studies were largely based on such approaches as cooperative learning strategy, guided inquiry with analogy, games, practical activities and demonstration in teaching for the acquisition of science process skills with no empirical evidence on the use of STS – Approach. Furthermore, the efficacy of STS-Approach as a reform needs to be tested in all aspects of Science Education. Therefore, this study seeks to find the effect of STS – Approach on students' acquisition of SPS in Integrated Science with gender as an intervening variable.

Purpose of the Study

The purpose of this study is to determine the effect of STS – Approach on the acquisition of science process skills in integrated science.

Specifically, the study sought to find out the following;

1) The differential effect of STS – approach and traditional approach on the acquisition of science process skills.
2) The effect of gender on the acquisition of SPS of Basic Science students thought using STS – Approach.
3) The interaction effect of STS – Approach and Gender on SPS acquisition of Integrated Science Students.

Significance of the Study

The findings of this study is expected to be of great benefit to the following: students, integrated science teachers, curriculum planners, educational administrators and policy-makers.

Integrated science students will benefit from this study since it is a student centered instructional approach. It will enable them to develop insight within their environment on how to solve their real life problems as students work in teams to solve one or more complex and compelling real world problems. This study might also enhance the students active participation in science which will help in improving the understanding of science process skills.

Furthermore, the finding of this study will help many science teachers who do not know the efficacy of this approach in the teaching and learning of science. The extent of the efficacy of the finding of this study is hoped to help the teachers in presenting their lesson down to the level the learners will understand. In addition, this could also help in stressing the need for students to acquire Science Process Skills since this will improve academic achievement especially in Integrated Science and by extension in Senior Secondary School Science Subjects. Again, for curriculum planners, the findings will bring to lime-light the importance of fully integrating STS – Approach into the curriculum of Junior Secondary School in Nigeria.

This study will go a long way in helping the educational administrators and policy-makers improve their services to the school by providing human and material resources, creating enabling environment that will help the teachers and students learn science effectively.

Scope of the Study

This study is on the assessment of the effect of STS – Approach on the acquisition of Science Process Skills in Integrated Science. The study was conducted using JSSII students and teachers in Enugu Educational Zone of Enugu State. The study was limited to Enugu

Educational Zone because of time factor and financial problem. It was also found that teachers in this zone rarely use STS – Approach in teaching. The content scope for the study are living and non-living matters, environmental pollution, thermal energy and uniqueness of man. The topics under living and non living matters that were treated include: matter, changes in living matters and non-living matters. Topics under environmental pollution also treated in this study include; meaning of pollution, identification of pollutants and their effects, causes of pollution and ways of reducing and controlling pollutions. These topics were selected because they fall among the STS topics in the JSSII Integrated Science Curriculum.

For the purpose of this study, seven out of the fifteen science process skills identified by AAAS were considered. They include observing, classifying, measuring, communicating, inferring, interpreting and experimenting

Research Questions

The following research questions were generated to guide the study

1) What are the effects of STS – Approach and the Traditional Approach on the mean acquisition of SPS among students of Integrated Science?
2) What is the influence of gender on the mean acquisition of science process skills of Basic Science students taught using STS – Approach.
3) What is the interaction effect of method and gender on the mean acquisition of SPS of Integrated Science Students?

Hypotheses

The following null hypotheses were formulated to guide this study at 0.05 level of significance .

HO_1: The mean science process skill acquisition score of students taught with STS – Approach will not differ significantly from those taught with Traditional Approach.

HO_2: Gender will not be a satistically significant factor in the acquisition of SPS of Basic Science students taught using STS – Approach.

HO_3: There will be no significant interaction effect of method and gender on the mean acquisition of SPS of Integrated Science Students.

CHAPTER TWO

LITERATURE REVIEW

The related literatures on the effect of STS – Approach on the Acquisition of Science Process Skills among Junior Secondary Two (JSS2) students were reviewed under the following headings.

Conceptual Framework

- ❖ Concept of Integrated science
- ❖ Concept of STS – Approach
- ❖ Concept of Science Process Skills
- ❖ Other Related Issues

Theoretical Framework

- ❖ Cognitive and social constructivists theory according to; John Dewey, J. Brunner, Lev Vygotsky and Jean Piaget.

Empirical Studies

- ❖ Studies on teaching approach and science process skills acquisition
- ❖ Studies on STS-Approach and students understanding of scientific ideas related to real world situation.
- ❖ Studies on Gender and Science process skill acquisition.

Summary of Literature Review

CONCEPTUAL FRAMEWORK

Concept of Integrated Science

Evolution of Integrated Science

Prior to the introduction of Integrated Science in the late 1960s, Nature study and General science used to be the science studied at the Primary and Secondary School levels. General science was later split into various science subjects such as Mathematics, Physics, Biology, Chemistry and Agricultural Science. Science then was without focus and direction, it was more aesthetic than functional. With the attainment of Independence, the greatest need of Nigeria was development both politically and socio-economically. It was then necessary to match Nigerian’s socio-economic and technological development with relevant education. Hence, frantic efforts were made at chanting a new course for Science and Mathematics Education based on the country’s new vision (Nwosu 2011). This effort was championed by various Nigerian bodies interested in progress in Science Education as a tool for individual and national development. Prominent among these bodies are; the STAN (established 1975) WAEC (established 1962) CESAC (established 1967). Their effort resulted in curriculum reforms in Nigeria. And so by 1970, STAN developed the first science curriculum called Nigerian Integrated Science Project (NISP) in conformity with the guidelines as specified in STAN curriculum development Newsletter No. 1 which contained the philosophy, methodology, content and evaluation. Other curricula which enhanced the teaching and learning of science both in Nigeria and in other countries of the world include: Bendel State Primary Science Project (BSPSP), Primary Education Improvement Project (PEIP), The Yoruba Six Year Primary Science Project (BSNSS), The Science Education Commission for American Association for the Advancement of Science (AAAS), Science – A Process

Approach (SAPA), Nuffield Project, Science Education Programme for Africa (SEPA). The (SAPA) for example places its emphasis on Science process skill in the Student (Nwokolo 2013). Following the result of the review of NISP and other Integrated Science materials, by 1981, a core curriculum for Integrated Science for Junior Secondary School level was drawn up by STAN and other agencies.

Integrated Science Curriculum

Structurally, Integrated Science core curriculum for JSS as stipulated by the FME (1981) consists essentially of six themes: viz Topic(s), performance, objectives, content, activity and notes. By this arrangement, each topic has four aspects across the column. The fifty-four (54) major topics treated in the core curriculum document focus mainly on six themes in Integrated Science as follows;

- You as a living thing
- You and your Environment (Home).
- Living Component of the Environment
- Non-Living Component of the Environment
- Energy and machine
- Controlling the Environment (Oludipe 2011).

The spiral nature of the themes ensures that content becomes gradually difficult as learners progress from primary 1 to 6 and from JSS 1 to JSS 3.

The integrated science curriculum has gone through various transformations and integrations of the science. The Nigerian Education Research Development Council (NERDC) convened a meeting of experts from various fields in 2006, who met and produced the reviewed curricula. In the re-structuring, Basic Science and Technology replaced

Integrated Science while Basic science replaced Primary Science. Basic Science and technology is basic training in Scientific skills required for human survival, sustainable development and societal transformation. The new themes infused into the Integrated Science curriculum include: Environmental Education, Drug Abuse Education, Population and Family life Education and Sexually Transmitted Infection (STI) including HIV/AIDS. The objectives of the Basic Science and Technology curriculum as stated by NERDC are to enable the learner to;

- Develop interest in science and technology
- Acquire basic knowledge and skills in science and technology
- Solve everyday problem
- Apply the scientific and technological knowledge and skills to meet societal needs.
- Take advantage of the numerous career opportunities offered by Science and Technology
- Become prepared for further studies in science and technology.

CONCEPT OF STS – APPROACH

Evolution of STS – Approach to teaching and learning of science

The science, technology and society movement in Science Education evolved as a reaction to the curriculum reform movement of the 1970s. The curriculum used then for the teaching of science subject was developed from curriculum projects such as Chem. Study in the U.S and Nuffield programs in the U.K. These projects which were developed during the late 1950s and early 1960s following the launching of the Sputnik in the USSR emphasized conceptual understanding of unifying themes and/or major theories and learning from both experimentation and model making. The programmes gave some students an indepth view of science rather than a mere collection of facts. They were amplified by sub-division of cognitive skills, an emphasis on inquiry skills and a recognition of a hierarchy based on Blooms taxonomy. These courses which had great influences on the teaching of science world wide from later 1960s until now was not without shortcoming. The curriculum was found to be deficient for the teaching of science, because, its teaching made science subjects difficult for the students to understand compared with other subjects. With this curriculum, science was divorced from technology and considered solely as pure rather than applied science with little or no reference made to the daily issues experienced by the students in their environment. Furthermore, the teaching method that prevails in these courses was more of traditional method in which the teacher supplied answers during experiment with less emphasis on scientific processes. Again, the recognition that man-made world around us is based on technology demands that to obtain a more technological literate society, there is need for people to receive a more relevant grounding in science. This grounding should involve the technology that surrounds them and in addition, the issues and conflicts that are related to the use of that technology in society. And so, the Educationist founding that this curriculum could no longer cope with the change in the trend of events world wide, advocated for a change in the objectives of science teaching. They advocated for the consideration of science from a societal view-point rather than that of a scientist. It was in response to this demand for change, that many agencies were established and mandated to research and improve on the existing science curriculum in the U.S. Prominent among these agencies are; Science Curriculum Improvement Study (SCIS), Science – A process Approach (SAPA) and American Association for the Advancement in Science (AAAS). Following their research reports, STS – Approach to the teaching of science was developed along side others approach such as: Analogy, Co-operative teaching, Constructivist, Concept mapping, etc. Many projects have been developed based on STS – Approach in different countries of the world. For instance, in the U.S, Science is taught as; Science and Technology in the Society (SATIS), other projects include Association for Science Education (ASE), Science in Society, Project Synthesis of Natural Science Foundation, UNESCO Project 2000+, U.S Project 2061 and Science for All America. In Nigeria, Early Science Series for Africa (ESSA) has taken the lead at the primary school level, while NERDC projects on population and family planning education follow at the secondary school level. Since the adoption of STS – Approach to Science teaching, it has been developing its own style, using some of the positive attributes and ideas of the 1960s (e.g. experiential active learning, developing inquiry skills, providing opportunities for individual projects) but paying special attention to selection of topics of generic interest to social interest and improved standard and quality of life.

Meaning of STS – Approach

National Science Teachers Association (NSTA) in the U.S. defined STS-Approach as the teaching and learning of science in the context of human experience with emphasis on the importance of technology and science. There are no concept and/or processes unique to STS-Approach, instead STS-Approach provides a setting and a reason for considering basic science and technology concepts and processes. It means determining and experiencing ways that these basic ideas and skills can be observed in society. STS-Approach focuses on real world problems which view Science and Technology components from the students' perspective instead of starting with basic concepts and processes. This allows students to identify, to analyze and to apply concepts and processes that can be used in real life situation (Yager 1992)

Aikenhead, (1994) defined STS – approach as that approach which emphasizes the link between Science, Technology and Society by means of emphasizing one or more of the following; technological artifacts, process or expertise, the interaction between technology and society, societal issues related to science or technology, social science content that sheds light on a societal issue related to science and technology, a philosophical and historical or social issue within the scientific or technological community. The idea behind STS – Approach is to provide real-world connection for the students between the classroom and society. The process should give the student opportunity to identify potential problems, collecting data with regard to the problem, considering alternative solutions, and considering the consequences based on a particular decision. The emphasis of science teaching around concept has been one of the set backs of previous science curricula. Advocates of STS-Approach have been careful in dissociating STS-Approach from this, rather, its emphasis is on integrating different disciplines and problem-solving by techno-scientific method. STS-Approach is a term applied to the latest effort to provide a real-world context for the study of science and for the pursuit of science itself. STS-Approach includes the whole spectrum of critical incident in the education process including goals, curriculum, instructional strategies, evaluation and teacher-preparation/performance (Yager 1989) cited in Jack (1992).

STS –Approach content may vary from one society to another but is often unified in aims/objectives. The importance of any attribute (in this case STS programme) needs to be seen from the value associated with it. Such perceived value or value claims are either intrinsic (i.e. by virtue of its very nature) or extrinsic (i.e. external or traceable to it from its effects). In either case, such value claims help to define the objective of the programme.

When all are considered – aims, curriculum contents and objectives they help provide justification for the programme.

Aims of STS – Approach

The overall aim of STS-Approach is to produce a scientifically and technologically literate citizenry that is capable of taking responsible decisions about crucial problems and issues, and taking personal action that can bring about development in the society. This is because of the present age of science and technology (in which we live), and the complex nature of our society. The knowledge of science and technology bring out attitudinal changes as we imbibe scientific and technological ways of doing things referred to as processes and skills. When we have these process skills and acquire enough science and technological concepts, we are in a position to solve problems that can advance society.

STS Curriculum

STS – approach to the teaching of science has no specific curriculum but is based on the existing curriculum that has been revised by employing integration, addition or deletion and application approach and increasing the science and technological concepts in the curriculum especially concepts that touch on environmental issues. For instance, in Integrated Science, the existing core curriculum based on NERDC project was revised by infusing into it topics (STS – topics) that border on environmental issues. For example, in a unit like living things, topics such as identifying self as a living thing, human intelligence shown by his/her organization, problem-solving skill were infused, etc while in unit like circulatory system topics such as: blood defects or diseases were infused. However, according to Aikenhead (1986) the objectives of STS curriculum can be viewed from the following perspective;

1) **Science Discipline:** To develop learners competency in understanding selected facts, principles, laws, theories and concepts and inquiry skills.
2) **Technology discipline content:** To develop learners understanding of selected concepts of designs, materials, systems and apparatus.
3) **Characteristics and Limitation of Science and technology:** To equip learners to distinguish between three interacting components, that is, explicitness of technology, explicitness of inquiry and tourism of scientist and technologist
4) **Interaction of Science and Technology with Society:** To distinguish between social responsibilities of scientists, technologists as social institutions, to develop learners' competency in making socio-scientific decisions and to suggest follow up activities for learners.
5) **Develop skills in communication:** To develop technologically literate citizens that are capable of taking responsible decisions about crucial problems and issues that can bring about development in the society.

STS Methodology

There is no single best method for the teaching of STS topics. The teacher, situation and nature of the topic or concept being taught determine to an extent the method to use. The curriculum which is learner-centered embraces the integration of different approaches to make learning meaningful. For Yager (1996), constructivism is the learning theory that underlines the teaching strategy of STS-Approach. In constructivist classroom, students are provided with opportunities to build on prior knowledge from authentic experience. Such classroom allow the students to confront problems full of meaning since these problems have real life context. In solving these problems, students are encouraged to explore possibilities, invent alternative solution and collaborate with other students (or external experts) to try out ideas and hypothesis, revising their thinking and finally presenting the best solution they derive.

Aikenhead (1994a), is of the opinion that teaching strategies appropriate for STS teaching should include; divergent thinking, small group work, student centered discussion, problem solving, simulation and debate. Media and other community resources should be harnessed for STS teaching. Discussion method can be used effectively to teach science and technology limitation while value clarification can be effective in teaching of science related social problems and influential issues such as birth control, abortion, sexually transmitted diseases, human cloning, global warming, malnutrition, desertification and energy shortage among others.

Different approaches to the teaching of STS topics have been well documented by various authorities and researchers thus; the STAN (2001), enumerated five possible approaches that a science teacher should consider in the teaching of STS lesson.

These include:

1) **Factual Approach:** In this approach, emphasis is on teaching the facts that have been uncovered by the scientist. The teacher simply teaches the facts as they are accepted by the community of scientist and the public in general.

2) **Conceptual Approach:** Here the emphasis is on the concepts and the conceptual schemes that are built around some major ideas capable of tying together the principle finding of science. Mani (1984), cited in STAN (2001), believes that the learning concepts is more demanding than remembering facts. In order to acquire concepts, the pupil needs to work with concrete objects, acquiring facts and manipulating ideas mentally. The demonstration of conceptual understanding occurs in three levels, thus:

a. Identification of examples and more examples of conceptual groups

b. Identification of attribute function or process of a given system

c. The classification of objects into groups based on similar characteristics that are defined explicitly

3) **Process Approach:** This approach entails, teaching processes through which science uncovers facts and develops models. It involves helping the pupils to behave like scientist by encouraging them to practice the behaviours of scientists such as observation, measurement, prediction, classification, communication, etc. The process approach thus helps pupils to become familiar with both the knowledge content and the process content of science.

4) **Out-door Science learning activities Approach**: There are a number of good variety out-door science learning experiences that could be meaningfully employed to help students learn science. Such experiences should however be used when they prove most beneficial to the learner. A general rule concerning the use of the out-door science learning experiences is that, they should be ideally used with pupils who are in the Piagetian concrete operational stage of mental development. Such activities should be suitable enough to meet some of the developmental needs of the learners. Group activities also should be encouraged, because such learning experiences afford the pupils the opportunities to handle and observe real objects, animals and plants in their natural settings.

5) **Consequence mapping Approach:** This approach simply highlights the key factors and consequences of a topic or concept using a map. It highlights the positive and negative outcomes on a map and this assists in weighing the consequence of the proposition. The

production of consequence map encourages students to consider a broad range of implication arising from an issue.

In Yager's (1996) own opinion, the teaching strategy that is both effective and flexible comprises of six basic steps, thus;

a) Brainstorm an issue or topic

b) Define specific questions or phenomenon

c) Brainstorm resources for obtaining information

d) Use of resources to collect information

e) Analyze, synthesize, evaluate, create and

f) Take action.

CONCEPT OF SCIENCE PROCESS SKILL

Nature

Recognizing the fact that science process skills (SPS) are integral part of science education, many research studies have been focused on the acquisition of the subject matter, investigated, identified and defined the process skills.

According to Osthund (1992) SPS are transferable skills that are applicable to many sciences and that reflect the behaviour of scientists. They are skills that facilitate learning in physical sciences, ensure active student-participation, help students develop the sense of undertaking responsibility in their own learning, increase the performance of learning, and also help students acquire research ways and methods, that is, they ensure thinking and behaving like scientists. For this reason, it is an important method in teaching science lesson. SPS are the building blocks of critical thinking and inquiry in science. SPS are activity – base skills which can be acquired through training and direct experiences. The acquisition of science process skills by students is influenced by the cognitive knowledge – based of the students (Igboegwu and Egbutu 2011).

Akinbobola and Afolabi, (2010) view science process skills as cognitive and psychomotor skills employed in problem-solving, problem-identification, data-gathering, transformation, interpretation and communication. In other words, science process skills are cognitive and psychomotor skills that can be acquired and employed in the scientific development of a child because it enhances concept development. In line with this, Ongowo and Indoshi (2013), assert that the understanding of the world around individuals depends on the development of concepts. The development of concepts depends on the process skills. The concepts and process skills are interrelated. As concept gradually becomes sophisticated, process skills need to be reformed and extended.

The American Association for the Advancement of Science (AAAS) through the launching of science – A Process Approach (SAPA) emphasized the laboratory method of instruction and learning of scientific processes by children. Thus, SAPA identified fifteen (15) science process skills. Some of these skills are listed and described below to throw more light on the nature of science process skills:

1) **Observation:** This involves using the five senses and appropriate tools to gather information about an object, event or phenomenon. It includes collating evidence, identifying similarities and differences, classifying, measuring and identifying relevant observations. For example, listing the similarities and difference of a cube of ice and a ball of ice, describing the colour and shape of an object.

2) **Inferring:** Making an "educated guess" about an object or event based on previously gathered data or information. Example; saying that the person who used pencil made a lot of mistake because the eraser was well worn.

3) **Measuring:** Using both standard and non standard measures or estimate to describe the dimension of an object or event. Example, using a meter stick to measure the length of a table in centimeters.

4) **Communicating:** Using word or graphic symbols to describe an action, object or events. Or representing observations, ideas, theoretical model, or conclusion by talking, writing, drawing, making physical models and so forth. It involves talking with a more knowledgeable person, using secondary sources, presenting reports, constructing data tables and creating charts and graphs. Examples; describing the change in height of a plant over time in writing and through graph, describing the relationship between the melting time of an ice cube and amount of salt sprinkled on the ice cube by writing or by constructing graph.

5) **Classifying:** Grouping or ordering objects or events into categories based on properties or criteria. Examples: placing all rocks having the same grain size or hardness into one group.

6) **Predicting:** Forecasting or stating the outcome of a future event based on pattern of evidence or a hypothesis (on explanation). A prediction based on a hypothesis can be used in planning a test of that hypothesis. Predicting includes other sub skills like justifying a prediction in terms of a pattern in the evidence and making a prediction to test a hypothesis. For example, predicting the height of a plant in two weeks time based on a graph of its growth during the previous four weeks, water flowing from a height of 8

inches will wash away more sand than water flowing from a height of 6 inches, this prediction is based on the pattern that water flowing from a height of 6 inches washed away more sand than water flowing from 4 inches, and water flowing from 4 inches washed away more sand than water flowing from 2 inches.

7) **Controlling Variables:** Being able to identify variables that can affect an experimental outcome, keeping most constant while manipulating only the independent variables. It includes planning and investigating. Examples: (i) realizing through past experiences that the amount of light and water need to be controlled when testing to see how the addition of organic matter affects the growth of beans, (ii) deciding to put a teaspoonful of sugar on another identical ice cube, setting them side by side and observing their relative melting rates in order to determine if one melts faster than the other.

8) **Defining Operationally:** Stating how to measure a variable in an experiment. Example stating that bean growth will be measured in centimeter per week.

9) **Formulating hypotheses:** Stating the expected outcomes of an experiment or giving a tentative explanation based on experience of a phenomenon, event or the nature of an object. A hypothesis is testable. Hypothesis is not the same as a prediction which is the expected outcome of a specific event. However, a hypothesis can be used to explain a specific event. Sub skills include: inferring, constructing models to help clarify ideas, and explaining the evidence behind a hypothesis. Example: increasing surface area causes faster melting (this explains why crushed ice melts faster than a block of ice of the same mass). The greater the amount of organic matter added to the soil, the faster the bean growth.

10) **Interpreting data:** Considering evidence, evaluating and drawing a conclusion by assessing the data or organizing data and drawing conclusion from it. In other words, answering the question “What do your findings tell you? Finding a pattern or other meaning in a collection of data. Sub skills include: interpreting data statistically, identifying human mistakes and experimental errors, evaluating a hypothesis based on the data and recommending further where necessary. Example: after observing the melting rate of ice cube sprinkled with salt and one without salt, concluding that salt reduces the freezing point of water. Recording data from the experiment on bean growth in a data table and forming a conclusion which relates trends in the data to the variables.

11) **Experimenting:** Being able to conduct an experiment, including asking an appropriate questions, stating a hypothesis, identifying and controlling variables operationally, defining those variables, designing a fair experiment, conducting the experiment and interpreting the result of the experiment. Examples, the entire process of conducting the experiment on the effect of organic matter on the growth of a bean plant.

12) **Formulating models:** Creating a mental or physical model of a process or event. Example, the model of how the processes of evaporation and condensation interrelates in the water cycle.

13) **Questioning:** Raising question about an object, event or phenomenon. Sub skills includes; recognizing and asking investigable questions, suggesting how answers to the questions can be found, and turning an investigable question into a question that can be acted upon. Example, “Will ice melt faster with or without salt sprinkled on it?”

Significance

The role of SPS in personal and national development at large cannot be over emphasized. Little wonder why science educators have always advocated for the inclusion of these skills in science curricula and the use of appropriate teaching methods that will enhance their acquisition by students. The use of SPS increases the permanence of learning in students. For learning by doing, students use almost all their senses and hands-on activities which enable them to acquire experiences that make learning permanent. The development of science process skills enables students to solve problem, think critically, make decision, find answers, and satisfy their concern. Not only do SPS get students to learn some scientific information but learning these skills enable them think logically, ask reasonable questions and seek lasting solution to personal, social, political and economic problems they encounter in life. The acquisition of research skills provides the students greater opportunity of developing their potentials and becoming competent. In other words, teaching through process approach creates a scientific literate individual capable of tackling scientific challenges world-wide.

However, research reports reveal that the acquisition of science process skills is determined by certain factors. According to Njoku (1994), factors such as students ability level, availability of relevant equipment and material and the approach adopted for carrying out activities determine how far the objectives of processes in science activities are achieved. Even when model teaching methods are used, factors such as level of intelligence of the teacher, socio-economic status of parents and learner characteristics such as scientific literacy level contribute to students' acquisition of process skills in Chemistry.

OTHER RELATED ISSUES

Relationship among Science, Technology and Society

Science, technology and society are interrelated and so affects each other. Science as a body of knowledge has its products which includes; concept, hypotheses, laws, principles, and theories. The authenticity of these products can only be proven by applying them in solving the scientific problems of the society. This application of scientific products is referred to as technology. That is to say, that technology involves a body of knowledge or laws, principles, etc applied to practical tasks, for the reduction of human suffering or improvement of productivity. In other words, technology is the means or activity by which man seeks to change or manipulate his environment through the application of the result of pure science. Therefore, technology centres on the application of scientific knowledge to industrial processes for the benefit of mankind. However, not all technology is based on science nor is science necessary for all technology. This is because certain inventions like making tools of irons took place before the science of its change was learnt. That not withstanding, science and technology are inseparable. The relationship between science and technology are evident in modern productions like in food production, agriculture, medicine, transportation, communication and so on to benefit the society.

Society refers to group of people with common culture. It represents a number of people associated for a common interest or distinguished by particular qualities as social organization. The study of society is important because it enables one to know the origin, development and history of a society, its cultural sources, features, growth at different times and in various areas, the effect of one society on another, the organization of occupation and other association in it, as well as the function of religion and culture (moral codes, administration of justice, basis of authority, etc). The knowledge of society determines to a large extent the scientific methods and technological activities to apply. That is to say that science and its methods and technology are the products of society and its needs.

Consequently, by their very nature, goals and values of science are dictated by society and are pursued for reasons of perceived benefit for all. The relationship between science, technology and society is such that no society, however ambitious, could advance or build an institutionalized science without a solid development in basic technology. The development of modern technology could not have been possible without man's advances in science. Science is the soil from which technology germinates and flourishes while the society initiates and controls scientific and technological endeavours. On the other hand, science and technology mould the society. It could thus be said that science, technology and society are interdependent terms and none of them can exist or be studied without the other. Perhaps, it is based on this interdependence of science, technology and society that the advocates of STS-Approach to the teaching of science maintained that science and technology teaching should not be divorced from the societal needs. For them, science education for sustainable development should take into consideration the environmental issues and problems of all irrespective of gender.

Concept of Gender

Gender has often been described as roles and responsibilities which families, societies and cultures assign to men and women, boys and girls. In the view of Patrick (2010), gender is a social attribute and opportunity associated with being male or female and the relationships between women and men, girls and boys, as well as the relations between women and those between men. A more comprehensive definition according to Ezeh (2013), refers to gender as ones subjective feeling of “maleness” of “femaleness” irrespective of one’s sex. Gender is generally classified into masculine and feminine and is concerned with the attitude that describes males and females in the social and cultural context.

Gender can as well be seen as a mind-set and as such depends on individual’s disposition, potential, determination and desire. It is socially constructed and are learned through socialization processes, therefore, gender can be changed. In certain cultures, it is gender that determines what is expected, allowed and valued in a woman or man, boy or girl. This is why certain responsibilities and roles are assigned to boys and girls thereby creating gender stereotype. This stereotype has resulted in gender bias/barrier in schools which are evident in teaching strategies, teacher attitude like (recommendation of gender biased textbooks, grouping of students activities and assignment especially in rural schools where sweeping are reserved for girls and cutting of grasses for boys) the content of compliment and criticism. This has influenced students’ achievement and interest in science and science related courses and created a gender gap in science education against women. Gender bias also influences the acquisition of science process skills as certain task are tagged male or female and not just for anyone who has the interest and potential to tackle it. This gender gap can only be bridged if equal opportunities are created for both male and female students to develop their potentials. Such opportunities can be made accessible through the use of gender sensitive approach to the teaching and learning of science. STS-Approach to the teaching of science is gender sensitive. It creates opportunity for both male and female students to participate in the learning process and develop their potentials.

THEORETICAL FRAMEWORK

In a STS classroom, the teacher employs more than one teaching strategy depending on the topic and situation at hand. However, all these strategies are underlined by the same learning theory, which is constructivism (Yager, 1996). Constructivism is a philosophy of learning founded on the premise that by reflecting on our experiences, we construct our own understanding of the world we live in (Okebukola, 2002). This means that we generate our own rules and models and use it to make sense of our experiences. According to the constructivists, learning simply means the process of adjusting our mental models to accommodate new experiences. Constructivists encourage learner autonomy and personal involvement in learning, looks to the learners as incumbent of significant roles and as agents exercising will and purpose. STS-Approach share the same idea and principle with the constructivists and this makes the constructivists theory relevant to this study. Therefore, the theoretical framework underlying this study is based on the cognitive and social constructivist theories of John Dewey, Jerome Brunner, Lev Vygotsky and Jean Piaget.

John Dewey’s Philosophy of work

John Dewey is one of the philosophers whose work has contributed to the understanding of how humans learn. As a constructivist, he believes that students thrive in an environment where they are allowed to experience and interact with the curriculum. Therefore, teachers should create an enabling environment that will give the students the opportunity to take part in their own learning. He encouraged hands-on-minds-on learning, that is, practical activities, and states that it is impossible to procure knowledge without the use of objects which impress the mind. According to him, the learner should be guided and assisted by the teacher to construct their learning and discover meaning within the subject area without depending on the teachers. Dewey emphasizes the use of observation, testing, scientific method, inquiry and discovery methods in teaching and learning of science. His view on the use of scientific methods forms the background for science process skills involved in science teaching.

The implication of this theory to this study is that the students must be engaged in meaningful activities that induce them to apply the concepts they are trying to learn. Again, teachers should emphasize on active learning by providing enabling environment for practical activities.

Jerome Bruner's Theory of Discovery Learning

Jerome Brunner's theory of cognitive constructivism stipulates that learning is an active process in which the learner constructs new ideas or concepts based upon their current or past knowledge. He believes that learners select and transform information, construct hypotheses and make decision relying on a cognitive structure to do so. For him, cognitive structure (mental models) provides meaning and organization to experiences and allows the individual to go beyond the information given. He argued that a learner even of a very young age is capable of learning any material so long as the instruction is organized appropriately. The curriculum should be organized in a spiral manner so that the students continually build upon what they have already learned. According to him, the purpose of education should not be to impart knowledge, but instead to facilitate a child's thinking and problem solving skills which can then be transferred to a range of situations.

The implication is that STS teachers should create situations that would help learners to discover facts by themselves as this makes for effective learning. The learner should be guided to explore their environment and find out the facts by themselves. Therefore teachers should present the learning instructions in a sequential order as this will help the learner to transfer what is learnt.

Lev Vygotsky's theory of Social Learning

Vygotsky is often associated with the social constructivist theory perhaps because he emphasizes the influence of cultural and social context in science learning. According to Vygotsky, development cannot be separated from its social context as the later influences not just attitudes and beliefs but also affects thinking, perception and memory. Central to his theory is the concept of zone of proximal Development (ZPD) which is the difference between what the child is capable of achieving unassisted and what he/she can achieve with the help of others in the society. He believes that the range of skills that can be developed with the help of an adult guidance on peer collaboration exceeds what can be attained alone. Therefore other people should help a child develop skills through scaffolding. He believes that language plays a central role in mental development since it is the transmitter of cultural tools.

The implication of this theory to STS is that in the curriculum, topics which are relevant to the child's cultural setting are selected. Teachers should create and manage the learning environment by setting the task to be done by the students. Opportunities and support should be provided for every child to develop optimally in the ZPD. Children should be allowed to learn through scaffolding so as to create social interaction among individuals and learning resources.

Jean Piaget's Theory of Maturation

Jean Piaget's theory of Maturation is another theory that gives a theoretical framework to this study. Piaget was interested in finding out the role of maturation in children's increasing capacities to understand their world. He believes that children cannot undertake certain task until they are psychologically mature to do so. He believes that cognitive development is influenced by heredity and environment. For Piaget learning is a holistic approach by which a child constructs understanding through channels like reading, listening, exploring and experiencing his or her environment. He believes that concept formation and cognitive development occurs through four stages of life. These developmental stages according to Onyehalu and Owuamanam (1993) are as follows;

1) **Sensory-Motor Stage (0-2years):** The sensory motor child has no language and cannot communicate verbally. He is mainly occupied with sensory perceptions and movements of the eyes, hands and the entire body. Through such movement and activities, the child explores his new environment. He manifests intensive geocentricism. Towards the end of this stage, he acquires “object permanence” and thus recognizes that objects that are currently out of sight are existing somewhere else and can still be recovered.

2) **Pre-operational Stage (2-7years):** This is an extention and an advancement of the sensory motor stage. How the child achieve verbal communication which enhances his active exploration and understanding of the environment. Nevertheless, he is still dominated by attention to striking physical attributes of task situation e.g. he will be deeply interested in colours, size and arrangement of objects rather than quantity. Again, his attempts at logical behaviour are compounded by his attitudes of centration that is, in a problem situation, he tends to pay attention to only one dimension at a time, neglecting the vital aspects. This naturally leads to wrong decision concerning amount or quantity. He is therefore a non-conserver at this stage.

3) **Concrete operational stage (7-11years):** The child now thinks in concrete terms and can solve simple problems if concretely presented before him. For example, he can do serial ordering of numbers and objects from the lowest to the highest and vice versa. Similarly he can classify objects correctly according to a specified criterion. He can now decentre his attention to focus on two or more variables simultaneously. He is therefore a conserver. The attainment of conservation lays the foundation for durable logical judgment about reality.

4) **Formal operational stage (12yreas and above):** This coincides with the outset of adolescence. The child now becomes capable of logical, flexible and propositional reasoning typical of adults. He can now consider alternative approaches in problem solving and make justifiable generalizations. The child can now engage in divergent and convergent thinking and derive meaningful conclusions through deductive and inductive logic.

Out of these stages explained above, the researcher considers the two last stages, that is, the concrete operational (7-11 years) and the formal operational (12 years and above) stages as the most relevant to the study. Reasons being that majority of the JSS 2 students that will be used for this study fall within these stages. Also within these stages, the students are fully matured to exhibit the science process skills of observing, classifying, measuring, experimenting, inferring, interpreting and communicating which are involved in this study.

Educational Implication of Piaget’s Theory

Piaget has obvious implications for teaching, they are as follows:

1) He proposed time specifications for the average child to attain certain mental abilities within the limits of individual differences, this will be a valuable guide for both parents and teachers.
2) Given the developmental nature of intelligence the teacher should arrange subject matter in sequence from the basic to the more complex.
3) The teacher should involve pupils in lesson development as far as possible especially by asking them simple relevant and guiding questions.
4) Lesson ought to be made concrete where possible. Audio visual aids and appropriate models should be used to facilitate theoretical explanations.
5) Problem solving approach or discovery method involving individual and group project is to be explored.
6) Children should be motivated to participate in class work through adequate feed back and prompt attention to their written assignments.

EMPIRICAL STUDIES

Studies on Teaching Approach and Science Process Skill Acquisition

Chukelu (2009), investigated the effect of Biology practical activities on students’ process skill acquisition in Abuja Municipal Area Council. The design of the study was quasi – experimental. Specifically, the pre-test-post-test, non-equivalent control group design. The sample consisted of one hundred and eleven (111) SSI Biology students (60 male and 51 female) randomly drawn from two Senior Secondary Schools in Municipal area council education zone, Abuja Federal Capital Territory. Three research questions and three hypotheses guided the study. The instrument used for data collection was the Science Process Skill Acquisition Test (SPSAT) designed by the researcher. The data collected were analyzed using mean and standard deviation to answer the research question while ANCOVA was used to test the hypotheses at 0.05 level of significance. The result revealed that practical activity method was more effective in fostering students' acquisition of science process skills than the lecture method. The interaction effect between teaching method and gender of the subjects was not significant. The researcher recommended the use of practical activity method by teachers to foster the acquisition of science process skills in Biology students.

Also, study was carried out by Igboegwu and Egbutu (2011) to investigate the effect of co-operative learning strategy and demonstration teaching methods on acquisition of science process skills by chemistry students of different levels of scientific literacy. The design of the study was quasi-experimental of pre-test post-test non-equivalent control group. The sample consisted of one hundred and forty-five (145) senior secondary two (SS2) chemistry students drawn from six randomly sampled schools in Onitsha Urban area of Onitsha Education Zone in Anambra State. Two research questions and two hypotheses guided the study. The instrument used for data collection was the Science Process Skill Acquisition Test (SPSAT) and the Scientific Literacy Test (SLT). Mean and standard deviation were used to answer the research questions while ANCOVA was used to test the hypotheses at 0.05 level of significance. The result revealed that students taught using co-operative learning strategy performed significantly better than those taught using demonstration teaching methods. There was no significant interaction between teaching methods and scientific literacy levels of chemistry students on science process skills acquisition. The researchers recommended the use of co-operative learning strategy to enhance science process skills acquisition in chemistry students.

Nsa, Akpan and William (2012) carried out a study on instructional strategies and students skill acquisition in vegetable crop production to determine the effect of discovery-learning, guided demonstration and expository instructional strategies and gender on students skill acquisition. Three thousand, two hundred and five (3205) Agricultural Science students in Senior Secondary School Two (SS2) in Akwa Ibom State formed the population. The sample consisted of 150 SS2 students selected from three intact classes in three schools out of 239 sampled in the area of study. A non-randomized pretest and post-test control group design were used. Three hypotheses were tested using ANCOVA and Scheffe's test at 0.05 level of significance. Result of the study revealed that students taught using guided demonstration strategy performed better in both laying out for vegetable production and sowing skills than their counterparts in discovery learning and expository groups. The findings further revealed that gender does not significantly influence skill acquisition. The researchers recommend guided – demonstration strategy for adoption in both secondary and tertiary institution.

In another study carried out by Nworgu and Otum (2013) to investigate the effect of guided inquiry with analogy instructional strategy on students acquisition of science process skills in biology, 160 Junior Secondary Class three (JS3) students was used. The study adopted a non-equivalent control group quasi experimental design. The data used for the study was collected using a test of Science Process Skill Acquisition (TOSPSA) developed by the researchers. TOSPA was subjected to both face and content validation while its reliability was established using Kudder – Richardson formular 20 (k-R20) mean, standard deviation and 2-way analysis of covariance were used to test the hypotheses at 5% level of significance.

The result of the study revealed that teaching method was statistically significant ($p<0.05$) in enhancing students acquisition of science process skills in favour of the guided inquiry with analogy. The researchers recommended the adoption of guided inquiry with analogy teaching method in science classrooms since it would encourage both male and female students to perform well and reduce the gap between the two groups.

In another research carried out by Nwokolo (2013), the effect of game on the acquisition of science process skills among JSS students was investigated. The study adopted non-randomized control group pre-test post test design. Three research questions and five null hypothesis guided the study. The hypotheses were tested at probability of 0.05 level of significance. One hundred and sixty students (78 males and 84 females) from co-educational schools were selected for the study. The instrument used for data collection was a twenty-five test of Students Science Process Skill Acquisition (TOSPSAT) items developed by the researcher. The reliability of instrument was determined using Kudder-Richardson formular 20 (K-R20). The data were analyzed using mean and standard deviation while ANCOVA was employed to test the hypotheses at 0.05 level of significance. The result of data analyzed revealed that students taught using games scored higher in the individual science process skills studied than those who were taught using conventional method of teaching. The use of game consistently enhanced acquisition of science process skill irrespective of gender and school location. There was no significant different on the acquisition of science process skills among male and female students exposed to game across school location. It was also observed that there was no significant interaction effect on instructional method and gender, instructional method and location on science process skill acquisition score of the students. The researcher recommend that games should be infused into science curriculum and teachers should explore activity – based instruction like game in teaching science for the acquisition of science process skills. Furthermore, Chukwuemeka (2005) investigated on the effect of mode of presentation of material resources on the acquisition of science process skills among primary school pupils in Nsukka L.G.A. of Enugu state. One hundred and eighty (180) pupils formed the sample. Intact classes was randomly assigned to experimental and control groups. The instrument used for data collection was a test of Acquisition of Science process skills (ASPS). Mean and standard deviation was employed in analyzing the data while ANCOVA was used to test the hypotheses at 0.05% level of significance. The study revealed that science process skills were better acquired through learners' active participation in the use of resources than conventional method.

Considering the literatures reviewed so far, it can be deduced that the researchers had a concensus that teaching methods influence science process skill acquisition by students. They therefore suggest that teachers should use teaching methods that are activity-based which gives the student room for active participation in teaching process rather than conventional method. Thus, this study will further investigate the effect of STS – approach on the acquisition of science process skills by Basic Science Students in Enugu Educational Zone.

Studies on STS – approach and Students Understanding of Scientific Ideas related to real world situation

Although many research studies have been carried out on the development of STS – approach since its adoption into the science curriculum, most of these studies are carried out in U.S.A; Canada, U.K, Australia with very few in Nigeria. As a result, the empirical studies to this work include both foreign and indigenous studies.

Larry and Kelvin (1987) carried out a quasi-experimental study in which 194 Kansas students in grade 68 and their 13 classroom teachers were involved. STS content was infused into science lessons and taught after the student had returned from visiting science and technology museum. After two weeks, of teaching STS lesson in public and private schools, the researchers administered pretest and post test and rated the students on attitude scale. The researcher ensured that museum non-visiting students who had no classroom lesson on STS were used as control group. In addition, the Scientific Attitude Rating Inventory (SAI) developed by Moore and Sultana (1970) was used for both pretest and post test, while Likert type scale for student responses, a type of VOSTS scale developed recently by (Aikenhead, Ryan and Flemming 1989) was also used. The result of the study revealed the following;

- The students who visited science/technology museum developed more positive attitude towards STS than did the non-visiting students. This also enhanced the performance of the latter.
- There was no significant difference between male and female on attitude measure.
- As students progress from lower through upper grade levels, attitudes towards Science tends to decline significantly especially for museum non-visiting students.

The researchers recommend the use of instructions that will require more student participation along with learner centered approaches by science teachers to facilitate learning.

In another research carried out by Achmad (1987) on the development of Science process skills when science is taught with a focus on STS. Eighteen (18) head teachers were involved. Students in grade 4 through 9 in public schools in Iowa was used. The students were exposed to a pretest at the beginning of the experiment and after STS focused teaching, a post-test was conducted in each of the six classes. The same instrument was used for both the pre-test and post-test. The instrument was validated and a reliability coefficient of 0.80 obtained by the test retest method using minitab. One hypotheses guided the work. ANCOVA was employed to test the hypothesis while Wilcoxon (Match pair) test was used to compare the pretest and post test scores of each of grade 4 through 9. The result of the study showed a significant growth in students process skills from pretest to post test. The rate of this growth also increased across grade levels. STS provides a real world context for science teaching and learning. This real world context seems to be a major factor in stimulating student learning of science process skills. They therefore recommended that teachers and Administrators can stimulate growth of process skills when science is taught with STS focus.

Another study by Negedu (2008) investigated the effect of STS – approach on achievement and interest of students' in Integrated science in Junior Secondary Schools (JSS) in Ankpa L.G.A Kogi state of Nigeria. The population of the study includes all the JSS II students in 15 co-educational schools in the area of the study. Six research questions and six hypotheses guided the study. The instruments used for data collection are Integrated Science Achievement Test (ISAT) and Integrated Science Interest Scale (ISIS). The pre-test and post-test scores were analyzed using the mean and standard deviation while the ANCOVA was used in testing the hypotheses. The study revealed that STS – approach enhanced achievement and interest among students than conventional approach irrespective of gender and location. The researcher recommended the use of activity-based approach such as STS – approach to enhance learners achievement and interest in science.

In a related study, Mbajiogu (2003) investigated the effect of STS – approach and scientific literacy level of students on their achievement in Biolgoy. 246 Senior Secondary Two (SSII) students selected from four schools stratified along gender line formed the population for the study. STS content was infused into biology lesson and taught for 4 weeks. After, the students were administered Biology Achievement Test (BAT) and Scientific Literacy Scales (SLS) on views-on-Science-technology and society (VOSTS). The finding are;

STS – approach fostered the development of scientific literacy. STS – approach aids in the development of an understanding of nature of science more than the conventional approach. It harmonizes the achievement of both sexes in Biology. The differential effect due to STS – approach on Scientific literacy and achievement in Biology in favour of rural than urban students. The result also revealed that STS – approach interacts with scientific literacy to influence achievement in Biology. The researcher recommend the use of STS – approach in the development of scientific literacy and achievement in Biology as against conventional approach.

Thus, for further development of the STS – approach, more STS instructions/topics should be infused into the science curriculum to improve teaching and learning of science with the focus on real-world situation. Also, students' participation and learner centered approach to instruction should be used by science teachers to foster and facilitate science learning. The question therefore is "to what extent will STS – approach to the learning of science effect the science process skills acquisition of JSS II students in Enugu educational zone of Enugu State in Nigeria.

Studies on Gender and Science Process Skill Acquisition

Shaibu and Mari (1997) carried out a study on gender related differences in the understanding of science process skill among Junior Secondary School Students in some Nigerian Secondary Schools. The population of the study comprised all the JSS classes 1 – 3 in Zaria and Sabon gari L.G.A of Kaduna State, from 5 co-educational schools and 3 male and 3 female single school. Stratified sample method was used to obtain a fair representation of boys and girls in the co-educational schools. Simple random sampling was used to obtain the subjects in the single sex schools. Thirty (30) students were selected from each school, 10 each from JS 1, 2 and 3 giving a total of 330 students. Two research instrument were used. The inventory of science process skills (IOSPS) and test of practical skills (TOPS). They contained 26 and 10 objective items respectively. Split half method was used to find the reliability of the instrument. The result of the study showed that female subjects has a significant better understanding of the science process skills tested compared to the male counterpart. They further found out that female students were notable to show their superiority in Science Process Skills in solving given problems.

Nwosu, (2001), investigated the effect of gender, cognitive ability and teacher practices on the acquisition of nine Science Process Skills by Senior Secondary one (SSI) students. The study was a pre-test-post test quasi experimental design. The sample consisted of 440 SSI students (246 girls and 194 boys) in four schools randomly draw from schools in Enugu and Nsukka educational zones. These were randomly assigned to the experimental and control groups. Two hypotheses guided the study. A researcher produced 45-item test on science process skills (TOSPS) was administered as pre and post tests. Both TOSPS and cognitive ability were validated and reliability found as 0.78 and 0.84 respectively. Data collected was analyzed using mean while the hypotheses were tested using ANCOVA. It was found that boys generally perform better than girls. The study also revealed that cognitive ability and teacher practices had stronger effect than gender on level of acquisition of science process skills investigated. Also the differential performance due to gender was not significant for the experimental group.

Also, Njoku (2012) carried out a study on enhancing girls acquisition of science process skills in co-educational schools. He determined the effect of mixed sex and single sex strategies in co-educational classroom on girls acquisition of science process skills. Two research questions guided the study. A sample of 84 eleventh grade (SS2) girls offering chemistry participated in the study. The subjects were from all the four streams of SS2 class of Army Day Secondary School in Enugu State. The study adopted the randomized post-test only control group design. The instrument for data collection comprised of Chemistry Practical Test (CPT) and a 5point, 57 items chemistry practical skill rating scale (CPSRSO) with an estimated inter-rate reliability coefficient of 0.58. The data was analyzed using mean, standard deviation and t-test statistics. The result showed that girls in single sex group scored significantly higher mean in science process skills than girls in a mixed sex group. Thus the micro atmosphere in the mixed sex group appeared to be favourable to female group members in particular, thus girls in mixed group according to him performed very poorly compared to their classmate in single sex girls group especially in those skills categories where male dominated, this exerted much influence on their participation.

Mari (2002) determined the effect of process based instruction on acquisition of formal reasoning ability among male and female subjects, so as to determine gender related differences in acquisition of formal reasoning ability. Thirty-eight (38) subjects were randomly selected from a secondary school in Kaduna State. The subjects were pre tested using group assessment of logical thinking test (GALT) after which they were exposed to process based instruction for 6weeks. The male and female subjects post test scores were compared using t-test statistics. The finding showed that the male subjects performed significantly better than the female counterpart in reasoning schemata, but there was no significant difference on the skill of manipulating variables amongst boys and girls. The researcher suggested that Science Process based instruction should be introduced in the early years in Secondary Schools as a means to reduce the male/female difference in reasoning ability.

Iloputaife (1995) investigated the effect of practical work method on practical physics process skills using a sample of 50 boys and 50 girls from two senior secondary schools in Abakaliki urban. The study revealed that there were no significant different in the attainment level of the practical physics process skill due to gender.

From the ongoing studies conducted on the influence of gender on the acquisition of science process skills, it is clear that the findings are inconsistent. While some reported significant difference in the acquisition of science process skills in favour of girls others reported so in favour of boys. In other words, the acquisition of science process skills is still inclusive, therefore this study will further investigate this issue.

SUMMARY OF LITERATURE REVIEW

The review of related literature to the study was done under four main sections namely; Conceptual Framework, Other Related Issues, Theoretical Framework and Empirical Studies. The conceptual framework considered the concept of integrated science (its evolution and curriculum), the concept of STS – approach (its evolution, meaning, aims, curriculum and methodology) and the concept of science process skills (Nature and Significance).

The review showed that integrated science was introduced into the Nigerian Science Curriculum as a result of the demand for a more functional science curriculum that will match

Nigerians' socio-economic and technological development. Since the introduction of this curriculum, it has undergone various transformations and integration of the science. Currently, the curriculum for integrated science (Basic Science and Technology) has infused in it some STS topics like; ethical issues, HIV/AIDS, Environmental pollution, Nutrition diseases, Energy Shortage, etc. Despite all the efforts made by government and some NGOs to improve the students poor performance and lack of interest in Basic science, the situation has remained the same. Researchers blamed this problem on the use of inappropriate teaching methods by science teachers in teaching Basic Science. Literatures also revealed that STS – approach to teaching of science was advocated for by some countries that felt dissatisfied with the teaching and learning of science divorced from societal issues. They rather advocated for the teaching of science with a focus on real world situation. It is also revealed that science process, skills are indispensable tools in the teaching and learning of sciences. These are skills used by scientists to facilitate learning especially in the physical sciences. AAAS identified and classified fifteen (15) science process skills into Basic Science Process Skills and Integrated Science process skills. The acquisition of these skills depends on certain factors such as students' ability level, teaching methods, intelligence of the teacher, socio-economic status of parents and learners among others. Many of the research studies reviewed show that there is a direct relationship between the acquisition of science process skills by students and the teachers' method of teaching. The research further suggested that the use of the teaching method that will enhance the acquisition of science process skills should be adopted in schools.

This study is anchored on the learning theories of John Dewey, Brunner, Piaget and Vygotsky. They believe that learning involves the cognitive structure of the learner.

John Dewey emphasized the use of observation, scientific method, testing, inquiry and discovery method. Brunner like Piaget believes that learning should be an active process. Vygotsky believes that learning involves social interaction between the learner and the environment. These theories are in support of science process skills acquisition by learners and use of activity-based method for the teaching of science.

The empirical studies were carried out under the following headings; teaching approach and science process skills, STS – Approach and students understanding of scientific ideas related to real world situation and gender and science process skills acquisition. The review showed that science process skills are vital tools used by scientist in carrying out investigation. The acquisition of these skills according to the review depends largely on the teaching method of teachers among other things. The review also revealed that STS – Approach is a reform in science education in response to changes in societal values. The approach enables the student to develop interest and positive attitudes towards understanding of scientific ideas. Empirical study on Gender as a factor in student science process skill acquisition was also reviewed. Research findings are at variance as to which gender perform better than the other. Some of the reviews reported that there is a significant difference in the acquisition of science process skills in favour of girls, others reported on the same issue in favour of boys. In other words, the effect of gender on the acquisition of science process skill is still inconclusive. The review also did not reveal the effect of STS – Approach on the acquisition of science process skills by Nigerian Secondary School Students. Therefore, the study will further investigate these issues – effect of gender and STS – Approach on the acquisition of science process skills.

CHAPTER THREE

RESEARCH METHOD

This chapter describes the method that was used to carry out the study under the following sub-headings; Design of the Study, Area of the Study, Population of the Study, Sample and Sampling Techniques, Instrument for Data Collection, Validation of Instrument, Reliability of Instrument, Training of Basic Science Teacher (research assistants), Method of Data Collection and Method of Data Analysis

Design of the Study

The design for the study is quasi-experimental. The study specifically applied pre-test, post-test, non-equivalent control group design. Quasi-experimental design is considered appropriate for the study because intact classes were used to avoid disruption of normal classes. The pre-test was used to partial out initial differences in the two groups and also to control selection bias which is a threat to internal validity. The study design is illustrated in the figure below

GP1 $\rightarrow \underline{0_1 X_1 0_2}$

GP2$\rightarrow 0_1 X_2 0_2$

Where 0_1 = Pre-test

X_1 = Treatment for experimental group 1

X_2 = Treatment difference from the experimental group

0_2 = Post – test

---------- = Indicates that there are two groups (treatment and control) which are not equivalent before treatment.

Area of Study

The study was carried out in Enugu Educational Zone. The Zone is made up of 3 L.G.A Enugu North, Enugu East and Isi Uzo Isi Uzo Local Government Areas. The Zone consists of thirty-one (31) Secondary School, (seven girls' school, 2 boys' schools and 22 co-education). The choice for this area was based on the fact that the researcher is familiar with the location of all the schools within the area. This gave the researcher the opportunity to monitor and supervise the research experiment. Again from personal interview with basic science teachers in this area, they are not conversant with this teaching approach (STS-approach) hence they will benefit from the study.

Population of the Study

The population for this study includes all the JSII Basic Science Students in Enugu Educational Zone. 19 out of the 31 Public Secondary Schools in the Zone are cited in the Urban Area. This includes 7 girls' schools, 2 boys' Secondary Schools and 10 co-educational schools. The total number of JS II students in Enugu zone was 6775. The study was conducted using JS II students because JS III students are already in the exam class preparing for BECE, JS I students have not been grounded in Basic Science.

Sample and Sampling Technique

The sample consist of 95 Basic Science Students randomly selected from 10 co-educational secondary schools in Enugu Education zone. Two schools were randomly sampled due to the experimental nature of the study. In each of the schools sampled a stream of JS 2 was randomly sampled for experimental treatment and control respectively.

Instrument for Data Collection

The instrument used in collecting data for this study is a Science Process Skill Acquisition Rating Scale (SPSARS) developed by the researcher. The instrument was used both for pre-test (for assessing the students entry behaviour on acquisition of science process skill) and for post-test (to measure the level of science process skill acquisition among the students). The instruments consist of 40 items which was designed to test the acquisition of SPS by students. The items were selected considering the science process skills of observing, classifying, measuring, experimenting, inferring, interpreting, and communicating. The choice of the science process skills was based on the objectives of the contents that was used in this study. The items were selected from the content; pollution, thermal energy, measurement and changes in living and non-living matters which are STS topics from JS II Basic Science curriculum. The researcher used a text blue print to guide the selection of items from each topic. By attaching a 4-point scale to the statement in the behaviour category, the rating scale was formed. The scale is an observational schedule that can be used for rating the level of SPS acquired by Basic Science students. The scale point include Very Low – (1) Low – (2) High – (3) Very High – (4). An instructional guide was also developed by the researcher to help the students perform the practical activities. Two sets of lesson plans were developed, one based the STS – approach (to be used for the experimental/treatment group) while the other was based on traditional approach (to be used for the control group). Both lesson plans were used for the same duration.

Validation of the Instrument

The research instrument (SPSARS) along with the purpose of the study, research questions, research hypotheses, lesson notes, practical instructional guide, and test blue print were face validated by three experts in the faculty of science Education. The experts validated the items in terms of proper wording of the items, clarity of instrument to the subjects and for appropriateness and adequacy of items. From the observation of the validators, most of the items addressing various skills were found appropriate. Two items validating communicating skills were discarded and replaced each with an appropriate item. Some items were reconstructed to improve on the clarity of the instrument. Based on the suggestions and corrections of the validators, the final draft of the instrument was developed. The lesson note for STS – Approach was also revisited and the right format for table was used. See Appendix A for the instrument.

Content Validity

The content validity of the SPSARS was determined using a test blue print that covered the chosen topics and the seven science process skills under investigation. The topics were from JS II Basic Science and Technology curriculum. The items were spread across the SPS according to the weight of the topics. See Appendix C for the test blue print.

Trial Testing

The instrument were subjected to final testing on a representative sample of ten (10) JS II Basic Science students randomly drawn from one secondary school in Enugu Educational zone. The school was excluded during sampling of population. The trial testing helped the researcher in obtaining data for the establishment of the reliability indices of the instrument. And also to determine the clarity of the test items, its readability, appropriateness and adequacy and as well help to determine the actual time it takes to accomplish the task by the students. During the trial testing, the three different raters were involved in observing each of the ten students.

Reliability of Instrument

Scores obtained from the trial testing was used to estimate the reliability coefficient of the instrument. The cronbach alpha reliability index was used to determine the internal consistency of the instrument. The choice for this reliability index is because the instrument is a likert-type scales and also the items are polychotomously scored. Cronbach Alpha reliability coefficient of 0.8 was found. The Kendall's coefficient of concordance (w) was used to determine the inter-rater reliability index. This is appropriate were more than one rater are involved. And is used to assess the extent of agreement of the scores by the different raters to ensure that the scoring patterns of all the raters scores are the same. After the calculation, an inter-rater reliability coefficient of 0.8 was determined. See Appendix E.

Training of Basic Science teacher as research assistants for the study

One Basic Science teacher was trained using the lesson plan for STS – approach method while the class teachers for the control group used the lesson plan for traditional approach since they are already teaching the intact classes and so were not trained.

Method of Data Collection

The data for the pre-test and post-test were collected immediately after scoring and the scores recorded.

Method of Data Analysis

The scores obtained from the pre-test and post-test were analyzed using mean and standard deviation for answering the research questions while Analysis of Covariance (ANCOVA) was used to test the hypotheses at 0.05 level of significance.

CHAPTER FOUR

RESULTS

The result of the study are here under presented according to the research questions and hypothesis.

Research Question I

What are the effects of STS – Approach and Traditional approach (lecture method) on the mean acquisition of science process skills among students of Basic Science?

Table 1: Mean and Standard Deviation of science process skill acquisition score of students taught using STS – Approach and Traditional Approach.

Method	Mean	Std. Deviation	Cases
STS – Approach	92.77	8.08	44
Traditional Approach (Lecture method)	76.94	5.77	51

Table 1 shows that the students taught using STS – Approach (experimental group) have a mean SPS acquisition score of 92.77 with a standard deviation score of 8.08 whereas the students taught using Traditional – Approach (control group) have a mean SPS acquisition score of 76.94 with standard deviation score of 5.77. The difference in the mean score suggests that STS – Approach is more effective approach to the acquisition of SPS than the traditional approach.

Table 2: Summary of ANCOVA result for the three hypotheses

Sources of Variance	Sum of Squares	df	Mean of square	F-cal	Sig of F	Decision
Covariates	5.35	1	5.35	.110	.741	
Pre scores	5.35	1	5.35	.110	.741	
Main effect	4307.65	2	2153.82	44.31	.000	
Method	4043.23	1	4043.23	83.18	.000	S
Gender	.251	1	.251	.005	.943	NS
2-way Inter-action						
Method X Gender	60.49	1	60.49	1.24	.268	NS
Explained	6018.23	4	1504.56	30.95	.00	
Residual	4374.65	90	48.607			

Hypothesis 1: The mean SPS acquisition score of students taught using STS – Approach will not differ significantly from those taught using Traditional approach (0.05 level of significant).

Table 2 shows that the F-calculated of 83.18 is significant at 0.000. Since the significant of F value is less than 0.05 significant level earlier set for the hypothesis, the null hypothesis is rejected. Therefore, the mean science process skill acquisition score of students taught using STS – Approach differ significantly from the mean score of those taught using Traditional – Approach. In other words, the earlier observation made in table 1 was not due to chance but due to actual effect of the treatment (STS – Approach).

Research Question 2

What is the effect of Gender on the mean acquisition of SPS of Basic Science Students taught using STS – Approach?

Table 3: Mean and Standard Deviation for STS – Approach across gender

Gender	Mean	Std. Deviation	Cases
Male	82.95	10.98	44
Female	85.41	10.06	51

Table 3 shows that the mean SPS acquisition score of male and female are 82.5 and 85.41 respectively with a standard deviation of 10.98 for male and 10.06 for female. This shows that there is a slight difference in the mean SPS acquisition score and standard deviation score of male and female student taught using STS – Approach.

Hypothesis 2: Gender will not be a statistically significant factor in the acquisition of SPS of Basic Science Students taught using STS – Approach.

Table 2 shows that Gender is not significant on the mean SPS acquisition score of students taught using STS – Approach. The table also reveals that the F-cal value is 005 while significant of f is .943, a value which is greater than 0.05 level of significant, the null hypothesis is therefore accepted. Therefore gender is not a statistically significant factor in the acquisition of SPS of Basic Science students taught using STS – Approach. It can then be concluded that the earlier slight difference in mean SPS acquisition scores and standard deviation scores of students taught using STS – Approach as shown in table 3 is not as a result of gender influence.

Research Question 3

What is the interaction effect of method and gender on the mean acquisition of SPS of Basic Science Students?

Table 4: Mean and Standard deviation for the interaction of method and gender

Method	Gender	Mean	Std. Deviation	Cases
STS – Approach	Male	94.00	7.85	17
	Female	92.00	8.27	27
Traditional	Male	76.00	5.62	27
Approach (Lecture Method)	Female	78.00	5.688	24

Table 4 shows that the mean scores and standard deviation scores for the STS – Approach male and female are 94.00 and 7.85; 92.00 and 8.27 respectively. Also, the mean scores and standard deviation scores for the traditional approach male and female are 76.00 and 5.62; 78.00 and 5.88 respectively.

Hypothesis 3: There will be significant interaction effect of method and Gender on the mean acquisition of SPS of Basic Science students.

The results on table 2 shows that the interaction effect of method and gender on the acquisition of SPS of Basic science students is not significant. The f-cal is 1.24 and the significance of f is .268. Since the significance of f is greater than 0.05 probability level set for the study, the null hypothesis is accepted. Therefore, the interaction of method and gender do not affect the mean acquisition of SPS of Basic Science Students.

Summary of the Findings

1. The students taught using STS – Approach had higher mean SPS acquisition scores than those taught using Traditional – Approach.

2. There is a slight difference in the mean SPS acquisition score and standard deviation score of male and female students taught using STS – Approach.
3. There is relative difference on the interaction effect of method and gender on the SPS acquisition score of students taught using STS – Approach and Traditional – Approach.
4. The mean SPS acquisition score of students taught using STS – Approach differ significantly from those taught using Traditional approach.
5. Gender influence is not a significant factor in the acquisition of SPS of Basic science students taught using STS – Approach.
6. The interaction effect of method and gender on the mean science process skill acquisition scores was not significant.

CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

This chapter presents the discussion of the findings, conclusions, educational implication of the research findings, recommendation, limitations, suggestions for further research and summary.

Discussion of Findings

The finding of this research are discussed under the following sub-headings:

(i) Effect of teaching methods on students' science process skill Acquisition.

(ii) Influence of Gender on the acquisition of Science Process skills of students.

(iii) Interaction effect of teaching method and gender on students acquisition of science process skills.

Effect of Teaching Method on Student Science Process Skill Acquisition

The findings from the study as shown in table 1 indicated that the mean science process skill acquisition score of the students taught using STS – Approach is higher (92.77) than that of their counterpart taught using traditional approach (76.94). Also, the ANCOVA result in table 2 revealed that the probability value associated with the f-calculated value (83.18) is 0.000. This figure is less than the 0.05 level of significance earlier set for the study. Therefore, the null hypothesis is rejected. This implies that the mean science process skill acquisition score of students taught using STS – Approach differ significantly from that of their counterpart taught using traditional approach. The indication is that STS – Approach had more positive effect on the students' acquisition of SPS than the traditional approach. The superiority of STS – Approach over traditional approach is due to the teachers use of the strategies involved in STS – Approach which includes (practical activities, field trip, small group work, discussion, problem solving, etc) in teaching the students. These strategies provided the students the opportunity to learn science in a real world context which enhanced their acquisition of SPS. This finding is an agreement with the view of Achmad, (1987) who opined that STS – Approach provides a real world context for teaching and learning of science which seems to be a major factor in stimulating students learning of SPS. The finding also confirmed the result of Mbajiogu (2003) that STS – Approach fostered the development of scientific literacy and aids in the development of an understanding of nature of science more than the conventional methods. The studies of Nwokolo (2013), Nworgu and Otum (2013) and Chukelu (2009) are related to the present study because of their practical activity oriented nature. As a result of this relationship, findings of the studies were used to support the findings of the present study.

Influence of Gender on the acquisition of Science Process Skill of Students

Results presented on table 3 showed a slight difference in the mean SPS acquisition score of male (82.95) and female (85.41) students taught using STS – Approach in favour of female. However, the ANCOVA in table 2 revealed that the difference in mean SPS acquisition score of male and female students taught using STS – Approach is not significant since the observed probability is not significant at 0.05 level of significance. This implies that the slight difference in the mean score is as a result of the teaching method (STS – Approach) not gender. Hence, gender is not a statistically significant factor in the acquisition of SPS of students. The finding is in line with the results of other previous researchers Nwokolo (2013), Nsa, Akpan and Williams (2012), Mari (2002) and Iloputaife (1995) who supported that gender does not significantly influence the acquisition of SPS of students. This results of no significant difference in terms of gender and performance could be as a result of the instructional method used by the researcher as was recommended by Aiyedun (2000) who discovered that difference in the performance of male and female students could be eliminated by using good teaching method, materials, and appropriate teaching strategies. This finding, however contradicts the finding of Shaibu and Mari (1997) which showed that female subjects has a significant better understanding of SPS tested compared to their male counterpart and therefore showed their superiority in science process skills in solving given problems.

Interaction effect of teaching method and gender on Students acquisition of SPS

The result from table 2 revealed that the interaction effect of gender and method was not significant since the probability value associate with the f-cal (1.24) is .268 which is greater than the 0.05 level of significance. This finding is in line with that of Nwokolo (2013), Igboegwu and Egbutu (2011), Chukelu (2009), which revealed that there was no significant interaction effect of instructional method and gender on students acquisition of science process skills. The finding also agrees with the opinion of Iloputaife (2001) and Ibe (2004) that there is no significant interaction between instructional method and gender on students performance. The finding also confirmed the findings of Chukwuemeka (2005) that gender did not combine with manipulation of material resources to affect pupils' acquisition of science process skills. Therefore, it can be concluded that since gender did not combine with teaching method to affect the students acquisition of science process skills in this study, any difference observed in the students' performance could be attributed to the instructional method (STS-A) used which facilitated the acquisition of science process skills by both male and female students in the course of the treatment (STS – A)

Conclusions

The results from this study suggest the following conclusions:-

1) STS – Approach proved a more effective approach to the acquisition of science process skills than the traditional approach. This is evident in the higher mean acquisition of Science Process Skills of students exposed to STS-Approach.
2) With STS – Approach, gender is not a statistically significant factor in the acquisition of science process skill as male students were not perceived as being better than their female counterpart and vice versa.
3) Gender and teaching method did not interplay in any way to effect the acquisition of science process skill by both male and female students.

Educational Implications

The conclusions of the results of this study convey several implications for students, science teachers, curriculum planners, educational administrators and policy makers in Nigeria. The obvious implication of STS – Approach for students is that they should be up and doing in carrying out their assignments and projects, making themselves available for field trips as this will foster the use of this approach which by its nature is student centered. Since STS-Approach is a reform, it becomes imperative that science teachers should start to change their lesson plans to include those strategies involved in STS – Approach. The fact that STS-Approach is an activity-oriented and child-centered approach demands that Basic Science teachers should through their lesson plans create an enabling environment, both inside and outside the classroom to ensure that students are constantly involved in active learning even while at home. This will enable the students to transfer classroom experience to solving problems in their real life situations. The feedback from this study demands that curriculum planners should revisit and restructure the existing basic science curriculum at all levels of education. More STS topics should be infused into the curriculum and this should be accompanied with appropriate student and teacher activities. Basic science textbooks should be reviewed to include these new topics and obsolete ones discarded. The government through policy making should ensure that these new textbooks and other instructional materials are gender friendly. Educational administrators should visit schools on a regular bases to supervise basic science teachers so as to ensure they are adhering to the student activities and teacher activities stated in the curriculum.

Recommendations

In line with the findings and discussion of this study, the following recommendations are made:

- The Government should encourage the Basic Science teachers to use STS – Approach by giving them financial incentives and instructional materials like ICT gadgets.
- The government should provide functional Basic science laboratories in Junior Secondary Schools to enable students start early to practice for the acquisition of Science process skill.
- Educational authorities should organize workshops and seminars for on-the-job teachers to enlighten them more on STS – Approach as a reform in science education.

Limitation of the Study

1) The use of the same SPSARS for both pretest and post test without reshufflement may have affected the study.

2) Regular Basic Science teachers used as research assistant were not much familiar with STS – Approach and this affected their effectiveness. This might have posed a limitation to this study.
3) All the students did not continue to the end of the experiment. Some completed the pre-test but failed to show up for the post-test. These group of students were not used for the study thereby reducing the sample size.
4) The use of only two out of the 10 – coeducational schools in Enugu Educational zone may have affected the generalization of the findings of this study.
5) Extraneous variables such as time allotted for Basic science on the school time table and classroom environment also posed a limitation to this study.

Suggestions for further study

1) A study can be carried out where interest, retention, location and school type can be used as variables.
2) Replication of the study can be done in another educational zone or state.
3) Researchers should investigate the efficacy of STS – Approach in science subjects other than Basic science.

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APPENDIX A

A rating scale for the assessment of Science Process Skill Acquisition

S/N	Observing skills	Very high (4)	High (3)	Low (2)	Very low (1)
1.	Ability to observe and identify the PH of different samples of water				
2.	Ability to identify water pollutant				
3.	Ability to identify air pollutants				
4.	Ability to identify soil pollutants				
5.	Ability to identify the meniscus of water				
6.	Ability to identify developmental changes in the human body from a chart				
7.	Ability to identify a conventional current in boiling water				
	Measuring Skills **Measuring the volume of a given Quantity of Water** **Specific Activities**				
8.	Ability to identify the correct instrument to use				
9.	Ability to read the graduation on a measuring cylinder				
10.	Ability to write the correct S.I unit				
11.	Ability to measure volume of a pebble				
	Measuring the height of a fellow student correctly **Specific activities**				
12.	Ability to identify the correct instrument to use				
13.	Ability to measure correctly				
	Measuring weight of a piece of stone provided **Specific Activities**				
14.	Ability to set the apparatus correctly				
15.	Ability to measure the weight correctly using spring balance				

	Classifying skill				
16.	Ability to classify given samples of matter into solid, liquid and gas				
17.	Ability the classify non-living matters into metals and non-metals				
18.	Ability to classify materials into conductors and insulators				
19.	Ability to classify water pollutants into physical, chemical and biological pollutants				
20.	Ability to classify measuring instruments into standard and non-standard instrument				
	Communicating Skill				
21.	Ability to describe the arrangement of particles in a solid state				
22.	Ability to draw to correctly any instrument used for measuring weight				
23.	Ability to describe two effects of pollution on the environment.				
24.	Ability to describe the method of heat transfer involved in a solar cooker				
	Inferring Skills				
25.	Observing the melting of candle wax and being able to infer that increase in heat causes melting				
26.	Being able to infer two ways of controlling water pollution after observing a pollution site				
27.	Being able to infer after measuring the volume of a pebble that solids displace quantity of water equal to their volume when immersed in a liquid.				
28.	Observing the pH of water sample and being able to infer that a sample is pure water because of its pH value				
	Experimenting Skills				

	Performing a simple water filtration process through the following steps				
29.	Ability to set up the filteration apparatus correctly				
30.	Ability to perform the experiment successfully				
	Carrying out the following activities and identifying whether each is a chemical or physical change				
31.	Burning of a piece of paper				
32.	Melting of wax				
33.	Dissolving salt in acid				
34.	Dissolving salt in water				
	Experiment to show heat flow from a hot body to a cold body using water **<u>Specific activities</u>**				
35.	Ability to identify the appropriate apparatus to use				
36.	Ability to set up the apparatus				
37.	Ability to identify and record change in temperature of the water mixture				
	Interpreting Data **Ability to interpret the rate of growth of a maize plant from a graph**				
38.	Ability to identify the height of the plant on day 5				
39.	Ability to identify the days between which the plant has the fastest growth				
40.	Ability to conclude that salt increases the melting rate of ice block after observing the melting rate of ice cube sprinkled with salt and one without salt				

APPENDIX B

Instruction for Practical Exercise

Carry out the following activities carefully and answer the questions that follow:

Section A: observational Skills

1. You are provided with four samples of water in the beakers labelled A,B,C and D. using the PH paper provided, identify which of the water samples is a pure water. Record the PH value.

2/3/4. Observe carefully the pollution sites in the diagrams set before you and identify the pollutants present. Record your observation as Air pollutants, water pollutants and soil pollutant.

5. Specimen E is a measuring cylinder half filled with water. Identify the meniscus and record the volume of the water.
6. Specimen F is a chart showing developmental changes in the human body. Observe it carefully and identify four (4) developmental changes which accompany adolescent stage.
7. You are provided with the following
    a. Crystals of potassium pomanganet
    b. Beaker of water
    c. Burnsen burner

Set up the burnsen burner and place the beaker of water on top. Allow it to heat for 5minutes. Add 3 crystals of potassium pomanganet at the bottom centre of the beaker on fire. Record your observation.

Measuring skills

8/9/10. You are provided with a quantity of water, and measuring instruments labeled A to E.

Choose the appropriate instrument and measure the volume of the water and record your measurement.

11. Take specimen F and immerse it in the water you have measured the volume. Allow the water to settle. Measure the volume a second time and find the difference in the two volumes.

12/13. Choose an appropriate instrument from the group labeled G to K. measure the height of two students in your class. Record and compare their heights.

14/15. Using a spring balance, measure the weight of a piece of stone presented.

Classifying Skill

16. You are provided with specimen A to J, classify them into solid, liquid and Gas.
17. Classify the following matters set before you into metals and non-metals.
18. Classify the following materials presented to you into conductors and insulators.
19. You are provided with a chart showing some water pollutants, classify them into physical, chemical and biological pollutants
20. Classify the following measuring instruments provided into non-standard and standard instruments.

Communicating Skills

21. Carefully observe the wooden block provided for you. What is the arrangement of its particles
22. Draw any instrument used for measuring weight.
23. Describe any two effect of pollution on the environment.
24. What kind of heat transfer goes on in a solar cooker.

Inferring Skills

25. You are provided with two metal cans A and B. Can A is painted black on one of its sides. Attach a wax on the side not painted, also attach a wax on can B. Place both at equidistance from the burnsen burner, observe the experiment carefully and infer why wax on can A has to melt faster.
26. Observe the diagram of pollution site presented and infer two ways of controlling water pollution.
27. Measure the volume of water presented using measuring cylinder. Immerse a pebble into the cylinder of water, re-measure the volume. Is there any change in volume? What can you infer about the change?
28. Test the PH of the samples of water presented what can you infer about the PH value of water samples .

Experimenting Skills

29/30. You are provided with samples of sand, gravel, charcoal, cotton, water, plastic bottle and tumbler. Set up a filteration apparatus using the samples and filter the water sample.

Perform the following experiment carefully and indicate whether each is a physical or a chemical change.

31. Burn the piece of paper provided
32. Melt the candle wax provided

33/34. Divide the salt sample provided into two equal parts A and B. Add A to the acid in beaker C and add B to the water in beaker D.

35/36/37. Perform the experiment to show heat flow from hot water to cold water using the appropriate instrument. Identify and record change in temperature

Interpreting Data

You are provided with a graph showing the rate of growth of a maize plant.

38. What is the height of the plant on day 5

39. Between which days did the plant have fastest growth?

40. You are provided with two ice cube of equal size. Sprinkle one of the ice cubes with half teaspoonful of salt. Which of the ice cubes melts faster?

APPENDIX C

TABLE OF SPECIFICATION

s/n	Content	Observation	Measuring	Classifying	Communicating	Experimenting	Inferring	Interpreting	total
1.	Pollution	1,2,3,4		19		29,30	26,28		9
2.	Measurement	5	8,9,10,11,12, 13,14,15	20	21,22		27		13
3.	Physical and chemical changes in living and non-living matter	6		16,17		31,32,33,34	25	38,39,40	11
4.	Thermal energy	7		18	23,24	35,36,37			7
	Total	7	8	5	4	9	4	3	40

APPENDIX D

Lesson plan on Basic Science using STS – Approach for experimental group

Week I

Duration - 80minutes

Class - JS 2

Subject - Basic Science.

Topic - Pollution

Content - Meaning of Pollution Sources of Air, Water and soil pollutants filtration of dirty water and Methods of controlling pollution hazard

Behavioural Objective: By the end of the lesson, the student should be able to;

- Identify pollution sites
- Identify pollutants
- Classify pollutants
- Carry out simple water filtration
- Suggest methods of controlling pollution
- Describe sources of pollutant
- Mention the hazards caused by pollution on man and on the environment.

Entry Behaviour: the students are conversant with pollution sites like refuse dump, dirty bodies of water, smoke from exhaust pipe of vehicles.

Instructional Material – Pollution sites like refuse dump, sewage, traffic site, polluted stream, charts, filter clothes, beakers funnel, charcoal, sand, gravel, dirty water, cutton.

Instructional Procedure

Steps	**Teacher Activity**	**Student Activity**	**Instructional Strategy**
Introduction	The teacher introduces the lesson by asking the students to mention the different ways by which they dispose refuse in their homes	The students mention the methods they know	Questioning skills
Application	The teacher takes the students on a short visit to pollution site close to the school. Instructs the students to record what they observe at the site.	The students followed the teacher to pollution sites. Record their observation and ask questions. The students collect water sample from the ditches	Excursion
Development	Back to the classroom, the teacher leads class discussion on pollution. The teacher guides the students through probing questions to state the type of pollution they saw at the site, mention the sources of these pollution and suggest ways of controlling them. The teacher also leads the students to state the effect of pollution on man and his environment. The teacher guides the students to filter the dirty water sample they collected and determine	The students participate in class discussion on pollution. Carry out a simple filteration method and determine the pH value of water.	Explanation, questioning skills, discussion.

	the pH value of samples of water.		
Evaluation	The teacher evaluates the lesson using the following questions; 1) What is pollution? 2) Circle two(2) air, water and soil pollutants each from the chart presented 3) Classify water pollutants into physical, chemical and biological pollutants. 4) Describe two(2) sources of air pollution in your environment 5) Mention three(3)hazards of soil pollution on the environment. 6) State four(4) controlling measure against these hazards	The students answer the questions and listen to corrections were necessary	Questioning skills
Summary and Conclusion	The teacher summaries the important points on the chalkboard	The students write down the points	Explanation
Assignment	The teacher ask the students to write in their assignment book two measure they can take to control pollution in their respective homes.	The students copy down the assignment	Questioning skill

Lesson plan on Basic Science using STS – Approach for experimental group

Week II

Duration - 80minutes

Class - JS 2

Subject - Basic Science.

Topic - Thermal Energy

Content - illustrating heat flow, heat transfer by conduction, convection and radiation and their application in homes. Conductor and insulators (examples and uses)

Behavioural Objective: By the end of the lesson, the student should be able to;

- Observe and identify heat flow and heat transfer by conduction, convection and radiation.
- Describe heat transfer by conduction convection and radiation
- Demonstrate heat transfer by convection, conduction and radiation.

Instructional Material – water, metal rod, stick, cans, plastics, clothes, paper, iron, copper, aluminium, candle, bursen burner, beaker, mateches.

Entry Behaviour: The students have fair knowledge of heat transfer during cooking at their homes.

Instructional Procedure

Steps	Teacher Activity	Student Activity	Instructional Strategy
Introduction	The teacher introduces the lesson by helping the students to recall the different forms in	The students mention the forms of energy they know	Questioning skills

	which energy can occur.		
Application	The teacher groups the students into groups of five. guides each group to demonstrate heat flow from a hot water to a metal spoon placed in the hot water. The teacher directs each group to carry out an experiment to show heat transfer; 1) Along a metal rod 2) Along a stick 3) In water 4) From a source of heat to another body without contact with the body	The students work in their respective groups. Carry out questions.	Demonstration
Development	The teacher leads class discussion on the students observations and activities. Explains methods of heat transfer by conduction, convention and radiation. Guides students through probing and leading questions to mentions some of the applications of heat transfer in their home.	The students participate in the discussion, ask and answer question	Probing and leading question, discussion.
Evaluation	The teacher evaluates the lesson with the following questions: 1) What is the kind of heat transfer along a metal rod	The students answer and ask questions	Questioning skills

	2) Classify the following into insulator and conductor (wood, plastic, nail, rod, bottle, clothes, copper, aluminum) 3) Briefly describe method of head transfer by conduction, convention and radiation. 4) Compare the conduction of iron and aluminum 5) Mention two(2) application of each of the following in your home (i) conduction (ii) convection.		
Summary and Conclusion	The teacher reviews the major points in the lesson on the chalkboard	The students writes down the points and listen attentively	Explanation
Assignment	The teacher asks the students to find out from their homes the kind of heat transfer that is applied in 1) Thermos flask 2) Air condition 3) Microwave 4) Hair drier	The students copy down the assignment	Questioning skill

Lesson plan on Basic Science using STS – Approach for experimental -group

Week III

Duration - 80minutes

Class - JS 2

Subject - Basic Science.

Topic - Measurement

Content - meaning, need, instruments and units

Behavioural Objective: By the end of the lesson, the student should be able to;

- Identify measuring instruments
- Classify measuring instrument into nonstandard and standard instrument
- Measure length and volume of substances
- State the differences and similarities between non standard and standard measuring instruments
- Identify the units for measuring length, weight, volume, time, mass.

Entry Behaviour: The students are conversant with the measurement of their height, shoe sizes and quantity of food.

Instructional Material – workshops, like meatshop, tailoring shop, cap entry, filling station, electric meter, laboratory, watches, etc.

Instructional Procedure

Steps	**Teacher Activity**	**Student Activity**	**Instructional Strategy**
Introduction	The teacher introduces the lesson by explaining to the student the origin and reasons for measuring things around us.	The students listen attentively	Explanation
Application	The teacher takes the students to physics laboratory, chemistry	The students observe the instruments, write down	Demonstration, questioning and

	lab, biology lab, food and nut, Homec lab. Instructs the students to find out the instruments used in carrying out measurement in those labs. What they are used for measuring and their calibrations. The teacher also guides the students to practice the measurement of length, volume, weight, time with the instruments find in the labs.	their names and uses. Draw and record the calibrations, measure weight, volume, length and time with the instruments. Ask questions	explanation
Development	Back to the class, the teacher leads class discussion on finding made by the students during their visits. Guides the students through probing questions to mention the needs for standard measurement, accurate measurement and the implication for wrong measurement to man and his environment especially in health, building and construction, etc.	The students participate in the discussion. Ask and answer questions	Explanation and questioning.
Evaluation	The teacher evaluates the lesson with the following questions: 1) Mention one instrument each used in measuring (i) weight (ii) length (iii) volume.	The students answer the questions and write down points	Questioning

	2) Classify the following instruments into standard and non-standard instrument (shadow clock, span, spring balance, measuring cylinder, beaker) 3) Using an appropriate instrument, measure the length of your basic science textbook. 4) State one different and two similarities between standard and non-standard instruments. 5) What is the S.I. unit for length, weight, volume and mass.		
Summary and Conclusion	The teacher reviews the important points on the chalkboard	The students copy down points	Explanation
Assignment	The teacher asks the students to produce one standard instrument used for measuring volume of liquid	The students write down points	Questioning

Lesson plan on Basic Science using STS – Approach for experimental -group

Week IV

Duration - 80minutes

Class - JS 2

Subject - Basic Science.

Topic - Changes in Matter

Content - Physical and Chemical Change, Permanent and temporary change in living and non-living things, causes of changes in matter

Behavioural Objective: By the end of the lesson, the student should be able to;

- Identify a permanent and temporary change
- Classify changes in matter as temporary/physical or permanent/chemical
- Carry out a simple temporary and permanent change activity.
- Identify temporary and permanent growth and developmental changes in human being
- Mention the causes of temporary and permanent changes.

Entry Behaviour: The students are familiar with melting of wax, ice block, increase in height of human being and plant.

Instructional Material – candle wax, ice block, water, salt, sugar, acid (dilute), burnsen burner, paper, maize seed.

Instructional Procedure

Steps	**Teacher Activity**	**Student Activity**	**Instructional Strategy**
Introduction	The teacher introduces the lesson by explaining to the students that change constantly takes place in matters around us. Every living and non-living matter undergo a change in responses to situations in the environment. For instance, candle wax and ice block can melt, new born babies increase in height and size and so on.	The students listens	Explanation
Application	The teacher guides the students to carry out the following	The students perform the activities, ask questions	Explanation and demonstration

	activities - Dissolution of salt in water and acid - Burning of a piece of paper - Melting of candle wax	and jot down points	
Development	The teacher initiates discussion based on the students observations and reactions from their activity section. Uses leading questions to help the students explain the nature of changes they observed and what they think is responsible for the change.	The students participate in the discussion, ask questions, write down points and answer questions.	Questioning and explanation
Evaluation	The teacher gives the following evaluations: 1) List five(5) temporary change you see in your environment 2) Classify the following changes into temporary and permanent change i. Melting of wax ii. Freezing of water iii. Rusting of iron iv. Development of breast in girls v. Development of milk teeth in children 3) Mention two causes of changes in matter	The students answer question and jot down points	Questioning

Summary and Conclusion	The teacher reviews the major issues in the lesson on the chalkboard	The students copy down points and listen.	Explanation
Assignment	The teacher asks the students to plant maize seeds and record the growth change in height for 5 days	The students copy down assignment	Questioning

Lesson plan on Basic Science using Traditional Approach for control group Week I

Duration - 80minutes

Class - JS 2

Subject - Basic Science.

Topic - Pollution

Content - Meaning of Pollution Sources of Air, Water and soil pollutants filtration of dirty water. Methods of controlling pollution hazard

Behavioural Objective: By the end of the lesson, the student should be able to;

- Identify pollution sites
- Identify pollutants
- Classify pollutants
- Carry out simple water filtration
- Suggest methods of controlling pollution
- Describe sources of pollutant
- Mention the hazards caused by pollution on man and on the environment.

Entry Behaviour – The students are familiar with refuse dumps, burning of refuse, smoke from vehicle, generator and other machines

Presentation

Introduction Step I: The teacher defines the concept of pollution

Application Step II: The teacher mentions and describes different pollution sites and the type of pollution from each site.

Step III Development: The teacher explains types of pollution (air, water and soil), effects of pollution and ways of controlling pollution.

Step IV Evaluation

1) Define pollution
2) Mention any 2 types of pollution
3) List three (3) effects of pollution on man
4) State three (3) effects of pollution on man
5) Mention two (2) ways of controlling pollution.

Summary and Conclusion: The teacher goes over the definition of pollution, causes and effects and control measures once again.

Step VI Assignment: Copy the note on this topic and submit before next class.

Lesson plan on Basic Science using Traditional Approach for control group Week II

Duration - 80minutes

Class - JS 2

Subject - Basic Science.

Topic - Thermal Energy

Content - Illustrating heat flow, heat transfer by conduction, convection and radiation and their application in homes. Conductors and insulators (examples and uses)

Behavioural Objective: By the end of the lesson, the student should be able to;

- Observe and identify heat flow and heat transfer by conduction, convection and radiation.
- Describe heat transfer by conduction convection and radiation
- Demonstrate heat transfer by convection, conduction and radiation.

Entry Behaviour – The Students are conversant with heat flow in a solid metal e.g. cooking utensils

Presentation

Introduction Step I: The teacher explains the concept of heat transfer from one body to another

Application Step II: The teacher defines conduction, convection and radiation. Demonstrates conduction.

Step III Development: the teacher explains conduction, convection and radiation. Gives examples of each and their application.

Step IV Evaluation

1) What is heat flow?
2) State how methods of heat transfer and one application of each.
3) Define radiation

Summary and Conclusion: The teacher reviews the important points in the lesson.

Step VI Assignment: Find out other application of radiation and convection in your home.

Lesson plan on Basic Science using Traditional Approach for control group Week III

Duration - 80minutes

Class - JS 2

Subject - Basic Science.

Topic - Measurement

Content - Meaning, need, instrument and units for measurement

Behavioural Objective: By the end of the lesson, the student should be able to;

- Identify measuring instruments
- Classify measuring instrument into nonstandard and standard instrument
- Measure length and volume of substances
- State the differences and similarities between non standard and standard measuring instruments
- Identify the units for measuring length, weight, volume, time, mass.

Entry Behaviour – The students have a fair knowledge of measurement in their homes. Example, in measuring quantity of food, drug, shoe size, etc.

Presentation

Introduction Step I: The teacher explains the origin of measurement

Application Step II: The teacher mentions the instrument for measurement and what they are used in measuring.

Step III Development: The teacher explains how the measuring instruments are used, how to read the calibration correctly.

Step IV Evaluation

1) What is measurement?
2) We measure things to find out their ____ _____ and _____
3) Meter rule is used in measuring _____
4) What is the S.I Unit for weight

Summary and Conclusion: The teacher summarizes the lesson on the chalkboard.

Step VI Assignment: Copy the note on this topic and read more about measurement from your textbook.

Lesson plan on Basic Science using Traditional Approach for control group Week IV

Duration - 80minutes

Class - JS 2

Subject - Basic Science.

Topic - Changes in Matter

Content - Physical and chemical change Temporary and permanent change in living and non-living things, causes of change in matter

Behavioural Objective: By the end of the lesson, the student should be able to;

- Identify a permanent and temporary change
- Classify changes in matter as temporary/physical or permanent/chemical
- Carry out a simple temporary and permanent change activity.

- Identify temporary and permanent growth and developmental changes in human being
- Mention the causes of temporary and permanent changes.

Entry Behaviour – The students are familiar with melting of candle, melting and freezing of water, dissolution of sugar in water.

Presentation

Introduction Step I: The teacher defines chemical and physical changes

Application Step II: The teacher mentions different examples of physical and chemical changes both in living and non-living matters

Step III Development: The teacher explains the examples and mention their causes and states the differences between chemical/permanent and physical/temporary changes

Step IV Evaluation

1) What is physical change?
2) State three causes of a chemical change
3) Mention four examples of a chemical change
4) Mention two differences between a physical and chemical change.

Summary and Conclusion: The teacher reviews the lesson briefly with emphasis on the important points.

Step VI Assignment: Read more about temporary and permanent change.

APPENDIX E

RELIABILITY USING CRONBACH ALFA

Overall Result

Case Processing Summary

		N	%
Cases	Valid	30	100.0
	Excluded[a]	0	.0
	Total	30	100.0

a. Listwise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.842	40

Kendall's W Test

Overall Result

Ranks

	Mean Rank
STUDENT 1	6.83
STUDENT 2	6.00
STUDENT 3	10.00
STUDENT 4	4.67
STUDENT 5	8.17
STUDENT 6	1.67
STUDENT 7	3.50
STUDENT 8	3.33
STUDENT 9	4.83
STUDENT 10	6.00

Test Statistics

N			3
Kendall's W[a]			.772
Chi-Square			20.843
Df			9
Asymp. Sig.			.013
Monte Carlo Sig.	Sig.		.001[b]
	99% Confidence Interval	Lower Bound	.000
		Upper Bound	.002

a. Kendall's Coefficient of Concordance
b. Based on 10000 sampled tables with starting seed 2000000.