UNIVERSITY OF CAPE COAST

STATUS OF TEACHING AND LEARNING OF SCIENCE IN JUNIOR SECONDARY SCHOOLS

AMINU ALIYU

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BY

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Thesis submitted to the Department of Science Education of the Faculty of Science and Technology Education, College of Education Studies, University of Cape Coast, in partial fulfilment of the requirements for the award of Doctor of Philosophy degree in Science Education

OCTOBER 2021

DECLARATION

Candidate's Declaration

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

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

Name: ……………………………………………………………………

Supervisors' Declaration

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

Principal Supervisor's Signature: …………………. Date: …………………

Name: ………………………………………………………………………

Co-Supervisor's Signature: ……………………………. Date: ………………

Name: ………………………………………………………………………

ABSTRACT

The study investigated the status of teaching and learning of science in junior secondary schools. An embedded mixed methods design, survey design and case study design were employed. The study involved 36 basic science teachers and 377 learners for the quantitative part, and 10 teachers, five principals, two zonal education directors, and 10 learners for qualitative part. Multistage sampling was employed in this study. Questionnaires, performance tests, interviews, and observation guides were the main instruments used to collect data. The findings of the study indicated that basic science teachers did not fully understand the basic science curriculum they were expected to implement. The teachers could not design science activities for learners to learn through exploration, guide learners to practise, and evaluate learners' learning outcomes. All the schools involved in this study have laboratories. However, these laboratories were not used for practical work except in three schools where they used the laboratory space for basic science lessons. The results further showed that the predominant teaching methods used in the teaching of basic science were question and answer, lecture, and demonstration methods. Teachers depended on the little available instructional materials in their schools to deliver their lessons. The research concluded that teaching and learning of science in the Junior Secondary Schools in Kebbi State were generally not good since many teachers seemingly neglected the basic aspects of the subject. It is recommended that basic science teachers be taken through in-service training, seminars, and workshops on assessment skills to enable them to function effectively in their role as teachers.

KEY WORDS

Basic science

Basic science curriculum

Basic science teachers

Instructional materials

Junior secondary schools

Learners' socio-economic background

Methods of teaching

Professional knowledge

Science laboratories

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DEDICATION

To my parents Alhaji Bashar Abdullahi and Malama Aishatu, wife Shafa'atu and children Yusha'u, Abida, Abdul Hakim, Ukashatu and Abdul Jalal.

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CHAPTER ONE

INTRODUCTION

The development of any society cannot be placed without knowledge and skills in science and technology. Mulemwa (2001) expressed that global confidence in the applications of science and technology, its processes and products in sustainable human living has made them precious that any society without science and technology risks being isolated from the global village. This means for an individual to be well-informed in science and capable enough to face the challenges of life in society, he or she must have gone through a science programme that is well planned, assessed and implemented. In line with this, the science-policy is aimed to develop awareness and sensitivity to the living and non-living environment through access to the natural environment (Policy, 2014). Basic science is science taught at basic educational levels that help pupils to develop a greater understanding of their environment and build carrier in science. A good background knowledge of science enables pupils to learn the world around them that affect their lives positively.

The objectives of basic science have been spelt out in the new basic science curriculum of Nigeria. One is not sure whether the objectives will be achieved, as documented. For some years now, the academic performance of basic science students of Junior Secondary School (JSS) 1-3 in Nigeria has declined compared to other subjects (Sambo, 2012). He also opined that language problems and poor attitudes to teaching and learning of basic science by both teachers and students result in low performance as associated with other subjects.

Background to the Study

Teaching basic science in schools in Nigeria has continued to generate great attention among parents, teachers, scholars and policymakers. The emphasis is that the output in basic science and mathematics of secondary school students has continued to deteriorate over the years. (Ajowole, 1990; Fraser, Okebukola & Jegade, 1991; West African Examinations Council, 2006). Government, professional associations and science educators have repeatedly expressed the need to identify the causes of poor performance in basic science for them to take steps to strengthen science teaching and learning as a way to promote scientific literacy. Some of the measures to be put in place are improving on the provision of science teaching and learning facilities (Onwuakpa, 2004); and science teacher training and retraining through pre-service and in-service programmes including workshops, vocation courses, and conferences (Ofoegbu, 2003). The Science Teachers' Association of Nigeria (STAN) has also taken giant strides in providing measures for improving the standard of science teaching and learning in Nigeria by organizing annual national conferences, workshops, and seminars. STAN is also involved in promoting and popularising science teaching and learning through quiz competitions and science exhibitions for secondary school students as well as through sponsored researches, culminating in the publication of STAN position papers (Ekuri & Asim, 2008).

The World Conference on Education for All (WCEFA) organised in Thailand between 5th-9th March, 1990 stated that every child, youth, and an adult must take advantage of the resources provided for them to fulfil their educational goals. The Federal Government of Nigeria, in complying with the declaration, came up with Universal Basic Education (UBE) programme to provide well-designed education for all citizens as a way of eradicating illiteracy, ignorance, and poverty among them (Yusuf & Ajere, 2009). On 30th September 1999, the Nigerian government launched the Universal Basic Education programme. Universal Basic Education is a restructured programme in Nigeria's basic education delivery. It is a free, compulsory 9-years education for all pupils irrespective of their socio-economic background (Universal Basic Education Commission, 2004; Dauda & Udofia, 2010). The Universal Basic Education encompasses the primary and first three years of secondary school.

In an attempt to achieve the Millennium Development Goals (MDGs) by 2015 and the priorities of the National Economic Empowerment and Development Strategies (NEEDS), the Nigerian Federal Government has agreed to update, modify and revise the existing basic education curricula to fit into the 9-year Basic Education Programme (Obioma, 2007). The Nigerian Educational Research and Development Council (NERDC) updated and re-structured Integrated Science based on the 6-3-3-4 school system and substituted it with basic science based on the 9-3-4 school system (Nnorom, 2012). This 6-3-3-4 scheme of education means that children will undergo six years in primary school, three years in junior school, another three years in senior school, and four years in a tertiary institution. The 9-3-4 system means nine years in basic education, three years in senior secondary school and four years in a tertiary institution. Execution of the 9-Year Basic Education Curriculum (BEC) generally began in Primary 1 and JSS 1 classrooms in September 2008. This education programme is viewed to strengthen the 6-3 - 3-4 system of education instead of the new system itself. Without question, the curriculum is the foundation of all educational reforms, from which basic science is no exception.

Science in basic education is taught as basic science. It is led to exposing pupils to the basic scientific initiative and to lay a foundation upon which science learning will be built. Basic science lays the foundation for the three core science subjects (Chemistry, Biology, and Physics) taught in senior secondary school. Integrating science subjects is designed to show the unity, entirety, and interrelationship among the various aspects of science. Basic science removes the segregation among the three science subjects, maintains flexibility, and shows the connection between science and society. The main objective of basic science is to introduce the three subjects in science which are Biology, Chemistry, and Physics to the pupils at the junior secondary school level. They serve as a foundation on which the students lay their scientific knowledge in their later lives and the experience gained in basic science will guide them to become scientifically literate, (Na'Allah, 2016).

Basic science is a subject that helps children to learn to understand their environment, observe and investigate the world around them. Also, children gather essential knowledge in science for the understanding of more complex and abstract concepts in life. It is necessary to lay a solid foundation in basic science to form ideas based on scientific reasoning. Basic scientific preparation is essential to find ways to a wider variety of professional opportunities. This does not only allow children to develop a better understanding of things around them but also helps them to cope more effectively in their lives with broader decision-making and problem-solving.

The Federal Ministry of Education [FME] (2004) explained that the junior secondary school basic science curriculum emphasised the need for a planned learning experience to be child-centred. The basic science curriculum is intended to provide quality education to all students regardless of their choice after leaving school. It emphasises the teaching of new knowledge and basic skills to develop the abilities to address current and future challenges in the present generation. The basic science curriculum assists the teacher in having a focus on what to teach. The curriculum content is, therefore, an important factor to consider if there must be any meaningful development in science and technology in the country. Adejoh (2008) and Aba (2003) said that the basic science programme might be the highest form of science education many Nigerians may be exposed to. Many students may not go beyond the junior secondary school level, and those who go beyond this level may offer other courses. This situation places greater responsibility and challenges on educationists regarding those programmes to ensure that learners can be introduced to basic science education by the end of junior secondary school. That will allow them to live and function effectively in a world dominated by science and technology.

Basic science teachers, in particular, are the facilitators of learning experiences. Improving the standard and quantity of learning gained by students, they provide learning opportunities and required guidance. Ben-Yunus (2002) states that classroom teachers form the keystone in the curriculum implementation. The teacher is the last person to guarantee that the curriculum is implemented according to the description. Therefore, if an instructor is unskilled or reluctant to implement what is planned in the curriculum, the objectives would not be attained.

A well-trained teacher can professionally and efficiently deliver the subject content. So, teachers who are well trained will teach their students' knowledge and comprehension of the subject matter material. These educators integrate different methods of teaching, thereby enhancing their delivery of content in the classroom. For all students to learn and perform at high levels, successful preparation focuses on the knowledge, skills and attitudes needed by the teachers. Research has shown that teacher training has several effects. For instance, Gamoran (2006) observed that teacher training has contributed to improved delivery of content in the classroom, increasing student achievement. Desimone, Porter, Garet, Yoon and Birman (2002) suggested that educational administration should ensure that teaching practice aims to achieve exemplary results in schools obtained by teacher preparation. Akinsolu (2010) notes that the availability of trained educators influences the success of school students.

Teachers should apply effective teaching methods that best fit particular goals and level to ease the transmission of information. A substantial literature on the efficacy of teaching methods specifies that teaching excellence is also expressed in learners' achievements (Elvis, 2013). It is also important for the instructor to be able to define the Zone of Proximal Development (ZPD) or "the state of readiness" in the area of learning to be learned. Such thoughts have consequences for the practice of teaching and learning, in particular as seen in "modelling" and "scaffolding"(Griffin, 2007, p.90). Thus, teaching methods play a significant role in generating good students' performance.

Today, teaching materials in basic science teaching and learning in secondary schools is not new. Owing to a lack of instruction around its use, for a successful use as well as transmission of information, many educators are not competent or make it challenging to use teaching materials while teaching. Isola (2010) identified the instructional materials as a device that encourages teachers to address their lessons rationally and successively to learners. Oluwagbohunmi and Abdu-Raheem (2014) recognised that the teaching materials used by teachers during the teaching and learning process are intended to reinforce interpretations and make the learning of the subject easier for students. Parents have to support their children to engage in the learning process by providing all their needs necessary for learning. In many ways, parental socio-economic status influences students' learning.

The socio-economic background of parents has more chances of increasing or decreasing the access of children to education and achieving better performance in school. Universal Basic Education Commission (2004) said the Universal Basic Education Act of 2004 suggested a free, compulsory 9-year education for all pupils regardless of their socio-economic background. And the goals for Education for All (EFA) in Nigerian context translate into full access to primary and junior secondary schooling for children and adolescents and the removal of all types of social, economic, political, gender, cultural, and educational problems in the process of curriculum improvement, career-long teacher development and promotion of lifetime learning skills, (Obanya, 2002).

Ayuba (2010) observed that a parent's socio-economic background influences the education of their children. Socio-economic status includes a parent's level of education, occupation, source of income, amount of income, and dwelling place. Ibrahim (2008) observed that children of parents of high socio-economic status attend school earlier than those in the lower socio-economic status. Similarly, parents from high socio-economic backgrounds can manage to send their children to pre-primary schools, which enhance the transition from home to school. They can also include all the requisite books, learning resources and even organise for extra lessons for their children. Mahuta (2007) indicated that the socio-economic status of parents, to a great extent, influences the educational life of a child.

The educational life of a child also depends on the performance of the teacher during classroom transactions. However, teacher training in Nigeria is faced with problems. For example, Otarigho and Oruese (2013) said that most of the issues arise due to inappropriate training background, content knowledge, assessment techniques and pedagogy of our science teachers, which is not quite adequate for teaching basic science. The inability of the teachers to teach students as it is designed in the curriculum brought about the poor performance of students in basic science education. This calls for constant assessment of the status of science education in the educational programme of the country (Alebiosu, 2002).

For learners to benefit from basic science, there is a need for appropriate teaching. Some researches like Obiekwe (2008) and Oludipe (2011) have observed that science teaching in secondary schools in Nigeria falls well short of the planned norm. One major problem of the teachers is the failure to use appropriate activity-based teaching strategy as spelt out in the basic science curriculum (Akbari & Allvar, 2010; Jekayinfa, 2007; Usman, 2007; 2010). They are used to the traditional lecture method that has been shown to lead to poor academic performance in junior secondary schools in basic science. Many of the teaching techniques utilised have been identified as ineffective and boring (Ibe, 2004; Madu, 2004; Igboegwu, 2012).

Attainment in the teaching and learning activities has something to do with meeting those teaching goals (Nnaobi, 2007). In science directives, for example, when a student completes a mission and achieves clear learning experience objectives, he or she is said to have accomplished his or her goals. A key concern of decision makers in education is the achievement of the goals of science education, one of which is the formation of scientific literacy (Federal Ministry of Education, 2004).

The teacher is also an essential determinant in the successful implementation of any curriculum innovation. There are not enough trained teachers to teach basic science in secondary schools in Nigeria. Otarigho and Oruese (2013) said that most of the problems arise due to the inappropriate training background of our science teachers, which is not quite adequate for teaching basic science. Again, some researchers (Akpan, 2015; Ivowi & Akpan, 2012) found that most basic science teachers are not academically qualified to teach the subject. For many years, there was an increase in students' admission at junior secondary schools in Nigeria, but few students are doing well in basic science (Shehu, 2017). The poor performance of students persists in basic science at the junior secondary school level despite several studies (Edet & Inyang, 2008). Edet and Inyang (2008) further explained that students' academic performance was of significant concern to parents, teachers, and even the government.

The present study is, thus, a response into the status of teaching and learning of science in junior secondary schools in Kebbi State, Nigeria. Due to the role of science education in the progress of society, there is a need for a constant evaluation of the status of science education in the educational programme (Alebiosu, 2002).

Statement of the Problem

Over the years, Nigeria has experienced several educational reforms and the most recent one was curriculum reform at the basic education level, which was implemented in 2008 and 2014. However, after some years of implementation, there were several complaints about the 2008 curriculum implementation therefore, the curriculum was revised and the new one was implemented in 2014. Some of the complaints were subject overload, poor funding, poor teaching methods, inadequate trained teachers, lack of instructional resources, a poorly equipped library, poorly equipped laboratories and assessment among others. Factors such as insufficient trained teachers, inappropriate pedagogy and unsafe learning conditions pose a threat to the successful implementation of the revised 9-year basic education curriculum (Olateru-Olagbegi, 2015). It was noted that most students worry about teaching principles that seem to be abstract in nature and full of teacher-centred activities (Personal communication, April 2, 2018).

Bello (2007) outlined some of the main factors for education changes, that include the need to: provide education relevant to the needs of the country, equip students with specific skills to transform their private and professional lives, equip schools with sufficient tools, develop teaching strategies and instructional activities, develop student assessment system, and prepare citizens for global challenges. For Nigeria to meet the targets of the 9-year basic curriculum in the context of the National Economic Empowerment and Development Strategies (NEEDS) and the Millennium Development Goals (MDGs), the new curriculum must be considered in line with Bello’s assertion. However, one area that needs urgent attention is the implementor of the curriculum; (that is the teacher).

Teachers involved in curriculum implementation seem not to understand the curriculum that has been implemented. Some studies have shown that most of the basic science teachers at primary and junior secondary schools are not familiar with the objectives of the basic science programme that has been implemented (National Research Council, 1996; Hancer, 2006; Odili, Ebisine & Ajuar, 2011). Furthermore, Achor and Ellah (2016) found that teachers were not completely clear about the basics of the new basic science and technology curriculum. This happened because most of the basic science teachers are single science specialists who are totally ill-equipped to manage this current curriculum in every way possible (Olarewaju et al., 2020).

If the reason behind the revision of the 9-year basic education curriculum must be realised, then it is important to appraise how teachers demonstrate their competencies in curriculum implementation. A study has stressed the need to assess the implementation of the basic science programmes after some years of establishment (Hudu, Johnson, & Ombugadu, 2014). Therefore, it is essential to conduct this research on the status of teaching and learning of science in junior secondary schools, after 7 years of the implementation of the revised curriculum.

Purpose of the Study

The purpose of the study was to examine the status of teaching and learning of science in junior secondary schools in Kebbi State, Nigeria. The researcher examined certain variables that take prominence in the teaching and learning science in basic schools in Kebbi State, Nigeria.

Research Questions

This research was motivated by the following research questions

1. What professional competence do teachers who teach basic science in junior secondary schools possess?
2. What predominant method(s) of teaching do teachers employ to teach basic science in junior secondary schools?
3. What instructional materials do teachers employ to teach basic science in junior secondary schools?
4. How are the science laboratories in junior secondary schools equipped with relevant materials for basic science practical lessons?
5. How does the basic science curriculum address domains of learning?

6. What are the dominant factors in exploring science learners' socio-economic background on their academic performance in basic science programme?

Null Hypotheses

The hypotheses tested in respect of this research work are Null hypotheses 1 and Null hypotheses 2.

Null Hypotheses 1

H_O 1a) There is no significant difference in the performance of basic science learners taught by trained teachers and those that are taught by untrained teachers in junior secondary school one (JSS 1).

H_O 1b) There is no significant difference in the performance of basic science learners taught by trained teachers and those that are taught by untrained teachers in junior secondary school two (JSS 2).

H_O 1c) There is no significant difference in the performance of basic science learners taught by trained teachers and those that are taught by untrained teachers in junior secondary school three (JSS 3).

Null Hypotheses 2

H_O 2a) There is no significant difference in the performance of basic science learners who use science laboratories and those that do not use science laboratories in junior secondary school one (JSS 1).

H_O 2b) There is no significant difference in the performance of basic science learners who use science laboratories and those that do not use science laboratories in junior secondary school two (JSS 2).

H_O 2c) There is no significant difference in the performance of basic science learners who use science laboratories and those that do not use science laboratories in junior secondary school three (JSS 3).

Significance of the Study

This study presents detailed information to the science educator, science curriculum planners and the government, which will help them to restructure actual science teaching in basic schools for effective learning of science. The findings of this study are also expected to:

1. promote teachers' appropriateness in implementing the core curriculum of basic science to help in effective learning in junior secondary schools.
2. provide an insight into the factors responsible for the actual teaching and learning of science and related areas in junior secondary schools. Thus, it is hoped that this research would help policymakers and curriculum planners in designing the content of the learning schedule to suit the needs and aspirations of students toward science and sustain their interest in participating in scientific learning and related activities.
3. provide insight into basic science teaching and learning in junior secondary schools by identifying the area of cognitive demand of the topics in the curriculum that should be reviewed. This would allow students to improve their success in studying complex topics.
4. highlight the need for adequate physical facilities in schools to the government, thereby making teaching and learning conducive.

5. provide a true picture of teaching and learning of basic science to the government and other stakeholders to guide them to improve the programme to attain the stated objectives of the programme.
6. benefit to science students as the knowledge will enable them to make an adjustment and develop a positive attitude towards science to enhance their performance.

Delimitations of the Study

There are government science colleges and government science and technical colleges in Kebbi State, Nigeria. These colleges have both junior and senior sections, that all offer basic science. This study was delimited to the junior secondary school sections of all the government science colleges and government science and technical colleges under the Ministry of Basic and Secondary Education of Kebbi State, Nigeria. It focused on teachers' professional competencies, parental socio-economic background, laboratory facilities, instructional materials, methods of teaching basic science, and learners' performance.

Limitations of the Study

This study faced some practical challenges. For example, some teachers were not willing to participate in classroom observation. The limited number of teachers involved in the study could limit the outcome of the study. The integration of quantitative and qualitative analysis approaches into the sample may have affected the results of this study, as the two methodologies are focused on separate assumptions; each has its limitations.

The teaching of basic science depends on contents and concepts. Therefore, classroom observation should take place throughout the whole academic year to reflect the teaching of basic science. However, data were collected in the third term, which may have posed a limitation on the study. It is also possible that the presence of researchers and research assistants in the class during teaching might have affected the behaviour of the teachers. This is because when people are aware that they are being watched, it is normal that they appear not to be themselves, and that might have affected the study's results.

Students' answers to the study might be influenced by fear, hate, affection, and other emotional worries about their instructors, which could influence the study's findings.

Definition of Terms

This section contains the definition of terms used in the thesis.

Status of teaching and learning: This refers to the present condition of teaching and learning.

Socio-economic status: This refers to an individual's/group's demographic, social and economic position with others. In this study, socio-economic status was measured in terms of parental social class, level of education and occupational status.

Academic achievement/ performance – The academic status of a student at a given time refers to how a person can effectively demonstrate his / her cognitive skills, particularly, when using his / her efforts or abilities.

Method of teaching: This refers to the procedures or ways the teacher employs to facilitate teaching and learning.

Teaching strategy: A teaching strategy refers to a teacher's dynamic instructional actions through strategies, techniques, tools, instruction and interactions to accomplish objectives and or goals.

Basic science teachers – Are those teachers teaching basic science in junior science secondary schools at the time of data collection for this research.

Basic science refers to basic science skills, knowledge and attitudes essential for human survival, sustainable development and social change.

Government Science College: This is a full science school responsible for secondary education. It has both junior and senior sections in the same compound with one principal. Students learn Biology, Chemistry, and Physics at the senior section and Basic Science at the junior section

Government Science and Technical College: It is full science and technical schools responsible for secondary education. It has both junior and senior sections in the same compound with one principal. Students learn Biology, Chemistry, Physics, Mechanics, Welding, Construction and Computer programming at the senior section and Basic Science and Technology in the junior section.

Organisation of the Study

This study consists of five chapters. The first chapter is the introduction. It introduces the study explains the background of the study, and highlights the statement of the problem. It also contains the purpose of the study, research questions and null hypotheses to guide this study. The chapter also presents the significance of the study, delimitations, and limitations of the study and definition of terms. Chapter Two reviews the related literature relevant to the study. Chapter Three describes the research methods used in this study. The results of the study and major findings are discussed in Chapter Four, while Chapter Five presents the summary, conclusions, recommendations and suggestions for further research.

CHAPTER TWO

LITERATURE REVIEW

This chapter looks at national and international research literature relevant to the investigation into the status of teaching and learning of science in junior secondary schools in Kebbi State, Nigeria. The Chapter begins with Theoretical framework that underpins the study.

Theoretical Framework

This research had been motivated by the constructivist theory of Brunner. In Brunner's constructivist instruction theory, learning is seen as a lively process. The creation of new ideas by the learners is based on experience or current knowledge. Brunner has helped us enormously in our understanding of learning for children. He promoted the idea that education must be prearranged with a spiralling style, so that pupils always develop their knowledge of what they have learned (Brunner, 1960). Practical knowledge-building approaches can contribute to rationalisation, the progress of new ideas and improved information management.

Brunner was particularly interested in the children's use of the strategy when learning new tasks, especially when engaging in problem-solving activities. He saw the teacher's position as very important in helping children to develop methods that are effective and help them learn. This led him to create the idea of scaffolding, where teachers work with pupils to build on the experience by directing their learning (Wood, Bruner & Ross, 1976). He also promoted the concept of learning from experimentation, which is a form of teaching focused on inquiry. Teachers interacting with pupils create an atmosphere where learners can have new learning experiences through exploration. He believed that learners must draw on previous experiences and knowledge, use their imagination and creativity, and look for further information to discover the facts for a teacher teaching pupil to have a clear view of the knowledge that currently exists. The principle finds that pupils learn to use instructional materials in steps with the possibility of changing one learning style to another. A physical object, pictures, diagram, graph and model are employed to improve the ability of pupils to think abstractly.

This theory stressed that teachers should consider the learning style of learners as a basis for the formation of successful teaching. For example, during science exercises in the classroom, the educators should be mindful of the learning style of the learner. (Inactive, iconic and symbolic) to help him/her choose appropriate materials and methods for instruction according to the complexity that suits the level of cognition of the learner. Brunner (1960) noted that children of any age could learn intricate knowledge. Still, responsibility for this learning rests on the instructor who must effectively teach any topic to any child at the developmental level. Brunner's ideas also complement the latest learning methods of assessment that help students to understand how to read. Questions are asked, and pupils work together to discuss their responses and reach an agreement. It is also geared towards expanding and increasing the practice of formative assessment to help pupils take greater responsibility for their learning. Therefore, Brunner's constructivist theory was used in this study.

Conceptual Framework

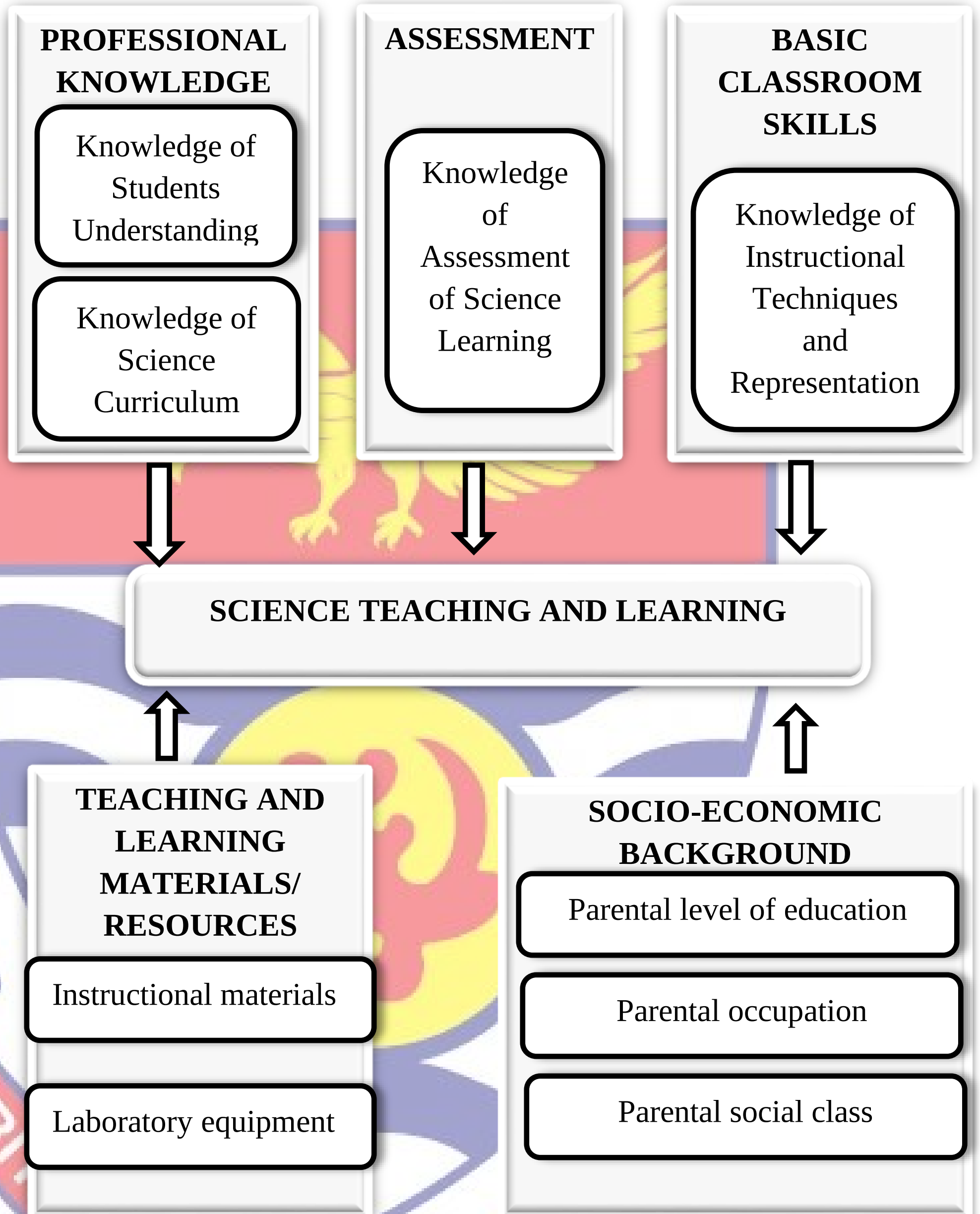

Figure 1: Conceptual Framework. Source: Aliyu (2019)

The conceptual framework for this study addresses variables and their relationship or connections with teaching and learning of science. The variables in this conceptual framework are among many variables to be used in assessing teaching and learning of science in schools to which Basic Science is no exception. In this conceptual framework, the variables are used to describe basic science teachers' competencies and how these inform their teaching. Generally, basic science teachers' knowledge and skills influences their teaching activities. Teachers acquire knowledge and skills that influence how they plan and implement active-learning instruction which affects students' learning of science.

In this study, knowledge of student understanding and knowledge of science curriculum were combined to measure teacher professional knowledge. This knowledge is an essential component of science teaching and crucial to the teacher for smooth instructional flow and enhancing students' better understanding of the lesson. The teacher requires knowledge of student understanding to address students' misunderstandings, learning difficulties and students' motivational interest in learning science. Knowing of learners understanding enables the teacher to explain concepts in science very well. Use appropriate strategies that promote students' understanding of science and give examples within learners' real-life experiences for effective teaching and learning. The teacher has to find out about learners' learning difficulties, and helping to overcome these difficulties, promotes learners' interest in science and consequently motivates learners to learn. The teacher is supposed to be knowledgeable in sequence and continuity of learning within a given subject over time. The integration of curricular contents in teaching science among knowledge domains at each level facilitates teaching and learning. Knowledge of the curriculum enables teachers to select and use appropriate curriculum materials for effective science instruction. Teaching and learning materials/resources are essential for any effective teaching and learning. Teachers are required to select, effectively use teaching and learning materials/resources to help in the deeper comprehension of the teaching and learning.

The teacher's knowledge of assessment of science learning has played a pivotal role in the assessment of students' learning outcomes. Assessment of learning outcomes must be done better and more efficiently to reflect science teaching and learning objectives. One method of assessment cannot evaluate the performance of learners; therefore, teachers need to use various assessment methods, each directing to different learning domains. Teacher's assessment knowledge informs successful teaching and learning of scientific knowledge and skills.

Knowledge of instructional techniques was also used in this study to measure basic classroom skills. Teachers must possess the skills needed to perform their teaching of science and attain the set educational goals for science teaching and learning. Instructional strategies are potent means for effective learning to help student's develop assessable knowledge and abilities as they participate in learning. Classroom presentation to increase the standard of instruction lies in the subject and topic-specific nature. The learning of a specific subject goes through a particular topic where learners' characteristics are being considered. Lesson presentations fully engage learners in the learning process. Teaching activities should all be connected to the objectives of the instructional process to help learners become more self-directed learners. The socio-economic background is an aspect that influences learners' learning, which in turn assists teachers to gain knowledge about teaching and learning groups of learners from a different socio-economic background. This also informs teachers how to go about their classroom practices by engaging learners from the different socioeconomic backgrounds.

As part of the research on the status of teaching and learning science, the opinions of teachers and other stakeholders were requested, observations were conducted for classroom teaching, science laboratories and curriculum that inform teaching and learning science. The results were used in making decisions about teaching and learning science in junior secondary schools in Kebbi State.

Research Paradigms

Biesta (2010) indicates paradigms are an appropriate method for the research process but are not aimed at being exclusionary. It is important to know philosophical premises about the nature of reality and how it affects the overarching view through which the study is formulated and conducted. Within social science and science studies, there are many study paradigms, including positivist, interpretive, critical theorist and analytical methods. The growing paradigm depends on how the researcher considers the nature of reality and how they study the phenomenon. Paradigms are, therefore, a reference that researchers use to focus their work. In this study, a mixed-method research design was involved in performing both quantitative and qualitative research to determine the status of teaching and learning science at junior secondary schools. In this study, pragmatism was chosen and used.

In mixed methods, four main paradigmatic viewpoints include pragmatism, transformative emancipation, dialectics and critical realism. Among these paradigms of mixed methods, one paradigm may be better suited for study over others. Pragmatism is an alternative to the "metaphysical and positivism" philosophy (built on critical theory, post-positivism, and participatory approaches) (Morgan, 2007). It emphasises on collaboration and mutual meaning-making to build concrete solutions to social issues. The implementation of mixed pragmatism research methodology is based on creating research questions that can be answered by combining quantitative and qualitative research findings (Creswell & Plano Clark, 2011; Tashakkori & Teddlie, 1998). Teddlie and Tashakkori (2009) said the empirical literature on mixed methods has suggested pragmatism as the 'right approach' for this practical.

Teddlie and Tashakkori (2009) claimed that pragmatists believe that it will take an objective approach from an epistemological viewpoint at some stage of the study. By not interacting with subjects, while at other stages, it would be appropriate to take a more subjective approach by communicating with research subjects to construct realities. Morgan (2007) discussed a basic structure to demonstrate how a pragmatic approach varies from both quantitative (positivist/postpositivist) and qualitative (constructivist) methods to the relation between theory and evidence and to interpret data. Pragmatism acknowledges the importance of principles in information theory, but as Morgan (2007) said, it opposes what he sees in other paradigms as the privilege in ontology over methodology and epistemology. Morgan (2007) clarified a holistic approach based on theory and its relation with epistemology and methods, devoting equal attention to each interaction. A realistic approach allows researchers to be versatile enough to take the most practical approach to research questions.

Research on mixed methods includes gathering and evaluating both quantitative and qualitative data, and at some stage, incorporating the two sets of findings into the study to conclude quantitative and qualitative results (Johnson & Onwuegbuzie, 2004). Integrating the findings of these two approaches provides a more comprehensive image of a research subject capable of addressing a set of research questions and providing detailed information that might improve the philosophy and practise development (Johnson & Onwuegbuzie, 2004).

Shannon-Baker (2016) defined mixed methods research as a form of theoretically based inquiry wherein single qualitative and quantitative methods are used. This combination, or the incorporation of these two methods, may occur within the conceptual or theoretical framework(s), data collection and analysis processes, overall research design, and research conclusions. Mixed methods attempt to get a more comprehensive interpretation of a phenomenon that would otherwise have been difficult with a single methodology within research (Creswell & Plano Clark, 2011; Morse & Niehaus, 2009). Through this definition of pragmatic approach, a rationale for taking a variety of pragmatic decisions is focused on using mixed methods design and used within this research process.

Background to the teaching of Basic Science in Nigeria

Basic education means the type of education offered at the first level of education, in terms of quality and content. It is the cornerstone on which other education levels are developed and a human and national development prerequisite

(Tahir, 2006). According to Ochoyi and Danladi (2008), the provision of basic education for all people has been a global target that Nigeria aims to accomplish via the Universal Basic Education (UBE) initiative, like some other nations.

Before the implementation of the UBE programme, according to Anaduaka and Okafor (2013), the current government education policy and the programme was found to cause distortions, high dropouts' rates, limited curriculum content and unqualified graduates that did not meet the needs of society. Consequently, the UBE system was introduced to solve these problems by supplying all children with free, universal, and compulsory basic education, irrespective of gender, age, cultural or racial affiliation, language, or status. It is also expected to complement a rigorous programme in adult learning.

On 30 September 1999, in Sokoto State, the Universal Basic Education (UBE) programme was initiated by the then President of Nigeria, President Olusegun Obasanjo. The programme is intended to provide children in primary and junior secondary schools with free and compulsory education. The scheme was initiated by President Obasanjo, who promised that the many obstacles raised by the 1976 Universal Primary Education (UPE) programme might not be permitted to obstruct the 9-year basic education program. He also responded by pointing out that the purpose of the scheme is to halt the deterioration and decay and to extend and develop the UPE scheme.

A child began primary school at or around the age of six and graduated with a primary certificate before the launch of the UBE. He or she first took a common entrance examination that qualified him/her for secondary school admission. The

UBE came in as a supplement for this method. Six years of primary school and three years of junior secondary school are part of the UBE, resulting in nine years of continuous education. While assessed by continuous evaluation, the move through one class to another is automatic (Anaduaka & Okafor, 2013).

For every Nigerian child, the UBE programme aims to make education compulsory for the first nine years. As illustrated in the Guidelines for the Implementation of the Federal Ministry of Education (Federal Republic of Nigeria, 2000), the basic goals of the UBE programme are as follows:

a. ensure unaltered access to adequate formal basic education for 9 years;
b. delivery of free, universal education for every school-aged Nigerian child;
c. reduce the rate of dropouts dramatically through increased relevance, consistency, and successful education from the formal school system;
d. ensure that sufficient levels of literacy, numeracy, deception, communication and life skills are obtained and the ethical, moral, and civic values necessary to create a strong base for life learning (Universal Basic Education, 2000).

The achievement of the above objectives is consistent with the UBE Act, enacted on 26 May 2004. The Act provided for obligatory, affordable, universal basic education, and other related issues. The Universal Basic Education Commission (UBEC) was formed following the enactment of the Act. Opoh, Okou, and Ikang (2015) clarified that for the implementation of the UBE, the Act provides three sources of funding. Such sources;

1. authorised Federal Government Grants of not less than 2% of the total tax fund; federally guaranteed credit funds or contributions; and state or international donor grants.
2. the State Government will only gain from the Federal Government block grant planned for the execution of the UBE when it can invest at least 50 % of the total cost of the project. This is to demonstrate the dedication of the State to the initiative.
3. the local government is to dedicate its share to the implementation of the programme.

Universal Basic Education (UBE) is precisely a reformed program in the delivery of basic education in Nigeria (from primary to junior secondary school class 3). It enhances the enforcement of the National Education Policy (NPE) supply enhanced quality and access control to the Federation as free and obligatory (Adomeh, Arhedo & Omoike, 2007). UBE, as permitted at the World Conference on Education held in Jomtien in 1990, is a framework and mechanism for achieving the target of Education for All (EFA). The programme is seen as a reinforcement of the education 6-3-3-4 framework instead of a new policy itself.

The New 9-Year Basic Education Curriculum

The Nigeria Educational Research and Development Council (NERDC) recently created a new 9-year basic education curriculum from the primary and junior secondary curricula. To cater to the requirements of pupils and students, the new primary and junior secondary curriculum has been updated, rearranged, and readjusted. The National Education Council (NCE) has passed a new curriculum structure, namely:

a. lower Curriculum for Basic Education (Primary 1-3)
b. middle Curriculum for Basic Education (Primary 4-6)
c. upper Curriculum for Basic Education (JSS 1-3)

The 9-year basic education programme will facilitate the consistency and continuity from primary to junior secondary school levels of themes, topics, and experiences. The curriculum depicts the breadth, suitability, and interdependence of the content of the curriculum. The related content of the 9-year basic education curriculum also included emerging topics that addressed value orientation, peace, and dialogue, including education on human rights, family life, HIV / AIDS education, and entrepreneurial skills. The curriculum usually pays careful consideration to the attainment of the MDGs and the essential components of NEEDS (Obioma, 2007). The new curriculum for basic education was approved in December 2005 by the National Council of Education (NCE). There is no question that the curriculum is the foundation of every educational reform that is not excluded from Universal Basic Education.

The Framework of the New 9-Year Basic Education Curriculum

The curriculum is structured to meet the needs and desires of pupils and students to provide suitable main and optional subjects with accomplished education at various levels of age.

1. implementation of the 9-year Basic Education Program started in September 2008 alongside primary one and JS1 nationwide. In the

2008/2009 school year, the current primary and junior secondary curricula continued to be used in primary 2-6 and JS 2-3. The old curriculum has been phased out slowly and gradually.

2. by 2014, the lower and middle elementary education curricula (for primary 1-6) would be in wide use. By the year 2011, the upper basic education curriculum (for JSS 1-3) would be finished. Before being put in junior secondary (JSS 1), every child must complete primary six.

The New Basic Science and Technology Curriculum

The repositioning and reorganisation of the updated program for primary science and junior secondary school integrated science is a 9-year basic science and technology curriculum, Adeniyi (2007) said that three major issues were established in selecting the content that decides the growth of nations worldwide and impacts the world of information today. These are a technology for globalisation, information and communication (ICT), and education for entrepreneurship. Nigeria's ability to be known worldwide with modern growth called for the infusion of the relevant content of four developments in the non-school curriculum in the areas of:

a. Environmental Education (EE)
b. Drug Abuse Education (DAE)
c. Population and Family Life Education (POP/FLE)
d. Sexually Transmitted Infection (STI), including HIV/AIDS.

The mixture of contents occurred from basic 1-9 in each class. At the lower and middle levels, several introductory technology topics were also added, thus leaving the upper level with strictly science topics. Igbokwe (2015) stated that the country had undergone two major curriculum reform schemes at the level of basic education between 2008 and 2015, which are:

1. The 9-Year Basic Education Curriculum (BEC) 2008- 2014; and
2. The Revised 9-Year Basic Education Curriculum 2014 –Present.

The purpose, aims and composition of the Basic Science and Technology Curriculum must be analysed as a standard case in the Updated 9-Year BEC of a complex or group subject. The revised BSTC, 2012, results from the restructuring and merger of four Basic education Curriculum (Primary and Junior Secondary Schools), namely: Basic Science, Basic Technology, Physical and Health Education, and Computer Science / Information Technology (IT). For the following reasons, the integration of these science curricula has become necessary:

1. Recommendations to decrease the number of subjects presented in primary and junior secondary schools at the Presidential Summit on Education 2010;
2. Feedback from the introduction of school curricula, which established recurrence and duplication of concepts as the main cause of overloading the curriculum;
3. The need to promote creative approaches to teaching and learning and strategies that foster learner critical thinking abilities;
4. The need for a systematic understanding of science at the level of basic education to better appreciate the current and changing world; and

5. Emerging topics of national and global interest, such as gender awareness, globalisation, catastrophe risk mitigation, customer education, climate change, and entrepreneurship, need to be addressed.

The Objectives of Basic Science and Technology Curriculum

The Basic Science and Technology Curriculum, (BSTC) Revised: 2012, as outlined by Adeniyi (2007) It is expected to allow pupils to:

a. cultivate a passion for science and technology;
b. learn basic science and technology knowledge and skills;
c. apply scientific and technical knowledge and skills to the needs of contemporary societies;
d. take advantage of the many job prospects that science and technology offer;
e. be prepared for further science and technology studies; and
f. stop drug abuse and be mindful of safety and protection.

The thematic approach to the content organisation has been adopted to ensure a thorough portrayal of the content of science and technology to learners.

The General Structure of the Basic Science and Technology (BST) Curriculum

The contents of the BST curriculum have been selected and organised based on the **thematic approach** to curriculum development. The four subject areas that constitute the Basic Science and Technology (BST) curriculum are used as the major **themes,** while the **broad topics** in the subject areas make up the sub-themes. From these sub-themes, smaller topics are derived or obtained. Each topic is further broken down into specific contents.

The BST curriculum is a teaching curriculum. It explains how the curricular contents in the various themes and sub-themes are arranged in a table containing the following columns:

a. Topic
b. Performance objectives
c. Content
d. Activities (teachers' activities and learners' activities)
e. Teaching and learning resources and evaluation guide.

This tabular arrangement helps to understand the curriculum fully and implement it according to the planned objectives. For instance, the curriculum document contains broad topics and the learning objectives that students must meet after each topic. Likewise, what the teacher and the learners should be doing in each topic to achieve the performance objectives are stated, and the resources which the teacher should provide are given with hints on evaluation. It is important to implement the curriculum well by closely following the various columns of the curriculum when planning lessons.

Curricular contents are also arranged in a **'spiral form.'** This is why the BST curriculum is said to be a **spiral curriculum.** This means that the topics in the curriculum re-occur at different class levels. But each time a topic occurs, it is treated in greater depth or broader scopes based on the age and intellectual capacities of the learners to enable them to learn the contents effectively. In other words, as the age and intellectual capability of the learners increase from Primary to Junior Secondary school level, the curriculum contents increase in scope and depth.

Relevance of the Curriculum of Basic Science and Technology

Basic Science is a compulsory subject to be taken in the first three years in a junior secondary school in Nigeria, National Education Research Development Council (NERDC) (2008). Basic Science introduces young learners to science within the first nine years of formal educational settings in Nigeria. The students should build on the Junior Secondary Basic Science and Basic Technology for the enriched reality of change associated and with the world of performances. Students who do not continue to offer science at secondary schools have learned science in basic science. This increases the scientific literacy of citizens. Teaching science, through an integrated approach, allows young learners to have a general understanding of the world of science and also appreciates the different opportunities that are available to them in science. Also, secondary school drop-outs will not be entirely out of tune as science discussions take place. It should be noted that the development of a nation is measured through science and technology, and without Basic Science and Basic Technology. There are no developments; therefore, the development of a nation is measured through science and technology (Afuwape, 2012).

In the basic science curriculum, topics under theme one you and environment, teach students about family affairs and health issues in the family and their society. This knowledge helps students to understand the patterns and personalities within families and society in general, the significant occurrences that have taken place in the past, the popular trends, and the prominent personalities that have influenced people's lives both locally and internationally. It similarly allows students to appreciate how various families are organised, controlled, and ruled. Essentially, this lets students understand their environment.

Other subjects in the Basic Science curriculum have a significant influence on the current and future generations. These lessons will help students gradually gain a deeper knowledge of their habitat and the interdependence that exists between natural and human ecosystems. Information gathered from those lessons enables students to understand some of the applications of air pressure in navigation, generation of electricity, floatation, and suction. The lessons also allow them to demonstrate the relationship between the earth, sun, moon, and other planets and the stars.

The curriculum of Basic Science and Technology helps to develop critical thinking abilities. Basic Science instills both lower and higher-order thinking abilities and skills such as Comprehension, Application, Analysis, Evaluation Synthesis and Creativity in students. Topics such as energy, renewable energy, and non-renewable energy, magnetism, and skills acquisition are expected to support students' growth, imaginative, innovative, survival, and critical thinking skills. This will help students to produce and develop products that will be beneficial to society. By the end, create wealth for themselves that will help to reduce poverty.

In the course of dealing with these subjects, learners become the main players in the classroom. They touch, observe, manipulate, assess, evaluate, engage, take actions, create, and discuss the next steps and the way forward. The profile of Passive pupils changed. This shift in the profile is closely related to the change in the instructor profile. Teachers and students enjoy the process of teaching and learning. This makes learning attractive. The Learning process focuses on the problem-solving approach. It helps prepare the future nation builders responsible for finding solutions to the challenges facing society and the world in general.

Economic growth is not feasible without a curriculum for practical science education. A balanced science education promotes not just growth in the economy but also productivity and increases individual per capita income. Their influence may be seen obvious at the micro-level of the human household, the mixture of which makes up the nation (Adegoke, 2015). Learning topics in theme 3, science and development, introduce students to advances in science and technology and skills that will allow them to address problems, make informed choices, develop successful strategies and learn how to function successfully within the international society.

The Content of the Syllabus

The contents of the science curriculum are organised in a logical, developmental, and sequential order. Performance objectives for and the topic of the curriculum have been established. The teaching curriculum is also organised into six sections, namely: the topics, performance objectives, content, activities, teaching and learning resources, and the evaluation guide.

The new Basic science and Technology curriculum is the rearrangement and repositioning of the updated core curriculum for primary science and integrated junior secondary school science. In the selection of content, globalisation, information and communication technologies, and entrepreneurship, three main issues have been described as crucial to the growth of children. It has developed hereditary for Nigeria to integrate related content into the school curriculum to identify with contemporary development globally. A thematic approach to the content organisation has been adopted to create a complete overview of the content of science and technology for the learner. As a result, three themes were used to include knowledge, skills and attitudinal criteria. These are: learning about our environment, you and energy, science, and development.

The new junior secondary school science curriculum has followed a spiral or concentric approach to teaching concepts using a guided inquiry method. This was meant to ensure that learning as an activity takes place during discovery, exploration, and discussion. The structure of the topics in junior secondary basic science curriculum from JSS1-3 is showing a vertical relationship among them. This begins from simple to complex, respectively. This is to sustain and maintain the comprehension of simple topics and then complex topics to facilitate effective learning. The prescribed practices among the topics solicited the active participation of pupils during the teaching and learning period. Content links knowledge to live outside of school ensures that learning moves away from memorization methods, and inspires a curriculum beyond textbooks.

Garson (1988) concluded that if children understand science, they must be respected by observations rather than by the pronouncements of textbooks and teachers. We must ensure that children accept exploration as a way of convincing nature to answer their questions and that children realize that no one knows. If we can offer these lessons to the students, they will have mastered science, no matter what information they have studied.

Many studies have shown that science education in Nigeria is overloaded with content which some are irrelevant to the societal needs (Nwosu, 2006). For this, many students complete their secondary school without possessing the skills to enter any vocation regardless of whether they are scientifically literate enough to make sound decisions. Adeyegbe (2004) believed that some of the aspects of the science curriculum were of no relevance to the planned stage of general education and could not even be studied within the time frame. It is also resolved that, if the goals of science education are to be fulfilled for economic development, curricula creators should be removed from the curriculum. This has been considered during the two major curriculum reform schemes at the Basic Education level, which was among the reasons stated for the integration (Igbokwe, 2015). It was referring to what the curriculum reform scheme addresses the area of content relevance, which will adapt adequately and efficiently to the needs and desires of people, families and communities.

Methods of Teaching Basic Science

Science has its own set of strategies and methods for teaching and learning. In an ideal class, science should be taught and learned using the science and methods utilized by scientists. The Primary Policy on Education recognized this and stated unequivocally that gaining necessary skills, behavioural, intellectual, and interpersonal abilities and competencies that would allow individuals to survive and contribute to the progress of society is one of the national objectives of education

(Federal Government of Nigeria, 2004). Demonstrations, observations, fieldwork, laboratories exercises, manipulations, modelling, readings, and seminars are some of the instructional tactics that have been advocated for science instructors in developing science process skills in their students (Ibe & Nwosu, 2003). As a result, science should be taught in a hands-on manner, in which students are placed in a problem-solving setting and surrounded by proper equipment, allowing them to use their knowledge to solve scientific challenges.

Despite this, research demonstrates that science teachers continuously adopt the lecture mode of instruction as their primary teaching technique in the classroom (Ibe & Nwose, 2003). Instead, use creative activity-based methods like the discovery method, idea mapping methodologies, and cooperative learning to engage students in hands-on and mind-on activities. Unfortunately, scientific teacher instructors may also be guilty of employing ineffective instructional approaches. This might have far-reaching consequences for Nigeria's educational system. Teachers, for the most part, teach the way they were taught. According to Johnson (2004), most instructors were not trained using activity-based techniques since their educators had never studied science using activity-based methods or undertaken scientific investigations.

In two decades, plans have been put in place to improve the teaching and learning of science. Some of these improvements include implementing inquiry-based science curricula in the US (Cohen, 1997). Research in Nigeria has also identified that the teaching method employed by most teachers is teacher-centred (Ahmad, 2008). Students learn science without actually understanding the concepts. Science teachers rely on teaching methods or techniques that are unsuccessful in fostering the comprehension of science. The lack of understanding of science is not only a problem for students but also a problem for the country. As science has been identified as one of the key agents of development, Nigeria being a developing country must ensure understanding and application of science (Ahmad, 2013). For the implementation of the Basic Science curriculum objectives, teaching methods to be adopted as recommended are guided discovery, inquiry, demonstration, discussion, field trips/excursion, projects, lecture, process-based, concept mapping, scaffolding, team teaching, role play, and cooperative learning (National Teachers Institution, 2009). These methods of teaching foster retention of concepts and skills development.

The teacher must be informed of the latest developments in teaching to decide on the most appropriate method for a specific case. The method used in teaching encourages or hinders learning. Science teachers must use the appropriate method to stimulate the interest of students and motivate them to develop a positive attitude towards a successful learning outcome. It is also important to use effective approaches that can enhance students ' interest in studying science at all stages of our education system to understand its overarching goals in the curriculum and national policy on education. Nwachukwu (2009) observes that a teacher's way of thought and conviction directs his/her actions and decisions within and outside the classroom. He also said that the instructor should have a large range of instructional and techniques and knowledge of student learning activities. Teachers' thoughts on the conception of education and learning are the foundations on which effective teaching is based.

Miles (2015) concluded that a teacher is likely to adopt various instructional methods that can ensure academic achievement for all science students. For any approach to be able to achieve a successful outcome at present, it should be a strategy that enables the highest degree of social engagement. Social contact between students and teachers and students plays a key role in learning (Nguyen, Williams, & Nguyen, 2012). They emphasised the need for students to be provided with a positive, accessible and engaging atmosphere to help them explore information.

Science Teaching and Learning

Abdullahi (1982) clarified that the roots for science teaching in Nigeria were established around 1861 and 1897 when the fundamental principles of science were laid down in the programme for certain missionary elementary schools. The teaching of science in secondary schools in Nigeria, however, began with the establishment of secondary schools after 1931. Science teaching is a dynamic practice at the core of science education. Science teaching and learning are relevant and maybe an instrument by which technological, economic, and political transformation can be accomplished. For students to study science successfully, they would have to be correctly trained using the correct approaches, finding relevant training resources and using the correct evaluation strategies. More specifically, the need for logical thinking through testing might allow students to analyse, identify, devise, experiment and understand crucial measures or skills in scientific inquiry (Ibrahim, 2014).

The educational system must act to sustain quality teaching. For the teacher to teach qualitatively, he/she needs to concentrate on the educational advancement of learners. By integrating his / her understanding of curriculum material and practical pedagogical abilities, by studying analytical instruction, gaining management skills inside and beyond the school context, for the learner to be scientifically literate. Quality science teaching is essential for the development of scientifically literate people and the enhancement of economic growth for sustainable development (NCMST, 2000). The report of the National Commission on Mathematics and Science Teaching for the 21st century (National Commission on Mathematics and Science Teaching (NCMST), 2000) presents a view of high-quality education that is summed up as follows: teachers have sufficient knowledge of the subject matter; encourages research and practical learning methods for students; considers individual students to be learners and assures that students learn; has sufficient observation, selection of content, processing, grading, prediction and measuring skills and strong standards of student learning; Provide regular motivation and resources for advanced development, continuing education and the productive use of technology; provide appreciated, assisted and compensated teachers; and evaluate teachers based on student success and achievement.

Constructivist Learning Theory

Constructivism is a thought theory centred on the idea that, by drawing on existing experience, we are constructing our first picture of the world wherein we live. Each of us creates our own 'laws' and 'mental patterns' that we use to create meaning of our experience. Training is thus essentially a method of changing our conceptual templates to match new experiences. Tytler (2002) also sees constructivist learning as a matter of fact: student achievement reflects on the educational environment and the learning experience of a learner; learning requires creating meaning, and creating meaning is a continuous and productive process.

Constructivism is an epistemology, a philosophy of information used to explain how we interpret what we do. The concept refers to the belief that learners are generating understanding about themselves. Every learner makes sense independently (and intellectually) as they learn, building value in learning. The drastic implications of this perspective are two-fold:

a. we ought to rely on the learner to care about studying, not the subject or the lesson to be taught.

b. no knowledge is autonomous of the context assigned to the understanding (built) of the learners or the learning community.

The epistemology that is prevalent in much of today's educational settings is close to objectivism. In other words, many teachers perceive knowledge as existing external entities apart from knowing and the knower. Knowledge is "out there," in writing, independently of a being of thought. Science is, therefore, conceived as a quest for fact, a means of discovering theories, laws, and concepts applicable to reality. As a result, teachers adopt a curriculum to improve that students have access to appropriate science material and opportunities to discover the facts that are normally recorded in a textbook building (Otuka & Uzoechi, 2009).

The constructivist epistemology argues yet the only resources accessible to an informed person are the senses. It is just through seeing, listening, touching, smelling, and tasting that a child connects with the world. With these messages coming from the senses, the human generates a picture of the world. Constructivism, therefore, maintains that knowledge exists in individual people; knowledge could not be passed on unchanged from both the head of the teacher to the head of the pupils. The learner is attempting to make sense of what is learned and adapt to his / her context.

Thus, words are not vessels, the sense of which is in the word itself; they are based on the structures of individuals. We should interact with the meanings of single words that must only be consistent with the interpretations of everyone else.

Constructivism and Science Teaching

Constructivism has been recognized as an effective approach to the growth of scientific literacy in contemporary teaching and learning reforms (Tytler, 2002). Constructivism is an epistemology, a philosophy of knowledge that sees learning as an individual creation. It is beneficial to researchers as it is used to make sense of everything they see, hear, and do. Analysis suggests that teaching assumptions on how people learn (their specific epistemology), whether clearly expressed or not, makes it easier for them to make sense of and guide their experience (Otuka & Uzoechi, 2009). Using constructivism as a guide, teachers can use problem-solving as a teaching technique, where learning is described as adjusting to the world they encounter. If one's perceptions of the universe are desirable, one attempts to make sense of this condition based on what is already known (i.e., prior information is used to make sense of the data that is interpreted by the senses).

Senses are not the direction of signals to the outside universe from which realities are brought into the body. The rationality of the minds of perception is not possible. Knowledge, therefore, is a development of how the world works, one that is feasible in the sense that it enables an individual to accomplish particular objectives. From a constructivist point of view, then, science is not the quest for truth. It is, in reality, a mechanism that helps us to make logical sense of our universe. Using a constructivist viewpoint, teaching science is much like the research that scientists do – it is a participatory, social means of producing a sense of experience compared to what we would now call "school science" (Otuka & Uzoechi, 2009). Driver (1989) used the constructivist epistemology as a guide in her study into children's concepts in science. Previous child awareness of phenomenon is a crucial component of how school science is viewed. Sometimes the interpretation of events differs from a scientific perspective to the perception that children create; the child develops concepts to complement their perceptions and desires. This will cause children to construct often interpretations that are different from what the instructor wanted to do. Teachers who make sense of teaching from an empirical perspective tend to recognize that students often resolve this perceptual tension by separating school science from their personal experiences.

Using the constructivist epistemology as a teacher guide, prior information, and processes that make sense of the phenomena can become more responsive to children (Otuka & Uzoechi, 2009). Research suggests that, as teachers change from objectivist to constructivist-oriented thought and behaviour, their teaching methods are profoundly evolving. It seems as if many conventional practices are drastically shifting, teachers no longer make sense. Learners require time to experience, to focus on their experience with what they already learned, and to overcome any challenges that emerge. Learners also need time to illustrate, describe, identify, compare, discuss, and find a consensus about what individual interactions mean to them. This learning process must take place inside the bodies of people; moreover, the inner voices of people can be complemented by interactions with others.

Tytler (2002) points out that to acquire a new understanding, learners need to be motivated to expand their existing experience to the current scenario and argue. If we assume that experience is extremely qualitative and that the basic challenge of learning new understandings applies it to new circumstances, then we want to prepare students to be introduced to a variety of circumstances. This would suggest, for example, that one-off activities followed by debate would have been unsuccessful. Students have to be specifically supported to apply new concepts to different circumstances as part of the process of conceptual change.

Constructivism is fundamentally a theory that helps a teacher to know how their students think and direct their teacher training (Ogunmade, 2005). There are three leading constructivist models in the field of science education. These are the generative learning model that explains how children learn and teach children; the interactive learning approach; and the 5Es instructional model.

The generative learning models

Preliminary, focus, challenge, and application are the four phases of the model.

Phase1: The preliminary step is defined by an educator who decides the previous experience that students can take to the learning atmosphere suitable for the new topic. Goodrum, Rennie and Hackling (2001) maintain that pupils' previous knowledge and experience take a strong impact on pupils' current information and understanding.

Phase 2: The focus phase is concerned with the practice that students participate in, making clear the spectrum of current students' values relevant to the new concept.

Phase 3: The challenge phase is defined by students matching theoretical theories with their thoughts from other students by discussion, question and checking each other's ideas, among other things.

Phase 4: The application phase is when students decide whether the definition can be beneficial and appropriate to a diversity of contexts.

2. Interactive learning approach: planning, exploratory exercises, students' questions, students' investigation and reflection are the five phases.

Phase 1: The planning process is the first step in which the instructor learns the prior information and thoughts that the learners have towards the subject and after that, arranges the resources for the learners.

Phase 2: The exploratory exercises include teaching students to question and promoting dialogue between students to boost their interest in the topic to gain an understanding of what thoughts or previous experience students have around the topic.

Phase 3: The student questioning process is mainly concerned with asking and clarifying the students ' questions.

Phase 4: The student investigation phase deals with the teacher encouraging students to prepare and perform research based on questions selected through exploration, reading papers or books, writing emails, asking for information, or communicating with experts.

Phase 5: Reflection phase during which students are assisted by the educator to register, analyse, and focus on the outcomes of the examinations and the methods used. Students are also invited to start asking questions, post, debate and study their observations with other students.

The 5Es instructional model

Bybee (1997) highlighted five phases in this model: engaging, investigate, describe, elaborate, and analyse.

Phase 1: The *engage* process encourages engagement and motivation, concentrating on curiosity-raising events, challenging learners and raising concerns for more analysis.

Phase 2: As a general, the *investigate* phase presents learners with alike realistic practises wherein learners seek to ask questions, listen to other people's perspectives, and start to examine various occurrences. learners are also able to exchange opinions although suspending moral decisions on beliefs.

Phase 3: The *describe* process allows learners to describe their observations to others and to discuss their ideas more closely. The teacher provides important scientific descriptions through this process, and learners should have a better understanding of the phenomenon under study.

Phase 4: The *elaborate* phase includes pupils adapting their new understandings, which have been acquired in previous phases, to various situations.

Phase 5: The *analysis* phase includes assessing student comprehension and learners are allowed to focus on and challenge their views.

Constructivist approaches to teaching science are equivalent to those of research-based scientists and give science teachers the potential to satisfy the constructivist hope for better teaching and learning (Hausfather, 2001). Hausfather (2001) noted that the constructivist epistemology helps teachers in making sense of their experience, feel and do to make learning easier for students. In constructivist classrooms, teachers need to consider the prior information that students bring to the learning environment, and then help them connect it to the concept being studied. Therefore, constructivist teachers are to scaffold the child to construct the knowledge by himself. A main complaint of constructivism is that more time is required to explore and negotiate an understanding with students (Tytler, 2002).

Principles of Learning

What are some guiding principles of constructivist thought that we need to hold in mind as we consider our position as educators? Here are some descriptions that all are grounded on the idea that learning is made up of individual meanings and then shows how they affect science education (Otuka & Uzoechi, 2009).

1. **Learning is a quest of meaning:** Consequently, learning necessity begins with topics that students are consciously seeking to construct meaning.
2. **Learning is an active process in which the learner uses sensory feedback and builds meaning from it.** The more conventional wording of this concept includes the language of the educational approach, emphasising that the instructor wants to do more about that training is not a passive recognition of experience that occurs "out there," but rather learning entails the engagement of the learner with the environment.
3. **Individuals study as they learn:** Learning is both the creation of meaning structures and the creation of meaning systems—for example, that. When we discover the facts of evolution, we learn the meaning of evolution at the same time. Each definition we build makes us more capable of giving meaning to other stimuli that might match a consistent trend.
4. **The main action to construct meaning is mental:** It is indeed going to happen in the mind. To teach well, we need to consider the conceptual constructs that students use to interpret the environment and the conclusions they draw to help these constructs. Consequently, learning is taking place in the mind. Physical action and hands-on experiences may be important for learning, particularly for children, but it is not enough; we need to carry out activities that involve both the mind and the hands.
5. **Learning is a language:** The language we use influences learning. On the empirical level, researchers have noted that people talk to themselves as they learn. On a more general level, there is a collection of arguments

presented most forcefully by Vygotsky (1962) that language and learning are inextricably intertwined.

6. **Learning is a kind of social practice:** Students' learning is closely linked with their connection with their teachers and their peers in the classroom. We are more likely to be successful in our efforts to educate students' if we recognize this principle rather than try to avoid it. Much of traditional education and towards isolating the learner from all social interaction and towards seeing education as a one-on-one relationship between the learner and the objective material to be learned. In contrast, progressive education recognizes the social aspects of learning and uses conversation interaction with others, and the application of knowledge as an integral of learning.
7. **Learning is contextual:** We do not learn isolated facts and theories in abstract separate from the rest of our lives: we learn in relationship to what else we know, what we believe, our prejudices, and our fears. On reflection, it becomes clear that this point adds to the idea that learning is active and social.
8. **One needs the knowledge to learn:** It is not likely to assimilate new knowledge without having some structure developed from previous knowledge to build on. We cannot identify and recognise what we do not already know. The more we know the more we can lean. Therefore, any attempt to educate must be related to the condition of the learner and must provide the learner with a route to the subject dependent on the prior experience of the learner.

9. **It takes time to learn:** Learning is not immediate: we need to revisit ideas, think about them, try them out, experiment with them, and use them for significant learning. This cannot happen in the 40 minutes normally spent in a lecture. The learner should have the opportunity to revisit the materials presented during the lesson in tutorials, class assignments and revision exercises.
10. **Motivation is a central component of learning**: It is not only that encouragement helps to learn; it is necessary to learn. This concept of motivation, as defined here, is widely conceived to include understanding of how information can be used. If the learners know "the reasons why," they will not be very interested in using information that may be instilled in them.
11. **The purpose of learning is to construct his or her meaning, not just memorise the 'right' answers and regurgitate someone else's meaning.** Because education is interdisciplinary in nature, making assessment a part of the performance process and to guarantee that students have an understanding of the outcomes of their learning.

Most teachers have adopted the notion that pupils have to be engaged, that to engage in learning, learners have to be involved in doing things, engaging in hands-on interaction, conducting exhibitions and programs. Physical participation is a required condition for children to learn, however it is not adequate. All hands-on tasks also must pass the mind-on test. The hands-on activities as well as minds-on activities are vital for learning.

Indeed, no other problem in constructivism poses additional concerns than the desire to find the precise level to involve the student. Vygotsky spoke of the "zone of proximal development" which corresponds to a level of comprehension that is achievable whenever a learner undertakes a role with the aid of a more skilled peer (i.e., a teacher). Learners understand as they are extended outside their own experience, just within a context inside their reach, provided what knowledge and skills they bring to the challenge (Otuka & Uzoechi, 2009).

Approaches for Effective Teaching of Science

It is a collection of values, beliefs, or ideas about the nature of learning brought into the classroom. Educators should emphasise how to enhance the learning environment of students. Enriching this experience has driven them to pursue more successful curriculum techniques that might be characterised as student-centered, and that learners are the key emphasis of the learning experience. In specific, mechanisms that allow students to use and exercise higher-level thought skills and train them to gain knowledge, to use analytical thinking skills to test this knowledge, and to apply acquired knowledge in various life circumstances.

Teaching approach

1. Direct/expository e.g., directive, deductive, demonstration
2. Indirect/guided/exploratory e.g., inductive, reflective, constructivism, problem-solving, inquiry, laboratory, metacognition, etc.

Indirect/Exploratory

As the idea of discovery learning begins, many academics today typically follow a student-centered approach to promote successful learning (Greitzer, 2002).

The majority of teachers today apply a student-centered approach to fostering student engagement, objective analysis, critical thinking, and enjoyment (Hesson & Shad, 2007). As the centre of both studying and instruction rotates across the pupil, it would be ridiculous if the teaching approach did not consider the essential position of the pupil and instead paid due attention to the student. In this phase, the student is deemed to be the first to fulfill all their needs. The teacher, then, guides instruction to serve the student best, so that he/she emerges to be a good and productive person with a broad range of schooling. This style of teaching finds the values, views, and importance of the student to be the subject of all instruction. The teaching method based on the student methodology encourages the student to participate in an open-ended laboratory experiment (Avwiri, 2011).

Indirect/Exploratory

Knowledge of the past will always be used to construct an understanding of the future. According to Okpala (2006), the inductive method starts from general to general, known to unknown, and from concrete to abstract. To study every simple word, it is advisable first to examine the definition and all the problems that contribute to it. Okpala (2006) states that the inductive method is a discovery method. The inductive method allows students to test different theories, rules, realities, and innovative ways of addressing a given problem or seeking solutions to science challenges.

Process Approach

In science, the term process refers to a set of activities that interact with one another. The interaction between input and output ties this process together. The process approach is a method of thought used to consider and organise the series and exchanges of operations within the system. When teachers use a process approach, they manage and control their teaching, the interactions between teachers, students' contents, instructional strategies, e.t.c., tie these processes together. Managing and maintaining these process interactions in a system lead to effective teaching. Teacher training programs have been promoted to improve the skills of the scientific method to cultivate teachers who are competent in teaching science through research (National Science Teachers Association (NSTA), 2002). Different science skills have been identified, classified, or categorized by other scholars and programmes: Science process skills which are categorised into two (Basic and Integrated) by the Elementary Science programme of the American Association for the Advancement of Science (1967), process skills, Reasoning skills, and critical thinking skills by Valentino (2000), acquisitive, organizational, creative, manipulative and communicative skills by Bybee, Powell, and Trowbridge (2014). All these skills, if acquired adequately at various levels of learning, can lead to meaningful, sustainable development.

Pupils' learning of scientific procedures is a top goal in science education since being thoroughly schooled on how to apply them allows students to think more practically. As a result, science teachers must provide students with scientific possibilities and practical learning settings, as well as activities that lead to the development of higher-order thinking abilities such as problem-solving skills and the application of scientific methods (Insaf, Heyam & Khetam, 2013). Scientific techniques help learners to expand existing learning opportunities through experiment and judgement, and to become more self-sufficient in their learning and problem-solving abilities.

The process approach helps in equipping the individual learner with the required abilities to solve problems and make appropriate decisions for the problems he or she is confronted with now and in the future. It also equips the student with suitable science procedures and scientific abilities, allowing them to mimic the researcher's approach to deciphering various elements of scientific information. This method allows the student to build a desire to acquire a variety of scientific facts, concepts, and generalizations that are relevant to his everyday life, resulting in a good attitude toward science learning (Khataibeh, 2005).

Students engage a variety of skills when learning science using the process approach, including motor skills like acquiring equipment, installing them, making observations, taking measurements, recording data, and drawing figures. Other talents include data analysis, creating similarities and contrasts between outcomes, as well as intellectual and academic skills. Students are also involved in a variety of techniques in order to solve an issue in a holistic approach. It is an event that prepares kids to address difficulties as they arise in the future. Students are not only reliant on memorization and recall, as is the case with traditional teaching approaches. They continue to focus on acquiring abilities that will help them solve challenges in a variety of circumstances (Abdel Hamid & Al Sanhouri, 2004).

Indirect/Exploratory: This strategy requires the use of questions to evoke the students' secret ideas. Students are required to see how well they have mastered the expertise and skills that they need. This interrogation approach or Socratic approach is an excellent way to determine students ' knowledge. Also, it provides the pupil with the opportunity to show what they have studied before or how well they have absorbed the new skills they have taught. According to Okpala (2006), this approach lets students build a feeling of self-expression and also acts as a way of delivering practical experience and information.

Indirect/Exploratory

Students are supposed to develop knowledge and meaning out of what they are taught by relating them to previous experiences. It has been proved by the three cognitive theorists, Jean Piaget, David Ausubel and Lev Vygotsky who have been highly influential in understanding the process of human learning. They have been very influential in understanding the mechanism of human learning. The constructivist approach to teaching science and technology emphasises the method by a study rather than "teaching science." The constructivist approach is not focused on the teacher but instead encourages empirical inquiry through the flow chart process. Children are naturally interested to systematically find out about their physical environment by noticing something interesting and asking questions about it. Teaching using a constructivist approach underlines the importance of pedagogical content knowledge and the ability of teachers to engage their learners in knowledge creation (Garbett, 2011).

Collaborative Approach: Indirect/ Exploratory

If not well planned, collaborative teaching can be frustrating. The teacher may take the following steps for effective planning and effective implementation: identification of goal/objectives; develop focus questions for activity; provide directions for activity; develop rubrics; develop specific group/individual assessment task and regularly reflect on group progress, and adjust (Nnene, Ene & Chime, 2014).

A collaborative approach helps the learner to know and learn more. It enhances the learner's understanding of science and learning itself. As a result, scientific knowledge and cooperative competencies are developed. Collaborative learning is a teaching approach that promotes competence, knowledge and social engagement within an academic setting while at the same time avoiding repetition, passivity, and individualism. Laal and Ghodsi (2012) define collaborative learning as a method of teaching and learning that includes groups of learners collaborating to solve a problem, accomplish a task, or make a product.

Carrió Pastor and Perry (2010) observed that to achieve a coherent proposal, interconnectedness and mutual understanding between the components of collective learning activities as necessary. Students and teachers should become a cohesive group that participates in dynamic class discussion and negotiation. Collaboration is the joint participation of the participants in a coordinated attempt to address the problem together. The main goal of Collaboration is to solve the problem, which is the very essence of science education.

Science Laboratory Facilities

Science teaching demands special skills due to their exceptional characteristics and peculiar features. The science laboratory is among its strange features. A laboratory is a place of work for a science teacher. It is a place where practical events are designed and executed. It includes resources, equipment and equipment for science teaching, ranging from easy-to-use supplies to a wide range of facilities needed for effective science teaching and learning. According to Dahar and Faize (2011), science laboratories play a crucial role in science teaching and learning process. Muhammad (2017) stated that science curricula should give students a chance to carry out research in real environments and that this should include working in well-equipped and funded laboratory environments in secondary schools. Science subjects require the obtainability of laboratories with facilities to improve manipulative skills and the development of information. Successful science teaching requires well-equipped laboratories.

Laboratory facilities play an essential part in teaching and studying science; hence they are the backbone of experimental work. There are no practical activities that will take place without the laboratory facilities and the use of appropriate laboratory facilities enable students to improve their domains (cognitive, psychomotor and affective). Practical practices are essential at all levels of science education and, in particular, are of great significance in secondary schools to help students internalize and understand theoretical knowledge in science fields such as chemistry, biology, and physics. To achieve the objective of realistic activities in science, equipment and tests must be carefully chosen to provide students with appropriate experience, and comprehension must also be improved if the activities originate from the everyday lives of students. The availability of suitable equipment and reagents is a critical but not sufficient condition for good science teaching (Ashebir & Bereket, 2016).

Olajide, Adebisi and Tewogbade (2017) said teaching basic science without laboratory facilities decreases the importance of science and makes the topic unfamiliar to students and prevents them from pursuing physics, chemistry, and biology in secondary schools and related courses in higher institutions. It would also be beneficial for Basic Science to be taught practically to encourage critical thought, objectivity, and rationality that science implies. It means that teaching and learning of sciences with adequate laboratory facilities afford the students the opportunity to discover facts themselves. According to Bajah (1983), many schools do not have basic science laboratories, and are available; their designs are inconsistent with their functions. The laboratory and its facilities help science teachers to teach and engage students to acquire scientific skills to do science as a scientist do science. But now a day our schools are facing some challenges. Gadzama (2012) viewed the lack of adequate facilities for basic science teachers and students to work within our science schools in Nigeria as the major challenge. Many schools have little or none or some basic science laboratories, necessary materials/ apparatus such as test tubes, beakers, Bunsen burners, and watch glass. These materials are vital for the practical teaching of basic science in our schools. Muhammad (2017) reported that laboratories had poor equipment and facilities and that stocks of chemicals and reagents for experiments were low. Schools often lack laboratory assistants, which results in inadequate maintenance and outdated design of laboratory facilities.

Ado (2009) further argued that it is beneficial for learners to exploit science learning materials and apparatus. It would encourage them to learn not only the skills of science processes and new ideas, but also scientific attitudes such as integrity, openness, and collaboration as a science morality, and to improve knowledge and retention of complex concepts and processes. A laboratory provides students with some insight into scientific concepts and leaves them with a sense of the reality of science that increases their academic success in their analysis (Habu, 2005). In achieving the objective of practical activities in science, equipment and experiments must be carefully chosen to provide students with appropriate experience, and comprehension must also be improved if the activities originate from the everyday lives of students. The absence of resources such as research equipment, research space, and a shortage of chemicals and safety equipment, are among the difficulties of teaching science. The provision of suitable equipment and reagents is necessary but not a sufficient requirement for good science teaching. But also, the commitments of teachers influence the quality of practical activities.

Availability of Laboratory Facilities

The purpose of the science laboratory and the adequacy of laboratory facilities in secondary schools is to ensure successful teaching and learning. The adequacy of laboratory equipment used during science instruction helps to establish principles that enable learners to make decisions. It is important to provide students with a broad background in science and mathematics education where laboratory facilities are sufficient in schools. The adequacy of laboratory equipment in secondary schools and the efficacy of teachers in the use of laboratory equipment, to promote and provide a successful learning experience for learners, make science teaching more concrete, motivating, and, as a result, improving student comprehension.

Studies have shown that there is a scarcity of science facilities in laboratories, and this leads to the low academic performance of students in science (chemistry) at the secondary school level (Ihuarulam, 2008; Ifeakor, 2006; Udo, 2006; Okafor, 2000). Laboratory facilities are also required to be adequately offered to secondary schools for successful teaching and learning.

Dahar and Faize (2011) stated that the worst of all is that science teachers do not use science laboratories with available equipment, apparatus, and materials. Thus, the availability of resource inputs does not have any significance for academic goals as long as they are not used. They further stated that if science laboratories are available to schools, then, are three ways in which they remain unused, used inefficiently, and used effectively. In most situations, because of insufficient funds, science laboratories are delivered to schools with low quality and less quality of supplies, equipment, materials, and chemicals. Dahar Faize concluded that students appear to understand and remember what they see more than they do because of laboratories in teaching and learning.

Utilisation of Laboratory Facilities

The method of planning and organising teaching and learning services is related to the usage of resources. According to Lewin (2000), the use of facilities is related to the degree to which services are offered to students. There are three options; perhaps they are used effectively or ineffectively, or they remain unused.

If the apparatus item is used in its entirety, that apparatus is well used. If the apparatus is not used as much as possible, it may be concluded that it is under-used. If there is much pressure on the use of equipment, it can result in overuse and can lead to loss of such equipment.

Teaching facilities ensure the efficiency of teaching and enable learning material meaningful. According to Ihiegbulem (2006), the use of educational materials during practical lessons instils in learners the ethic of close study, problem - solving skills, thinking, and creativity of the learners. However, Lewin (2000) concluded that science facilities are only necessary if they are used. One of the main problems facing science teaching and learning is the utilisation of the available tools. Ogunleye, (2000) noted that the transfer of resources needs the science teacher himself to be inventive and imaginative, and to be careful in the handling and use of available facilities, particularly fragile ones. It is important because, if the services are misused, they could not provide the best service they need.

Maintenance of Laboratory Facilities

Momoh and Onjewu (2006) described management as any actions or group of activities taken to ensure that the facility remains in good working condition for as long as humanly possible. When operations such as maintenance, greasing, etc. are put in place to maintain or rebuild the part of the item, the item shall be maintained. Teachers must properly take care of laboratory equipment and services to maintain their usual working conditions. Maintenance avoids degradation and also eliminates redundant objects that no longer serve the necessary purpose. Momoh and Onjewu (2006) defined the following as priorities for the maintenance of facilities: -

1. To ensure that facilities are still available to offer full value to staff and students;
2. Ensure the operational readiness of continuous service facilities to minimize losses;
3. Protecting operating staff and preserving services; and
4. Extend the use of the facility to the full gain.

Maintenance may be regular ongoing tasks, such as daily or weekly inspections of laboratory equipment and facilities periodically. Operations such as monitoring and lube of sections of the device to maintain a consistent operating condition or repair work, may include operations to correct the failure of the equipment. Maintenance of the plant also includes the protection of the equipment and services. It includes protection against severe damage to rats, burning, storm, etc. It also refers to safety against stealing or illegal use. Teachers do not delay until the device is fully broken down until it is repaired or replaced. Reporting on the need for improvement or renovation of equipment must be forwarded to the school authorities with a commitment to rendering timely repair and improvement proposals to avoid duplication and deterioration. However, it has been stated by Ogunleye (2000) that the management of available capital is one of the major challenges facing the teaching and learning of science. The inability to handle resources correctly in the laboratory is an indication of poor management. Moses (2006) said that the culture of maintenance in Nigerian schools, households, offices, and industries is fragile. These equipment and facilities are waste disposal due to breakdown; others are forced to break down by dust and cobwebs due to neglect and lack of care.

Instructional Materials

Successful instruction of any subject will not only raise the interest of students in the subject but will also improve their academic achievement. There is the need for the use of teaching materials to create an efficient teaching and learning process. The instructional materials are seen as an important tool to be involved in teaching and learning. Throughout classroom teaching, the value of consistency and good training materials in teaching and learning will emerge from their successful use. Here, educational resources contain all tools that teachers can use to make learning more enjoyable and interesting. Instructional materials are those materials with intellectual content that, in teaching a subject or course, serve as the main tool to help. The instructional materials used must comply with the objectives and course descriptions.

Ibeneme (2000) described teaching aids as tools used by students and teachers for practice and presentation in the classroom situation. Ikerionwu (2000) saw instructional materials as objects or tools that allow the teacher to address the lessons in a clear and meaningful way to the learners. Fadeiye (2005) said these instructional materials are concrete or non-concrete visual and audio-visual aids used by teachers to enhance the efficiency of social studies teaching and learning activities. Isola (2010) also defined instructional resources such as objects or tools that help teachers to present their lessons to learners logically and sequentially.

Oluwagbohunmi and Abdu-Raheem (2014) clarified that teachers use instructional materials to clarify and make learning topics accessible to students during the teaching process.

Note that educational materials are significant catalysts for social re-engineering and the transformation of learners. Successful instructions are not possible without the use of instructional materials. Advances in technology have taken educational materials, particularly, foresight and electronic resources, to the forefront as the most revolutionary instruments of globalisation and social change that have greatly influenced the learning situation in the classroom. Such technological breakthroughs as networked and unplanned, visual, audio-visual, electronic media are significant landmarks in the transfer of information. With instructional materials, both teaching and learning have been an enjoyable experience (Wambui, 2013). Such instructional materials give meaning to learning by encouraging learners to learn. The use of instructional materials in the classroom will help the teacher better explain new concepts and contribute to a deeper comprehension of the concepts the students are taught. They are not an end in itself, however, but are a means to an end (Kadzera, 2006). Good teaching tools can never replace the teacher, but they are used by the teacher to achieve their teaching and learning goals.

Education in science and technology is among the subjects that require adequate instructional materials to be imparted and enable a student to be self-reliant, self-employed and join a vocational centre. Individuals and society viewed education as the path to life's success. Training has affected all human societies, past and present, in profoundly affecting individuals and community survival.

Teaching and learning materials at all levels of education are essential, as textbooks and other resources are basic tools. Absence or shortage of teaching and learning materials allows teachers to deal with subjects abstractly, defining them as tedious and non-exciting. Examples of instructional materials are textbooks, charts, maps, audio-visual, and electronic instructional materials such as radio, tape recorder, TV, and videotape recorder contribute a great deal to make learning more enjoyable (Atkinson, Derry, Renkl & Wortham, 2000). The value of instructional materials is also apparent in the success of student’s (Adeogum, 2001). Adeogum (2001) also states that schools whose teachers make good use of more educational resources performed better than schools whose teachers do not use of instructional materials. Accordingly, schools at all educational levels were directed to provide appropriate and adequate instructional facilities to boost the academic performance of their students.

Eniayewu (2005) observed that the use of instructional aids for teaching delivery is crucial to allow students to acquire more knowledge and encourage academic performance. They provide effective knowledge transmission platforms for teachers and encourage the learners to learn effectively. They usually make it easier to teach and learn and less stressful in teaching and learning process. They are equally essential catalysts to the learners 'social and intellectual growth.

According to Olumorin, Yusuf, Ajidagba and Jekayinfa (2010), instructional materials help teachers to teach easily and learners to learn without difficulty. They claimed that all sense organs have direct interaction with instructional materials. Kochhar (2012) maintained that instructional materials are important resources for learning and teaching. He recommended the need for teachers to find the required teaching materials to enhance what the textbooks deliver to expand concepts and stimulate the interest of students in the subject.

The advantages of teaching materials are that they are cheaper to make, useful for educating many students at a time, inspire learners to pay due diligence and increase their curiosity (Abolade, 2009). However, Akinleye (2010) claimed that successful teaching and learning involves teachers provide instructional resources to students and use practical exercises to make learning more vivid, rational, logical, and realistic. Esu, Enukoha, and Umoren (2004) stated that successful teaching and learning practices require instructional materials. Ekpo (2004) also maintained the use of teaching aids in assisting the sense organs at all times.

Ogaga, Igori and Egbodo (2016) stated that instructional materials promote teaching and learning activities and thus enhance the achievement of the aims of the lesson. However, it depends on the suitability and acceptability of the materials chosen. Also, this ensures that learning resources are not randomly chosen (Jiya, 1993). Instructional materials are important because they benefit teachers and students from overemphasising recitation and rote learning that can easily overpower a lesson. Resource materials enable learners to have real experiences that help them improve their skills and ideas and function in different ways (Tuimur & Chemwei, 2015).

Teachers use instructional materials to teach their students. A good instructional material has a major influence on students learning capability. The participation of learners in hands-on activities gives them an idea of how to incorporate the acquired knowledge into a real-life situation. Albarico et al. (2014) said that the educational system also has its demand for the suitability of instructional materials to help effective learning for the student.

Selection of Instructional Materials

The following guide listed by Corpuz, Brenda and Lucido (2008) expresses the standards to be taken into account when selecting instructional materials:

1. instructional materials provide a true picture of the given concept/topic.
2. instructional materials add important content to the subject matter.
3. the instructional materials will support the teacher to meet the educational goals.
4. the instructional materials are suitable for the learners 'age, intelligence, and experience.
5. the physical condition is appropriate for the instructional material.
6. instructional materials allow students to think differently and improve their analytical skills.

The materials must be chosen because of their suitability to achieve the desired educational objectives, and not just because they 'appeared to be usable' or because the instructor or trainer wanted to 'fill in time (Albarico et al., 2014).

Instructional Materials Management

Instructional materials are costly to acquire. Therefore, it is crucial to ensure that this valuable educational resource is well handled by properly accounting for and making full use of the materials currently in your school. The management of instructional materials for schools is given as a reference for the principals, directors and teachers in managing their schools' instructional materials. Office (2006) opined that each school should have instructional materials inventory and locked storage area. This area should be secure, safe, dry, and insect-free. Materials are not to be placed on the floor. Any damage caused by insufficient storage or lack of storage area maintenance is not protected by insurance and is the responsibility of the school.

All materials should be kept correctly according to their categories and labelled; all new materials must be labelled, marked, or stamped before storage. Schools are expected to maintain separate documents, correspondence, and form files for instructional materials. Such files should contain reports of materials from students/teachers received and returned, lost/damaged items (Office, 2006).

Availability of Instructional Materials

The success of any program depends on the available resources to run the program. However, educational tools have been described as an essential factor for qualitative and quantitative education. The relevance of the teaching and learning materials available cannot be overemphasised. Services and equipment are a tactical element in the functioning of the institution and, to a considerable degree, decide the smooth operation of any social agency or structure, including education (Owoeye & Yara, 2011).

The science education programme as a scheme can only be successfully applied with sufficient educational resources. Teaching services and equipment help to increase the interest of students. When optimally used, these facilities and equipment create greater student interest in the learning environment and thus improve the retaining of thoughts. Achievement of goals of any educational program depends on various factors, such as the accessibility and appropriateness of educational resources. The accessibility and adequacy of appropriate teaching facilities, materials and resources promote learning, inspire both teachers and students, and increases the attainment of the students.

Parental Socio-Economic Status

Science education is imperative in every culture to make a successful living. At the heart of producing the resources required for the socio-economic, science and technological growth needed to advance any country (Osuafor & Okonkwo, 2013). Most researchers agree that family history affects the success of children at school, given that education begins at home. The family context is a composite term consisting of social class/sexuality, economic status, family size, family composition, parents' level of education, occupation, and other factors relevant to family life.

Socio-economic status is a collective economic and sociological indicator of an individual's job experience and the economic and social role of a person or a family relative to others based on earnings, education and occupation. It is the indicator of how the social environment impacts people, families, neighborhoods, and schools. The socio-economic status is linked to the social class concept.

Woolfolk (2007) described socio-economic status as an individual member's position within a society based on wealth, power, history, and prestige. Fundamentally, educators have categorised socio-economic status as high socio-economic status, medium socio-economic status and low socio-economic status. An increase in income and social status is generally associated with an increase in levels of education. A person's knowledge is closely related to their life chances, wealth and well-being (Battle & Lewis, 2002).

Leung, Chung and Kim (2016) declare that parental occupational class, parental income, and participation of parents determine children's goals. They serve as an indirect indicator for the material resources that can be found in the family during a student's childhood stage. The different domains of parental background may also signify the social status or prestige that good for the children's education.

Emeka, Ushie, Ononga and Owolabi (2012) point out that parental socio-economic background is one of the tools used to measure students' academic attainment. Additionally, it is described that students whose parents engaged in the right academic professions and earned high income tend to perform the highest in any subjects. Thus, parental socio-economic status is capable of influencing children's behaviour, and that determines their aspirations. Families with a high socio-economic status tend to be more successful in planning their children for school. They usually have access to a wide range of resources-quality childcare, books and different learning at home.

Several studies were conducted about students' academic success examples (Ajila & Olutola, 2000; Ojimba, 2013; Ayanleye, 2015; Bolu-Steve & Sanni, 2013). Such studies show the connection between parental background and student academic achievement in several disciplines like Mathematics, Science and English. For example, an empirical survey of Ahmar and Anwar (2013) show that the provision of extra-learning services and the quality of the support children from high and middle socio-economic status to perform well in the learning environment. It is further emphasised that one of the factors affecting students' academic attainment is the parental background. Yunus and Hamzah (2016) explained that parents are expected to encourage and guide their children to become well-accomplished persons in society.

Most students in Nigerian secondary schools cannot pursue their education because of the socio-economic imbalances they face. Students with a low socio-economic background compete unfavourably with their high socio-economic background peers. Children from successful homes have exposure to television, radio, libraries and toys, and thus experience 'ethnic consistency between home and school' (Antwi, 1992).

Low-income students have scarcely enough money to pay for their parent-teachers association (PTA) levy and buy all necessary learning materials and therefore become emotionally disturbed. This influences the concentration of students in the class and then influences their academic achievement rates. Those conditions cause some students to drop out either from school or be absent from periodically, which will affect their academic achievement. Forsyth and Furlong

(2003) clarified that financial problems that force students from less privileged families to part-time or full-time jobs to fund their education would have detrimental effects on their coursework. The explanation is that some of these students have to look after themselves and that they could be away from school from time to time to work to get enough money to pay their PTA levy to buy their educational needs. Such disparities in students 'parental socioeconomic backgrounds, directly and indirectly, impact them in their academic pursuits, and children from low socio-economic homes won't find it simple.

Parental Social Class

Socio-economic status is the social status of a person in society concerning their level of education, income, occupation form, and overall value of life. It also protects his or her marketplace access to products and services. The social class is put into three categories, the upper level is the highest, the middle class is middle, and the lower class on the class hierarchy is the lowest. The upper class, 'persons in their communities, are dominant and strong' (Ornstein & Levine, 2006). Thompson and Hickey (2005) think of the upper class as a category of people who dominate the economic power and political affairs of the country. This class consists of emirs, obas', egwues', productive elites, top professionals, senior managers, businessmen, among others. The middle socio-economic class is seen as a moderate societal class that is made up of individuals who are professionals, managers and small business owners, skilled employees, technicians, sales and clerical employees. Those who have differentiated themselves through their high level of education and are economically stable (Ornstein & Levine, 2006). Low socio-economic status is considered to be "weak in prestige and strength." This class consists of people with ranks in professional and lower-level management, such as art people working for the middle class (Williams, Swayer & Wahlstrom 2005). Indeed, the factors that decide one's class may differ from person to person, even within the same society.

Parental Level of Education

Parents, as the children's first educators, play important roles in their education. Parents influence their children's education in several respects, such as encouraging them and meeting their educational needs. The education level of parents is vital for education because parents want their children to uphold the established order (Mallam, 2009). It is often understood that higher education guardians have greater faith in their children's academic abilities and higher ambitions. They want their kid to do perfect results so they can do better in school and go to college. These hopes and trust towards their children inspire them to do better in school. Trust guardians also encourage their children to construct up their self-esteem and self-conception that are vital to their education (Malam, 2009). Muruwei, (2011) points out that the 'quality of parent education influences children's academic performance in school.' Parents who are well-educated and have a decent income can have a good learning atmosphere for their children to succeed in their education (Muruwei, 2011; Michieka, 2011; Nguyen, 2006).

Eccles (2005), in his view, held that children also learn by example through homemade observations. When children's parents read books, take part in continuing education lessons, and take them to museums and libraries. All these things informed parents are more appropriate to do-engage the child in various meaningful learning opportunities that can support him or her obtain the best in education. Often educated parents are showing interest and provide support for their children's education. However, the education level of parents plays a substantial part in the academic success of children. Parents who have reached a high standard of Western education are likely to promote a positive attitude towards the school. Better-educated families may relate to the development of the children via their day-to-day experiences with their children and involve themselves in the school work of their children (Ajila & Olutola, 2000). To Karshen (2003), students with well-trained parents have higher roles than those whose parents are not qualified. Successful individuals support their school children's job programs and provide them with academic opportunities. Muruwei (2011) stated that parents that have attained tertiary education are likely to transfer more academic culture to their children over the years than parents who are uneducated or semi-literate. It means that trained parents have encouragement, great speech models, and an improved school environment, including the availability of textbooks, magazines, dictionaries, learning scientific manuals, television, and other services that facilitate their learning of science and English at home. If students have access to appropriate textbooks, facilities, and a comfortable environment to facilitate learning, this will increase the success level of students at school. It is highlighted by the World Bank report, which says 'the provision of textbooks is a very cost-effective way to enhance learning outcomes' (World Bank, 2004).

When choosing the locality for well-educated parents, they are more likely to consider the standard of schools in their locality, trained teachers, and the accessibility of teaching and learning resources to ensure that their children receive quality education. Educated parents improve the growth of their children and their human resources by building on their specialised language abilities to communicate with their children (Egalite, 2016). Parental education has been essential to this end in deciding whether children can obtain their education.

Parental Occupation

Occupation is a profession that helps the main source of livelihood for one. Children are very much affected by the people around them. Members of the society have a status-varying profession. Some individuals have more access to higher-status-occupation than others, and various levels of power to control institutions of a society. A parent is among the agent of socialisation which children associate with, and they put more effort into socialising children within their environment. Adekeye (2002) observed that by the occupation of parents, and by efforts to socialise children to become active people in education and public life. Ajila and Olutola (2000) found that the home affects the students 'psychological, mental, social, and economic status significantly. Hence, the state of the residence affects the child because the parents are the first socialising agent of a person's life.

Parental occupation represents children's educational attainment at school. If parents have a better career, they can provide their children with sufficient education. They provide children with economic, educational, psychological, and emotional support, enabling them to do well in their educational achievement. In support of this, Okioga (2013) observed that occupation status tests social role by defining job requirements, decision-making, skill and control, and workplace psychological demand.

Teacher Training

Teacher preparation is a worldwide, ongoing process. It aims to provide the teachers with the information and expertise required to offer education to students. As described earlier, Nigeria aims to provide better results to competent teachers and to generate extremely motivated, diligent, and effective classroom teachers at all grades of our educational system (Federal Government of Nigeria, 2004). Teacher education is for teachers organised around the world. Several studies have shown that teacher preparation has an impact on the teacher's content delivery in the classroom. Research at the University of Wisconsin by Gamoran (2006) suggested that teacher preparation improves student success through its effect on instructional practices, such as content distribution. Also, it is known that normal high-quality teacher training is a great way to boost teacher performance in the classroom. Teachers also claim that the more time they spent in school, the more often they believed how their teaching skills had increased (Choy, Chen & Bugari, 2006).

The teaching career is a professional vocation under the 1993 Teachers Registration Council of Nigeria [TRCN] Act No. 31. It is a law passed by the Federal Republic of Nigeria National Assembly for the protection and controlling of the teaching profession **"**in all aspects and ramifications**."** TRCN shall have the powers and obligations to recognise professional competence and experience, including practical skills in the discipline. Section 2-5 as provided for in the Act. Teaching as a discipline has all the qualities of expertise that are similar to most noble occupations. Many of these features are standardised and organised manuals named ‘Professional Guidelines’, which reliably describe whatever the practitioner needs to learn and behave, and the basic principles, beliefs, and behaviour that the practitioner wants to embody. Therefore, professional standards apply to a minimum collection of expected knowledge, skills, principles, attitude, behaviour, rights, privileges, and obligations of a professional (Teachers Registration Council of Nigeria, 2010). Teacher quality is an essential component of academic performance for students, but few transparent qualities of teachers affect classroom results (Buddin & Zamarro,2009).

Teacher Quality

Teacher quality is a dynamic phenomenon but with a little agreement to calculate it. For example, meanings vary from those that concentrate on what to teach and how to impart knowledge. However, two specific elements characterise the quality of the teachers:

a. Preparation and qualifications for the teachers, and
b. Teaching practices.

The first applies to pre-service learning (e.g., post-secondary education, certification) and continuing learning (e.g., professional growth, training with other teachers and teaching experience). The second relates to the real attitudes and activities demonstrated by the teacher in the classrooms (Richard, 1996). Such components are not independent of teacher quality; outstanding teacher preparation and qualifications are required to contribute to exceptional teaching (Lewis et al., 1999). Teacher qualities are standards-based, and specify the knowledge, skills, and arrangements that teachers will display. Perhaps the most significant factor influencing achievement at school is teacher quality. Teacher efficiency is considered to be the most significant factor influencing learner outcomes. Every student deserves a high-quality teacher. When students want to learn, they must feel confident in their environment of instruction. In that regard, the personal connection that an educator creates with the students helps to build a relationship of confidence and appreciation (McBer, 2000). The effect of teachers on children's learning is strengthened when children are taught with well-prepared educators who incorporate their teaching skills with a deep sense of caring for the individual child they teach.

Qualification of Teachers

Teacher qualifications are the specific expertise or form of training or information that someone needs to make them eligible for teaching. Accordingly, the qualifications of teachers will also mean all the qualities that the teacher wants to teach successfully. These capabilities include structured preparation, practice, subject matter experience, pedagogy study, training time, certification / licensing, and career growth (Zuzovsky, 2009). Some may get a teaching certificate at hand, but without proper knowledge of the subject matter, they do not have any teaching qualifications. Similarly, anyone who does not have sufficient pedagogical knowledge or who has spent a few years in training before completing the requisite years has no teaching qualifications. (Darling-Hammond et al., 2001). Strauss and

Vogt (2001) believed that teachers' teaching qualifications, skills, and knowledge are good determinants of student academic achievements.

Kola and Sunday (2015) reported that the qualifications of teachers have a significant impact on the academic performance of the students. Eryilmaz and Laslan (1999) found that teacher qualification is one of the many significant variables in the teaching cycle. A teacher teaching qualification is another quality of the teacher. It means that the qualification of a teacher is important when it comes to successful teaching. Darling-Hammond (2000) claimed that certificate or license rank is a standard of teacher competence that blends facets of subject matter expertise with teaching and learning. The Nigeria Certificate in Education (N.C.E.) is the minimum educational qualification in Nigeria as specified by the Nigerian Federal Government (Federal Republic of Nigeria, 2004). Abe and Adu (2013) and Wiki (2013) stated that a teaching certificate or teacher certification is among several academic and technical degrees that require an individual to become an enrolled primary or secondary school teacher. These qualifications include a Postgraduate Certificate in Education (PGDE) but are not limited. The Diploma of Professional Education (PDE), Bachelor of Education (B.Ed), and Nigeria Certificate of Education (NCE). In Nigeria, teacher qualifications are graded under four categories, as follows:

1. Group A (Doctoral Teachers): Ph.D. holders in education or Ph.D. in other fields plus teaching qualifications, e.g., Postgraduate Diploma in Education (PGDE); Professional Diploma in Education (PDE); Nigeria Education Certificate (NCE).

2. Group B (Master Teachers): holders of a Master's Degree in Education or a Master's Degree in other fields plus teaching qualification example, PGDE, PDE, NCE, etc.
3. Group C (Diploma Teachers): holders of a Bachelor's degree in Education or a Bachelor's degree in another field plus a teaching credential, such as PGDE, PDE, NCE, etc.
4. Group D (NCE Teachers): holders of the Nigeria Education Certificate, the minimum national teaching qualification.

The above categories are based on the provisions of Section 2(e) of the Registration Council of Teachers of Nigeria [TRCN] Act 31 of 1993 that gives TRCN the duty of "classifying from time-to-time members of the teaching profession according to their level of training and qualification (p. 3.)." Consequently, classification is a legislative requirement that should be focused on training in which the level of qualification of teachers is also required by law. In essence, Nigeria's teacher categorisation emphasises the need for teachers to continuously upgrade their academic qualifications as a crucial basis for professional development and growth. The categorisation acknowledges that knowledge is fundamental and needs to be based on the highest likely academic qualifications. That is why entry as a teacher needs to require academic qualifications in the various levels of the education system. For example,

a) To teach at the level of basic education, the National Policy on Education recommends a minimum requirement for the Nigerian Certificate of Education;

b) Teaching at the secondary school level, the policy commends a minimum of a Bachelor's degree in education or a Bachelor's degree in other fields plus a teaching certificate.

c) The National Technical Education Board and the National Commission for Colleges of Education have defined a Master's degree as a minimum qualification for teaching in polytechnics or colleges of education;

d) The National University Commission has defined a doctoral degree as a minimum qualification for teaching at any Nigerian university.

Certain qualities that the teacher obtained over a certain period of his or her life is linked to what qualifies someone to teach and can influence the academic performance of the students. Certificates of degree, formal education, and in-field preparation are not in a teacher's entire life. The quality of curriculum delivery and reform programs depends heavily on teacher qualifications and productivity (Garet, Porter, Desmone, Birman & Yoon, 2001).

Teaching Experience

In the classroom environment, teaching experience refers to the number of years of teaching a teacher has. Teaching experience is the amount of time a teacher has spent in the teaching profession. Over time teachers have learned their disciplines and through experience, become knowledgeable in the practice of education. In other words, teaching practice improves the learning experience and approaches used. The years of experience of teachers are one of the qualification indicators of the teacher, they are assumed to be a vital cause of the academic success of the students. Boyd, Landford, Loeb, Rockoff and Wyckoff (2008) said that well teaching experience would produce better-performing students. Researches have shown that inexperienced teachers are usually inferior to seasoned teachers (Darling-Hammond, 2000). Researchers have also established a clear connection between the effectiveness of teachers and their years of experience, and a successful teacher has a positive influence on the academic performance of students. (Agharuwhe, 2013). Research results have also shown that the teaching experience of teachers has a strong correlation with the learning outcome. Raw (2003) confirmed that students with higher academic results turned out to be teachers with years of experience in the field. It is because these teachers can harmonize their students 'minds and feelings in the classroom, resulting in improved academic success. Several studies have shown that the expertise and professional credentials of teachers have greatly influenced the academic performance of students (Asikhia, 2010; Olaleye, 2011). Current evidence indicates that although new teachers are less successful than more experienced teachers, the benefits of experience level off (Rivkin, Hanushek, & Kain, 2000)

Professional Competence

Professional knowledge and skills are the elements of professional competence that every teacher needs to teach effectively. Teachers should possess the qualifications, skills, and professional knowledge required to guarantee their effectiveness.

Professional knowledge and skills

Teaching as a discipline now has all the qualities of professionalism similar to other prestigious occupations. Teaching defines the education and training requirements that provide professionals with the unique expertise and skills required to carry out their specific position within that field. Professional knowledge shows that education for teachers is complicated by combining the teacher's role and experience as a teacher and as an engaged teacher at the cutting edge of teaching and potentially research skills (Ohi,2007).

It is a task for teacher education systems worldwide to provide teachers with the skills to organise good education that supports students to understand they are possible and maintain this effort over a long teaching career (Furlong, Cochran-Smith, & Brennan, 2011). To meet students 'varied desires, perceptions, abilities, and experiences, teachers' skills and expertise need to build a vast body of knowledge beyond material knowledge.

This expertise enables teachers to translate subject knowledge into successful teaching approaches to fit individual students 'learning needs (National Research Council, 1996). Pedagogic knowledge of content is at the root of this kind of knowledge. It is crucial to consider Shulman's (1986) domains of teacher knowledge when evaluating the origins of professional knowledge of teachers.

Shulman (1986, 1987) first developed Pedagogical Content Knowledge as a special blend of content and pedagogy that directs the way the subject is interpreted and articulated that makes it accessible to others (1986). Scholars have been working on the definition since the beginning of PCK. Therefore, the description of PCK was viewed in various ways by various scholars and researchers, both of them referring to specific consistency, feature, meaning, attribute, behaviour, etc. (Park & Oliver, 2008). It contributed to various PCK models (Friedrichsen et al., 2009; Hashweh, 2005; Magnusson, Krajcik, & Borko, 2006; Park & Oliver, 2008).

The consensus model emerging from the international summit of researchers has been called 'teacher's professional knowledge and skills model like PCK' (Gess-Newsome, 2015). Sometimes, the model is frequently mentioned as the 'PCK Consensus System' (e.g., Ziadie & Andrews, 2018). In their conceptual framework of the Subject Matter Knowledge (SMK)-PCK relationship, PCK models differ (Kind, 2009). For example, while Grossman (1990) and Magnusson, Krajcik and Borko (2006) considered SMK and PCK to be different teaching knowledge bases, Marks (1990) and Fernández-Balboa and Stiehl (1995) included SMK in the PCK. Van Driel, Verloop, and de Vos's (1998) conceptualisation of PCK as a type of skills knowledge guiding the behaviors of teachers in instructional practice underline PCK's role in action (Loughran, Milroy, Berry, Gunstone, & Mulhall 2001).

Five elements of Pedagogical Content Knowledge (PCK): (a) Teaching Science Instructions, (b) Knowledge of Student Understanding, (c) Knowledge of Instructional Techniques and Representations, (d) Knowledge of Science Curriculum, and (e) Knowledge of Science Learning Assessment, as identified by Park and Chen (2012). The Consensus Model that originated from the International Researcher Summit has been identified as a Consensus Model. PCK has been a commonly useful notion and has been used since its introduction in 1987. In the area of science education, for example, scholars such as Anderson and Mitchner (1994); Hewson and Mariana (1988); Cochran, DeRuiter and King (1993); and professional organisations such as the National Science Teachers Association (1999) and the National Council for Accreditation of Teacher Education (1997) have all highlighted the importance of PCK in teacher preparation and teacher education. For this study, the researcher focused on four PCK components out of five. These include (a) Knowledge of Student Understanding, (b) Knowledge of Instructional techniques and Representations, (c) Knowledge of Science Curriculum, and (d) Knowledge of Science Learning Assessment.

In its document "Professional Standards for Nigerian Teachers", the Teachers Registration Council of Nigeria (2010) points out criteria for professional knowledge and skills that teachers should demonstrate while teaching. These include knowledge of content, pedagogy, curriculum understanding, a socio-economic context for students, learning planning, resourcefulness, teaching, and communication.

Smith (2017) indicated that an effective teacher might significantly affect a student's life. Still, a professional skill is needed to leave a positive impression and cope with the day-to-day pressures of classroom management. Effective teaching practice focuses on the current relationship between the teacher and the student. Every learner in such a class must be delighted like they are relevant. It is more likely to lead to engaging and honest pupils of what they know or do not learn, encouraging them to share ideas that ask questions. Jackson and Davis (2000) stated that teacher training enhanced teaching skills and expertise while improving the delivery of their content.

Teaching needs assessment, *i.e*., assessing student comprehension in the light of the aims of the lesson or the course. It is a broad concept, and however, there are several ways of evaluation, including student study. You can grade or ungraded the job; it may take a few minutes (like in the one-minute paper), or it may take weeks (like in the group project). It requires students to illustrate comprehension or learning of skills by writing, production, or presentation of a product or being able to accomplish any task. It could be asking students to show they are known as individuals or as members of a community.

Learning outcomes for students explain what a student will learn or must be achieved upon completion of a course or programme. The student learning outcome assessment provides information that brings student learning at the heart of school planning processes. Evaluation is an essential part of the educational method. It points out where the students are and also what degree they have accomplished; it provides the learners' updates on their learning; it determines the learners ' needs for more development; and it allows curricula, resources, and activities to be prepared (Alderson, 2005). The significance of the role of teachers in the evaluation process is unavoidable since they are at the centre of this procedure: making decisions on the lesson plan, recognizing the strengths and shortcomings of the options available to them, making decisions on their knowledge, and assessing the performance of their learners (Rea-Dickins, 2004).

A vital evaluation task is one that test the academic success obtained by the learners. The aligned curriculum (Biggs, 2003) is one of the keys to successful learning: this ensures that learning outcomes are transparent. Learning processes are structured to support students in achieving such outcomes, and carefully planned assessment activities enable students to demonstrate such outcomes.

The following illustrated the concept:

1. The consequences of learning are apparent.

2. Learning environments (face-to-face and virtual) are intended to help students achieve these learning outcomes.

3. The evaluation tasks enable learners to show their achievement of these learning outcomes.

Education evaluation will profoundly influence students 'educational experiences'. Effective assessment should also ensure that the learning objectives are closely related. Teaching and learning practices meant at achieving learning objectives may be an important framework for student learning. They can:

a. understand a topic
b. reflect on their learning
c. learn or study in your classroom or previous lessons.

Summary of Literature Review

Basic science laid a solid foundation of the three science subjects (Chemistry, Physic, and Biology), which should be taught in the first three years due to the 6-3-3-4 education policy and now changed to the 9-3-4 policy of 2008 (Adekunle, 2012). Basic Science learning involves helping the child to explain the events in nature, teaching in children how to think and reason logically, helping the children to identify and solve simple problems they encounter daily. It involves helping the children to develop physical and social skills (National Teachers Institution, 2009). Teaching science with materials and demonstrations, learners tend to learn better (Attamah, 2012). Furthermore, teaching science with the materials found in the learner's environment yields better understanding. A basic level of education teaching of science does not require a complex laboratory and equipment. In the basic science and technology curriculum, a thematic approach to the content structure was introduced. The topics under each theme have been compiled in a spiral, starting with the simple-to-complex 9-year Basic Education to maintain the interest of learners and facilitate substantive learning. A child-centred activity base method of teaching was prescribed for every subject to encourage learning through doing and skill development.

Many types of research had recognised that enhancing the standard of the learning and teaching science in schools was the basis for people in becoming intellectually curious and fulfil problems of modern science and technology (Goodrum, Hackling, & Rennie, 2001; National Research Council, 1996). For Nigeria to develop its science teaching and learn to meet the challenge of modern world science and technology, it must study, restructure and align the basic science and technology curriculum with a constructivist approach to effective learning. It must also acknowledge that constructivist approaches to teaching can help improve science education and learning, and that science teaching should focus on study and action for successful learning (Bell, Blair, Crawford & Lederman, 2003). Constructivists advocate for situated cognition as a teaching strategy because learning is simply a matter of creating context from the actual daily activities. Shor (1987) looked at situated cognition to relate the subject matter to the learner's needs or concerns. Brunner and Piaget belong to the constructivists' tradition. Both of them believed that learning should be constructed to suit the cognitive level of the learner so that learning could be more comfortable. The level at which most learners at the basic level of education will be operating is likely to be at the concrete or iconic levels of cognitive development. Therefore, the methodologies that require the use of authentic materials must be pursued.

In conclusion, the conceptual framework sketches the relationships of prominent variables in teaching and learning basic science and its influence in teaching and learning basic science.

CHAPTER THREE

RESEARCH METHODS

This chapter describes the methods employed in this research work. The research design, study area, population, sample and sampling techniques, data collection instruments are examined. The chapter also contains data collection procedures, data processing and analysis, and the chapter summary.

Research Design

This research aimed to study the status of teaching and learning of science in junior secondary schools. The study used embedded mixed method design, survey design and case study design. The mixed methods design allows the use of observations, interviews, documents, performance tests and questionnaires. Using a mixture of methods to study a phenomenon broadens our understanding of it (Creswell, 2009). Embedded mixed methods design requires the collection of quantitative and qualitative data; however, one of the data categories plays a supplementary role in the overall design. This design assumes that a single data set is insufficient, that separate questions need to be answered, and each type of question needs unique data structures. A single data set provides a supporting second function in a study based primarily on other data sets (Creswell, Plano Clark, Gutmann & Hanson, 2003).

In this research, qualitative data were embedded within a quantitative design. The researcher begins with quantitative results and builds on the ensuing compilation and analysis of qualitative data. The researcher used quantitative and qualitative techniques to triangulate and corroborate findings from basic science teachers, stakeholders, learners, documents, and the science laboratory to fully explain the topic under study. Mixing happens in the way the two data forms are related to each other during the interpretation of the findings.

The survey design involved the use of instruments to survey the views of both basic science teachers and learners. The teachers' survey was to determine the professional competencies basic science teachers demonstrate in their teaching. The teachers' survey helped to identify the competencies teachers possess and practice in curriculum implementation which involve professional knowledge, basic classroom skills and assessment in basic science. The students' survey was to obtain information about their parents' socioeconomic background and academic performance in basic science. Surveys have been shown to give participants the ability to answer survey items at a time and location that is convenient for them, as well as produce responses that are simple to code. (Gray, 2004). A survey design provides descriptive and inferential information that can be used to describe an item or a topic under research.

The case study design involved classroom observation of basic science teachers, observation of science laboratory apparatus, reagents and safety equipment, interviews with basic science teachers and key stakeholders such as principals, zonal education directors and learners. Also, the case study design in this study involved documentary analysis of the basic science curriculum. Classroom observation and interview provide in-depth knowledge of what basic science teachers accomplish in their classes. The case study design, according to Heitzmann (2008), gives "several chances and ways to acquire insight into events that occur within the school and classroom. Case studies provide first-hand information and allow for triangulation using a variety of approaches and sources to assess how well what teachers claim they do matches what they do or are observed to accomplish (Sarantakos, 2005). Survey and case study design were found to be the most suited for the study to understand the topic under investigation. Since data from many sources might provide more perspectives in a study than a single source (Bogdan & Biklen,2007; Yin, 2009).

Study Area

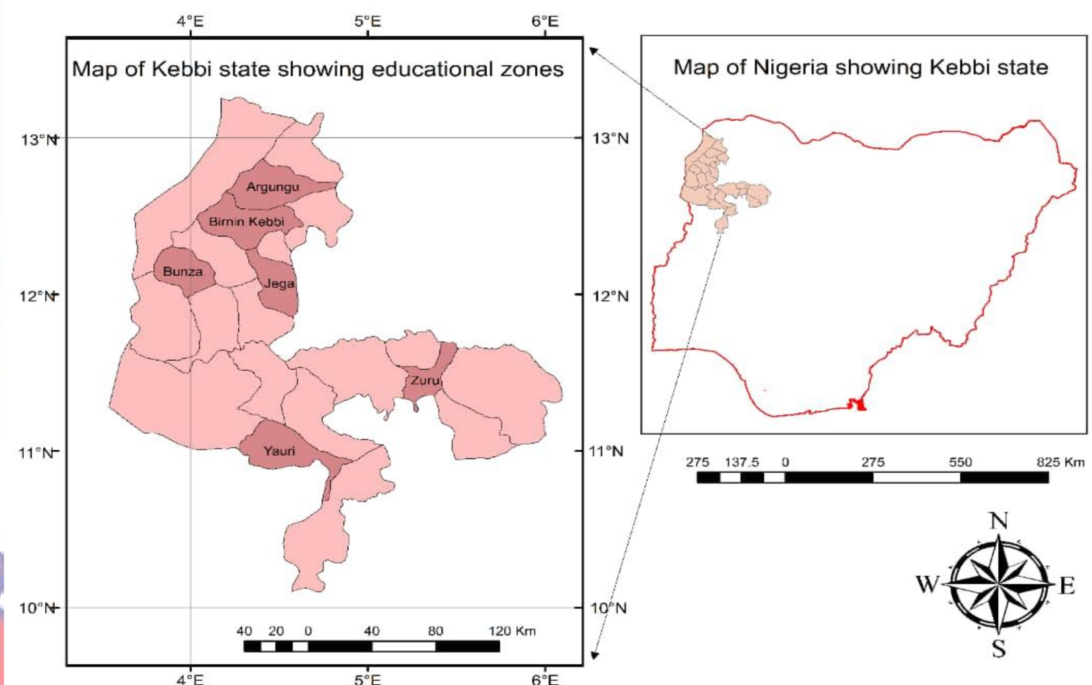

Figure 2: Map of Kebbi State

Source: Field survey, Aliyu (2019)

The research was conducted in Kebbi State. Kebbi is one of the north-western states in Nigeria with its capital at Birnin Kebbi. Kebbi was founded by the Sokoto State in 1991, with a total population of 3,755,816 (projected from 2006 census). It has a total area of 37,698.69 km². Kebbi has two ecological zones: Sudan Savannah in the northern part and Guinea Savannah in the southern region (Kebbi State Ministry of Information and Culture, 2016). It is found on latitude 10^0 and 13^0 15' north and longitudes 3^{0} 30' and 6^{0} east. Kebbi is surrounded by Sokoto and Niger States, Dosso in the Niger Republic, and the Benin Republic. The people in Kebbi are mainly farmers and predominantly Muslims who practise Islam. The state has two ministries of education; a Ministry of Basic and Secondary Education and a Ministry of Higher Education. The Ministry of basic and secondary education comprises the Arabic and Islamic Studies Board, Secondary School Management Board, and Universal Basic Education Board with six educational zones, namely, Argungu Zone, Yauri Zone, Zuru Zone, Birnin Kebbi Zone, Jega Zone, and Bunza Zone. The schools under this research are distributed within these educational zones.

Population of the Study

The population of this study comprised all zonal education directors, principals, basic science teachers, basic science learners, science colleges and science and technical colleges in Kebbi State. There are 13 government science colleges and three government science and technical colleges in the state. All the 16 colleges in Kebbi State offer basic science and have both junior and senior sections. There are 38 basic science teachers (33 males and five females) in all the schools with different teaching experiences. Twenty-five were trained teachers while 13 were untrained teachers. Teachers were considered for this study because they are the implementers of the Basic science curriculum.

There were 6821 learners from 16 government science colleges and science and technical colleges in the 2018/2019 academic year in the State. Out of 6821 learners, 2667 were from JSS1, 2241 from JSS 2, and 1913 from JSS 3 learners.

Learners participated in the study because they were directly affected by the curriculum and socio-economic background of their parents.

Principals were the heads of the schools. They were charged with the responsibility to supervise teaching and non-teaching staff, monitor learners' educational progress, and develop academic programs. They were involved in the study because they supervise teachers and monitor learners' academic progress. Zonal education directors were officials of the State Ministry of Education that are charged to head Zonal offices. They were responsible for regular schools' inspection and constant monitoring of teaching and other educational activities.

The researcher used junior classes (JSS 1, JSS 2, and JSS 3) because the research focus was science at the basic level of schooling. The choice of upper basic school was based on junior secondary school learners who are within 12-15 years of age and are expected to develop interest, ideas, attitude, understanding and plan on science learning. The schools under study and their students are presented in Table 1. For ethical considerations, the names of the schools are denoted by pseudo names.

School	Type of school	Number of students			Total
		JSS 1	JSS 2	JSS 3	

Yag	G*	100	88	80	268
Sat	B*	40	35	29	104
Kos	B	250	180	150	580
Zas	B	213	198	164	575
Rig	G	228	118	141	487
Zat	B	186	167	158	511
Nab	B	385	275	246	906
Sok	B	50	47	33	130
But	B	153	147	136	436
Dag	G	235	231	198	664
Das	B	250	245	199	696
Gun	G	186	184	126	496
Sab	B	64	56	40	160
Bas	B	66	61	45	172
Asa	B	163	129	116	408
Was	B	98	80	52	230
TOTAL		2667	2241	1913	6821

Table 1- Schools and Number of Students at Each Level

Source: Fieldwork (Aliyu, 2019) G*: Girls School; B*: Boys School

Sample and Sampling Procedures

Sampling is a method for selecting a representative sample from the population under analysis. The results obtained may be generalised to the population being studied (Trochim, 2006). Multi-stage sampling was employed in this research. The samples of this study came from the Ministry of Basic and Secondary Education. There are 16 government science and science and technical colleges in the state where 12 are for males and four are females. Fifteen were considered for this study because of the security challenges around the area in one of the schools. There are 36 basic science teachers in the schools under study, and the researcher used all of them by census. There were 6821 students in the sampled schools, and out of this figure, 377 were selected following the mathematical formula for determining a sample size suggested by Yamane (1967). In this study, stratified random sampling was used to choose the sample size of learners to participate in the collection of data. Strata were formed from the population, and then, a simple random sampling technique was applied to each stratum where the sample size was selected. The technique was used since it enabled all members of the population to be chosen without prejudice and is, therefore, simple to use (Mugenda & Mugenda, 2003). The learners' sample size was 377 respondents. Out of this figure, 147 learners comprising 104 boys and 43 girls were sampled from JSS 1. In JSS 2, 124 learners were sampled comprising 88 boys and 36 girls. For JSS 3, 106 learners comprising 75 boys and 31 girls. Participants involved in the observation and interview were selected using purposive sampling because of their willingness to engage in the research. These participants included two zonal education directors, five principals, 10 learners, and 10 teachers. The zonal education directors, principals, and learners were interviewed, whereas the teachers were observed during teaching and later interviewed.

The participating teachers had a wide range of credentials and teaching experience. Their educational qualifications ranged from National Diploma (ND) to Master of Science (MSc). There were 13 untrained teachers, representing 36.1%. Others with professional qualifications ranged from Nigeria Certificate in Education (NCE) to Bachelor of Science in Education [B.Ed. (Science)] some with additional Post-Graduate Diploma in Education an educational qualification that is a requirement to teach in Nigeria. It constituted the trained teachers being 23(63.9%). Ten teachers were found teaching Basic Science in JSS 1, nine teachers in JSS 2, and 11 teachers in JSS 3. The other two teachers were found teaching Basic Science in JSS 1 and 2, one teacher was teaching in JSS 2 and 3, and finally, three teachers were teaching in JSS 1, 2 and 3. The participating teachers were of varying teaching experiences. For example, six teachers had teaching experience that ranged from 0-4 years; nine teachers were within the range of 5-9 years, nine teachers had teaching experience that ranged from 10-14 years also five teachers had teaching experience that ranged from 15-19 years. Lastly, seven teachers had teaching experience that ranged from 20-24 years. There were 36 basic science teachers in this study, 31 males (86.1%) and five females (13.9%). Table 2 presents the schools and the teachers involved in the study.

Table 2- Schools and their Teachers

s/n	Schools	Number of teachers	Classes			Trained teachers	Untrained teachers	Teaching experience	Gender	
			1	2	3				M	F
1	Yag	3	*√			√		8	√	
				√			√	4	√	
					√	√		8		√
2	Sat	1	√	√	√		√	21	√	
3	Kos	3	√			√		20	√	
				√			√	8	√	
					√		√	24	√	
4	Zas	3	√				√	4	√	
				√		√		24	√	
					√	√		20		√
5	Rig	3	√			√		8	√	
				√			√	16	√	
					√	√		4		√
6	Zat	3	√			√		15	√	
				√			√	12	√	
					√		√	23	√	
7	Nab	3	√				√	12	√	
				√		√		16		√
					√	√		11	√	
8	Sok	1	√	√	√	√		4	√	

Table 2- (Cont'd)

s/n	Schools	Number of teachers	Classes 1	2	3	Trained teachers	Untrained teachers	Teaching experience	Gender M	F
9	But	1	√	√	√		√	20	√	
10	Dag	3	√			√		4	√	
				√		√		8	√	
					√	√		16		√
11	Das	3	√			√		12	√	
				√		√		10	√	
					√		√	8	√	
12	Gun	3	√				√	12	√	
				√		√		4	√	
					√	√		8	√	
13	Sab	2	√	√		√		10	√	
					√		√	16	√	
14	Bas	2	√	√		√		6	√	
					√	√		12	√	
15	Asa	2		√	√	√		11	√	
			√			√		8	√	
	Total	36				23	13		31	5

Source: Field data (Aliyu, 2019) *√ : Number of teachers

Fifteen junior secondary schools of the government science colleges and government science and technical colleges were involved in this study. Eleven were boys' schools (70.8%) and four were girls' schools (29.2%). The principals were made up of four males (80%) and one female (20%), all of them had a Bachelor of Education degree with teaching experience ranging from 20-32 years and administrative experience of 5-9 years. Furthermore, two male Zonal Education Directors were involved in this study. They possessed a Bachelor of Education degree with 32 and 31 years of teaching experience and 2 and 1 years of administrative experience, respectively.

Data Collection Instruments

In this study, 10 data collection instruments were used. These were two sets of questionnaires, one performance test, two observation guides, four interview guides and the basic science curriculum.

Questionnaires

Two forms of closed-ended questionnaires were used in this study. These questionnaires were Basic Science Teachers' Questionnaire (BSTQ) and Basic Science Learners' Questionnaire (BSLQ). The BSTQ was developed using personal teaching experience and literature on pedagogical content knowledge, as proposed by Shulman (1987). There have been studies where researchers have developed their expertise assessment tools (Gilmore & Feldon, 2010); Kardash, 2000); Powers & Enright, 1987). The other questionnaire, BSLQ, was adapted from the socio-economic status of parents and its effects on students' achievement (Yelkpieri, 2016). The chosen items have been changed to fit the purpose and context of this study. The questionnaires were structured to provide information on the characteristics or views of the respondents (May, 2001).

The Basic Science Teachers' Questionnaire was structured into two sections, A and B. Section A solicited information from the respondents on their demographic factors like gender, academic qualification, professional qualification, teaching experience, and the class they were teaching. Section B contained three sub-scales: professional knowledge, basic classroom skills and assessment for learners' learning outcomes, each with items under it (see Appendix A). These sub-scales were used to measure basic science teachers' professional competencies and were rated using 4-point Likert- type scales. Some examples of items on professional knowledge were "I use learners' prior experience to plan and build the lesson," "I link content with learning experience/ real-life situation," "I allow learners to construct their own understanding," and "I demonstrate knowledge of subject matter." Some examples of measuring basic classroom skills were "I control my class," "I introduce and explain tasks within the experience and ability of students," "I guide learners' practice, and "I communicate clearly within learners understanding,". Lastly, items measuring assessment for learners' learning outcomes were "I base evaluation on instructional objectives," "I use different assessment strategies and tools appropriate for the content and learners," "I use appropriate questions," "I evenly distribute questions" and "I react appropriately to learners' questions in the class" respectively.

The Basic Science Learners' Questionnaire was used to gather data from learners on their parental socio-economic status. This questionnaire was structured into two sections A and B. Section A comprised gender, class, and demographic information on parents' educational level, occupation, and social class. Section B contained eighteen items that were closed-ended and were rated using a 5-point Likert scale of strongly agree, agree, undecided, disagree, and strongly disagree (see Appendix D). Some examples of the items were "my parents' level of education encourages my science background," "my parent's occupation always allows me to attend to my academic needs," and "my parents' social class influences my aspiration towards learning science" among others.

The BSTQ and BSLQ were content validated by four experts in science education, two from the College of Education in Nigeria and two from the University of Cape Coast Ghana. After content validation, some items were dropped because they appeared unclear to the validators. The observations, modifications, and corrections of the experts have been used to enhance the efficiency of the instruments. The items were also construct validated to ensure they would measure what they were intended to measure. During the construct validation of BSTQ, 300 basic science teachers from Sokoto State responded to the items on the questionnaire. Exploratory factor analysis was performed on the items to check the construct validity, with principal component analysis as the extraction and rotated with Varimax rotation. Factor analysis was used to make sure that all the items in the instrument measured a particular construct; hence the instrument was multi-dimensional with three constructs (professional knowledge, basic classroom skills, and assessment for pupils learning). The exploratory factor analysis was performed and the factor loadings for each subscale were found.

Initially, 35 items were used to measure the professional competence of the 300 teachers who taught basic science in junior secondary schools. For the first sub-scale, 14 items were constructed to measure basic classroom skills (teacher planning, classroom management, and presentation). In this analysis, a loading factor at and above 0.4 was considered, (Tabachnick & Fidell, 2013). The choice of cut for loading size were said to have been viewed as a matter of researcher's choice. Field (2013) recommends that the maintained variables should get at least three loading items greater than 0.4. The higher the load, the more component is the pure measure of the element. Comrey and Lee (1992) say that loads in a total of 0.71 (50 % overlap variability) are pronounced excellent, 0.63 (40% overlap variability) extremely good, 0.55 (30% overlap variability) good, 0.45 (20% overlap variability) reasonable and 0.32 (10% overlap variability) poor. Cross-factor loadings were also considered using the cut-off indicated above.

During the analysis, item 15 with factor loading .330 and item 19 with factor loading .342 were deleted because of lower loading (see Appendix L). Item 31 was deleted because it was not loaded (see Appendix L), thereby retaining 11 items for further analysis. For the second sub-scale, nine items were constructed to measure assessment for learners' learning outcomes, and all the nine items were highly loaded on one component, thereby retained. For the third sub-scale, 12 items were constructed to measure the professional knowledge. During the exploratory factor analysis, item 16 was deleted because of cross-loading (see Appendix L). Also, item 25 with factor loading .377, item 30 with factor loading .308 and item 32 with factor loading .338 were deleted because of lower loadings (see Appendix L). Therefore, eight items were retained for this construct.

After exploratory factor analysis was performed, it was found that out of 35 items initially constructed for the instrument to measure professional competencies that basic science teachers possess, a total of seven items were deleted. So, 28 items were retained for the research (see Appendix L). The BSTQ was found to have a reliability coefficient of r=0.911 for basic classroom skills, 0.901 for assessment for learners learning outcomes and 0.797 for professional knowledge using Cronbach alpha.

Two hundred and fifty basic science learners from Sokoto State responded to the items on the BSLQ for the construct validation of this instrument. Sokoto State is a neighbouring State which has the same characteristics with the Kebbi State. Exploratory factor analysis was performed on the items to check the construct validity, with principal component analysis as the extraction and rotated with Varimax rotation. Factor analysis was used to make sure that all the objects in the instrument evaluated a particular construct; hence the instrument was multi-dimensional with three sub-scales (level of education, occupation and social class). The exploratory factor analysis was performed and the factor loadings for each subscale were found. Eighteen items were used to measure the influence of parents on learner's academic performance in basic science. Items 11 from the occupation sub-scale, 12 from a level of education and 15 from the social class were deleted because they were not loaded. Items 1 to 5 were loaded uniquely and labelled as a level of education, items 6 to 10 were also loaded uniquely and labelled as occupation and lastly, items 13, 14, 16, 17, and 18 were loaded on subscale labelled as social class (see Appendix M). The BSLQ was found to have a reliability coefficient of r=0.819 for a level of education, 0.779 for occupation and 0.865 for a social class using Cronbach alpha.

Observation Checklists

Two observation checklists were used in this study. These were the Teacher Classroom Observation Checklist and Laboratory Apparatus, Reagents, and Safety Equipment Observation Checklist. A structured observation involved the use of a checklist, which has the same items as the teachers' questionnaire used.

The Teachers' Classroom Observation Checklist (TCOC) was adapted from BSTQ and used to measure teacher professional competencies on pedagogical content knowledge. TCOC items in each sub-scale have collaborated with items recorded in BSTQ that each trained teacher was expected to practice during his/her teaching. TCOC contained 28 observable items and were scored during the lesson as not observed, observed once, observed twice and observed thrice (see Appendix B). An item was scored "0" if it is not observed, "1" if it is observed once, "2" if it is observed twice and "3" if it is observed thrice. This observation aimed to determine how basic science teachers used their professional competencies in teaching basic science. These twenty-eight observable items are expected to be seen during teaching. Some examples of these items were "ability to use learners' prior experience to plan and build the lesson," "ability to link content with learning experience/ real-life situation," "ability to introduce and explain task within the experience and ability of learners," "ability to guide learners practice," "ability to base an evaluation on instructional objectives" and "ability to ask a simple and direct question." The teachers' classroom observation checklists (TCOC) were content validated by three experts in science education. Further validation was performed during pre-testing with an inter-rater reliability of k= 0.7 using Cohen's Kappa formula (see Appendix N).

The Laboratory Apparatus, Reagents, and Safety Equipment Observation Checklist (LARSEOC) consists of the list of apparatus, reagents and safety equipment that are used for the teaching of basic science in junior secondary schools. LARSEOC was extracted from the basic science teaching syllabus. This instrument was used to observe the class size, availability/not available of apparatus, reagents, safety equipment and the state of reagents and number of items available. LARSEOC was scored during the laboratory observation as available and not available of apparatus, reagents, or safety equipment in the science laboratory (see Appendix C).

The LARSEOC was content validated by three experts in science education, one from the College of Education in Nigeria and two from the University of Cape Coast, Ghana. Expert observations, modifications and corrections were used to improve the accuracy of the instruments.

Basic Science Performance Test (BSPT)

The Basic Science Performance Test (BSPT) was designed by the researcher and used to measure the academic performance of learners in basic science. Items were drawn from basic science curriculum content in the use of each level. There were 20 multiple choice test items in each level (JSS 1, JSS 2 and JSS

3) and each multiple-choice test item had four options (see Appendix I). One mark was assigned to a correct answer and zero to a wrong answer with a total score of 20 marks. The items were developed based on Bloom's taxonomy of cognitive, educational objectives. The table of the specification was designed to guide the item construction for each level. Cognitive domain levels are arranged in columns and topics are arranged in rows containing the number of items to be built from each topic at each cognitive level. This table was used to ensure content validity in setting the questions at each level. After setting up questions, BSPT was content validated again by two basic science teachers. Basic science teachers are the implementers of the basic science curriculum in their schools. They were requested to examine the clarity of questions in measuring the performance of learners in the subject adequately. The instrument was then given to two specialists in science education to verify. The modifications and corrections of the experts were used to improve the quality of the instrument. A simple random sampling technique was used to Select 60 basic science learners, 20 from each level (JSS 1, JSS 2 and JSS 3) and the items were administered to them. The items were pilot-tested and item analysis was performed to determine which items to keep, modify, or discard. The discrimination index of the items was moderate to high. Apart from item 12 (JSS 2), which was very easy (see JSS BSPT analysis results), the difficulty level of the rest of the items was moderate.

The Kuder-Richardson KR 20 was used to calculate the reliability coefficient because the test items were a multiple-choice objective item test that was scored dichotomously. The KR-20 is used when all items being analysed are dichotomous (Allen, 2017). The KR-20 coefficient of reliability for JSS 1 r= 0.75, JSS 2 r= 0.74 and JSS 3 r=0.81. Three tables of the specification were developed to guide the item construction (see Table 3, Table 4 and Table 5).

Table 3- Table of Specification for JSS 1 Performance Test

Topic	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
Nutrition	1	1	-	-	-	-	2
Environmental pollution	2	-	-	1	1	-	4
State of matter	1	2	1	-	-	1	5
Energy	2	-	-	1	1	1	5
Force	1	-	1	-	-	-	2
Living thing and non-living thing	1	1	-	-	-	-	2
Total	8	4	2	2	2	2	20

Source: Adapted from Bloom, Englehart, Furst, Hill and Krathwohl, (1956)

Table 4- Table of Specification for JSS 2 Performance Test

Topic	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
Safety measures when using chemicals	1	1	-	1	-	-	3
Classes of chemical base on hazardous and toxic	1	1	-	-	-	-	2
Types of energy	-	2	2	1	-	-	5
Heat flow	2	1	-	-	-	1	4
Refining of crude oil	-	1	-	-	-	-	1
Characteristic features of stages of development	1	-	-	-	1	-	2
Adaptation of living thing to their habitats	1	-	-	-	1	-	2
Family health diseases	-	-	-	-	-	1	1
Total	6	6	2	2	2	2	20

Source: Adapted from Bloom, Englehart, Furst, Hill and Krathwohl, (1956)

Table 5- Table of Specification for JSS 3 Performance Test

Topic	Knowledge	Comprehension	Application	Analysis	Synthesis	Evaluation	Total
Family traits	1	1	1	-	-	-	3
Drug and substance abuse	1	-	-	-	-	-	1
Environmental hazards II	-	1	1	-	1	1	4
magnetism	1	1	-	1	-	1	4
Electrical energy	1	-	1	-	-	-	2
Resources from living thing	1	-	-	-	-	-	1
Resources from non-living thing	1	-	-	-	-	-	1
Light energy	-	-	-	1	-	-	1
Sound energy	-	-	1	-	-	-	1
Radioactivity	-	1	-	-	-	-	1
Processing of materials timber	-	-	-	-	1	-	1
Total	6	4	4	2	2	2	20

Source: Adapted from Bloom, Englehart, Furst, Hill and Krathwohl, (1956)

Interview Guide

In this study, a structured interview guide was designed for teachers, zonal education directors, principals, and learners (see Appendix E, F, G, and H). The interview guides were used to get in-depth understanding of the participants' responses in the questionnaire. Mathers, Fox and Hunn (1998) reported that in structured interviews, respondents are asked the same questions in the same manner. Based on the literature of the Pedagogical content knowledge as proposed by Shulman 1987, the interview items were designed by the researcher.

The interview guides were made available to two experienced basic science teachers and two science education experts to check the focus of the items. Their comments and suggestions were used to revise the items. Pilot testing was conducted in April 2019, where two basic science teachers, two principals and three learners were interviewed to find out the clarity and familiarity to participants and to standardise the instrument and the process. The interview guides were subsequently modified and finalised after pilot testing. During the interview, the researcher used the same presentation and order of items to normalise the process of the interview. The items were directed to the purpose of this research. Gray (2004) and Cohen, Manion and Morrison (2007) recommended that the validity of both formal and semi-structured interviews is discussed by ensuring that questions are connected to the goals of the research.

The teachers' interview guide was made up of three sections A, B, and C. But the interview guides for zonal education directors, principals and learners were made up of two sections A and B. Section A of the interview guides for the teachers, zonal education directors, and principals solicited information such as rank, highest educational background, and year participants stated teaching or working in an office. Section A of the interview guide for the learners asked for their class and sex. Section B of the teacher interview guide contains three questions in the same format for the zonal education directors and principals interview guides. The questions asked the participants about the professional competence of the basic science teacher, the predominant method(s) of teaching, and instructional materials used in their teaching. Section B of the learners' interview guide asked the instructional materials used by their teachers while teaching, and their views on practical work during basic science lessons. There were five items in Section C of the Teachers' Interview Guide. These items asked participants for their views on the basic science curriculum, the textbooks they use, and the teaching manual/guide.

In the teachers' interview guide, the demographic information solicited the rank of the teacher's highest educational background and when he/she first started teaching. There were three items on Section B and five items on Section C. the principal interview guide contains questions like: when did you start teaching? When did you first become a principal? With four other questions on Section B., zonal education director guide contains questions like: when did you first start working at zonal educational office? In Section B of the teachers, principals, and zonal education directors' interview guide, there were three items. Some of the items in these guides were "What professional competence do teachers who teach Basic Science in science secondary schools possess? "and "What predominant method(s) of teaching do teachers employ to teach basic science in junior secondary schools?". In Section C, teachers responded to questions like "Are you aware of the basic science curriculum?" and "Is the textbook you are using approved by the government?" and "Is it based on the curriculum?". The learners' interview checklist solicited learners' class and sex. At the same time, Section B contains two items; some of the item's students responded were, "Do you usually understand science lessons and "What instructional materials do teachers employ in teaching basic science in science secondary schools?"

Basic Science Curriculum

The Basic Science curriculum is a teaching curriculum that has been designed to provide a body of knowledge to fulfil daily living requirements as well as to provide a foundation for learning other subjects related to science. A thematic approach to the content organisation was adopted. The curriculum contents are also arranged in a 'spiral form.' This means that the topics in the curriculum recur at different class levels with increasing degrees of depth. Learning of scientific concepts and skills was matched to learners' cognitive development. As a result, four themes have been used to encompass the knowledge, skills and attitudinal criteria that learners would relate to in their daily experiences. These are:

1. You and Environment
2. Living and Non-Living Things
3. 'Science and Development
4. You and Energy

Theme 1 You and Environment

Everything we do as humans affects the environment; therefore, we need to teach children how to take care of themselves and our environment. Their attitudes and behaviour will help to shape how they react to the environment. Study you and the environment will allow the learners to understand the value of the environment and make it healthier and more beautiful. Topics addressed under You and Environment include the following in JSS 1: Family Health, Environmental Conservation, Disease Vectors, Disease prevention, Prevention of STIs, HIV/AIDS, and Drug Abuse I. In JSS 2 it includes Family Health(diseases), Environmental Pollution, and Drug Abuse II. In JSS3 it includes Family Traits (Genetics), Environmental Hazards, and Drug Abuse III.

Theme 2 Living and Non-living Thing

This theme reflects the living and non-living elements of the world. Living and non-living experiments will help the child to have a more in-depth view of himself as a living entity and will also help to realise the value of living. The theme has spirally arranged the following topics from JSS (1-3). These include Matter, Living Things, and Non- Living Things to be taught in JSS 1. For JSS 2 the topics include 'Living Thing (Habitats), Uniqueness of Man, Changes in Living Things, Changes in Non- Living Things and the Human Body. In JSS 3 the topics include Metabolism in the human body, Sense organs, Reproductive Health, Non- Living things, Resources from Living things, and Resources from Non-Living things.

Theme 3 Science and Development

The theme "Science and Development" has been introduced to introduce students to scientific and technological developments along with skills that will help them address problems, make educated choices, build effective plans and learn how to live successfully within the global world. Topics covered under this theme in JSS1 include Gravitation and Weightlessness, Space Travel and Satellite. In JSS 2 the topics to be taught include Information and Communications Technology (ICT) and Crude oil and Petrochemicals. While in JSS 3 topics includes Skills Acquisition and Ethical Issues in Science Development.

Theme 4 You and Energy

Energy affects both living and non-living things that make everyday life change. Many forms of energy exist and one form can be converted to another. Studying this theme will enable learners to appreciate the importance and uses of energy and the need to explore and preserve energy. The theme includes the following topics arranged spirally from JSS (1-3) topics in JSS1 includes Energy, Renewable and Non-Renewable Energy and Forces. In JSS 2 the topics to be taught include Work, Energy and Power, Simple Machines (Wheel and Axle), Simple Machines (Screw Thread), Simple Machines (Gears), Efficiency of simple machines, Kinetic Energy and Thermal Energy. In JSS 3 the topics to be taught include Light energy, Sound energy, Magnetism, Electrical energy and Radioactivity.

The curriculum contents in the various themes and sub-themes are arranged in a table containing the following columns:

a. Topic

b. Performance objectives

c. Content

d. Activities (teachers' activities and learners' activities)

e. Teaching and learning resources and evaluation guide

This tabular arrangement is meant to help you to understand the curriculum fully and implement it according to the planned objectives. For instance, you can see from the curriculum document the broad topics and the objectives that the students are required to accomplish topics by the end of learning. Likewise, what the teacher and the learners should be doing in each topic to achieve the performance objectives is stated, and the resources which the teacher should provide are given with hints on evaluation.

Data Collection Procedures

An introduction letter was collected from the Department of Science Education, University of Cape Coast, Ghana, to the Honourable Commissioner of Education, Kebbi State to introduce the researcher and humbly request for permission and assistance in conducting the research in the state (see Appendix T). Thereafter, a letter of introduction was obtained from the Ministry for Basic and Secondary Education to its zonal education offices (see Appendix U) for further permission to conduct research in their areas of jurisdiction. Letters of approval were also received from some of the Zonal Directors (see Appendix V), while others made a phone call with the principals concerned to solicit their usual support and co-operation in the conduct of the research in their schools. The researcher discussed the purpose of the study with principals and Basic Science teachers and sought their assistance in participating in the study. Two research assistants were trained to help in the collection of data in this study.

The researcher, with the help of research assistants and Vice-Principal Academics in each school, distributed questionnaires to Basic Science teachers and students. The researcher waited for participants to complete questionnaires given to them to collect the completed questionnaires on the same day in each school, and this resulted in the return of all the questionnaires distributed. On the second-day basic science performance test was administered to the learners for 30 minutes and invigilated by the researcher, research assistants, and vice-principal academics in each school. After the test, laboratory apparatus, reagents and safety equipment observations were conducted with the use of LARSEOC in each school.

The classroom observation was conducted with the use of TCOC at two different times. Ten teachers from JSS 1, 2, and 3 were selected and observed during their lesson presentation. Four teachers were selected from JSS 2, while three teachers were selected each from JSS 1 and 3. Each teacher was observed three times. The first classroom observation was done in the fifth week of the term by the researcher and two research assistants, which lasted for 10 days and each lesson observation lasted between 30-40 minutes. Second and third lesson observations were done from week nine to week twelve of the third term. It lasted for 10 days each with the same procedure as in the first lesson observation. Each teacher was observed in his school at a convenient time. The number of learners present in each class during observation ranged from 35-47.

During the classroom observation, 23 topics in different lessons were observed from different teachers at different levels. The researcher sat at the back of the learners and observed the lesson. This kind of observation was non-participant (Cohen, Manion & Morrison, 2007; Punch 2009).

During the lesson observation, to minimise the biases of the observation, the researcher made a pre-discussion with participating teachers before the lesson. The researcher spent the entire lesson time in each classroom with teachers to reduce the impact that the presence of the researcher might have on them in the course of the observation. Classroom activities were recorded with the aid of the TCOC. The TCOC had statements referring to the actions expected to be observed. When certain activities took effect, the underlying TCOC statement was checked. Table 6 shows the observed lessons of ten teachers on different levels.

Table 6- Observed lessons

Teacher	Classes observed	Lesson topic	Number of observations
A	JSS 1	Matter	3
		Matter	
		Matter	
B	JSS 1	Branches of science	3
		Nutrition	
	JSS 3	Vectors quantity	
C	JSS3	Digestive system	3
		Sense organs	
	JSS 2	Water pollution	
D	JSS 1	Energy	3
	JSS 2	Air pollution	
	JSS3	Sound	
E	JSS 1	Nutrition	3
		Soil	
F	JSS 2	Pollution	

Table 6- (Cont'd)

Teacher	Classes observed	Lesson topic	Number of observations
	JSS 2	Skeleton system	3
		Elasticity	
	JSS 3	Sound	
G	JSS 2	Type of friction	3
		Machine	
		Force	
H	JSS 2	Thermal energy	3
		Friction	
		Adv &dis adv of friction	
I	JSS 3	Sense organ	3
	JSS 1	State of matter	
		Sources of food	
J	JSS1	State of matter	3
		Nutrition	
		Carbohydrate	

Source: Field survey (Aliyu, 2019)

Ten teachers, two zonal education directors, five principals, and ten learners were also interviewed. Interviews were conducted with the use of guides prepared for each category of participants from May - July 2019. The interview started with an exchange of greetings and a short overview of the study and purpose of the research. Both interviews were audio-recorded, and the interviewees were assured that their responses would be used purposively for research only.

The basic science teachers, principals, and zonal education directors were asked the same questions, though there were additional questions in the teacher's interview while learners were asked different questions. Each interview lasted between 15 to 20 minutes. The researcher kept constant eye contact with the interviewees to notice non-verbal gestures like smiling or nodding to take note. Each interview ended with appreciation to the interviewee.

Data Processing and Analysis

Qualitative and quantitative data methods were used in the analysis of the data. The quantitative data obtained were coded and then entered into spreadsheets in SPSS using numeric values and analysed using descriptive and inferential statistics. The qualitative data collected were analysed, using narrative analysis and content analysis.

The first research question was answered using mean scores and standard deviations from the survey data and observed class lessons. The lesson observation data were used to complement the survey data during the interpretation of the data.

In BSTQ, a four-point Likert scale format (1= strongly disagree, 2=disagree, 3=agree, and 4= strongly agree) was assigned to the items. In TCOC, items were assigned values (that is 0= item not observed during the lesson, 1=item observed once during the lesson, 2=item observed twice during the lesson, and 3= item observed thrice during the lesson). Descriptive statistics was used and, the results are presented in Tables 11, 13, and 15. The results from TCOC were compared with the teachers' reported response from BSTQ.

The second and third research questions were answered using interview and observation data from 10 teachers and interviews from two zonal education directors, five principals, and 10 learners. The audio recordings from the interviews conducted have listened to several times for their accurate translation and transcription. All interviews have been transcribed verbatim by the interviewer. The transcripts were coded. The researcher coded only the section of data that were important to or recorded something significant about, the research questions. The analysis was driven by study questions and was more of a top-down analysis. The researcher read and reread the transcripts to identify the categories across the different interview transcripts. Research question four was answered using data generated from LARSEOC. Descriptive statistics of frequency counts and the percentages were used to analyse this data.

Research question five was answered, using content analysis. Bloom, Englehart, Furst, Hill and Krathwohl, (1956) taxonomy of cognitive learning, Krathwohl, Bloom and Masia, (1964) taxonomy of affective learning and a synthesis of the taxonomies of Simpson (1972), Dave (1970) and Harrow (1972) informed the content analysis of the basic science curriculum content in use in junior secondary schools. The basic science curriculum was obtained from one of the schools under study. The units of analysis were performance objectives, activities (teacher's activities and learner's activities) and the evaluation guide. Bloom's educational objective, Krathwohl's educational objective and Simpson's educational objectives framework were used to code the units of analysis. It took about two weeks each to code the curriculum of each level (JSS 1, JSS 2, and JSS 3).

Coding allows a content analysis to be accurate; it should be consistent (Krippendorff, 2004). Moreover, high efficiency means that the content analysis methodology is accurate and reliable. The coding was started at the beginning of November 2019 to the end of December 2019. Three observers were used to rate 15 codes where six were from cognitive domain, five from affective domain and four were from psychomotor domain. They have one question to answer i.e. "Does the code used correspond to the units of analysis?" where 1=yes, 2=no and 3=partial.

The code sheet was introduced to them by the researcher and briefed them about the coding process. After they have studied the code sheet for two days, topics were randomly selected from the curriculum of each level (JSS 1, JSS 2, and JSS 3). Each observer worked independently and came up with his result showing all codes for each unit of analysis without any missing data. Krippendorff's α was used to calculate the inter-rater reliability. An SPSS macro functions as a mini program within the syntax of SPSS was used to conduct the analysis. The Krippendorff's α for inter-rater reliability was found to be 0.89 (see Appendix S). Table 7 is the framework that was used in analysing the cognitive processes in the units of analysis.

Table 7- Framework for analysing the cognitive processes

Cognitive process	Description	Guideline
Knowledge	Ability to remember previously studied materials	1. Opportunity for students to recall, identify previously learned material 2. Use verbs such as to define, list, name, recall, recognise, record, relate, repeat, underline, state, memorise e.t.c, to classify the objectives to guide the classification.
Comprehension	Ability to understand the meaning, explain, relate restate ideas	1. Opportunity for students to demonstrate comprehension 2. Use verbs such as translate, restate, discuss, describe, recognise, explain, express, locate, report, review, classify, pick, select to guide the classification

Table 7- (Cont'd)

Cognitive process	Description	Guideline
Application	Ability to use learning resources in new circumstances	1. Opportunity for students to use learned material in new situations 2. Use verbs such as Interpret, apply, employ, use, demonstrate, dramatise, practice, illustrate, operate, schedule, shop, sketch, use, initiate, utilise, generalise to guide the classification
Analysis	Ability to separate material into the component part and to demonstrate the relationships between parts	1. Opportunity for students to separate material into the component part and show relationships between parts 2. Use verbs such as distinguish, analyse, differentiate, appraise, calculate, experiment, test, compare, contrast, criticise, diagram, inspect, debate, inventory, detect, relate, solve, examine, categorize, predict, estimate, develop, determine, deduce, criticise and calculate to guide the classification
Synthesis	Ability to bring together different ideas to form a new whole, to create new relationships.	1. Opportunity for students to separate ideas to form a new whole, establish new relationships. 2. Use verbs such as compose, plan, propose, design, formulate, arrange, assemble, collect, construct, create, set up, organise, manage, prepare, modify, produce to guide the classification
Evaluation	Ability to judge the value of material against specified criteria	1. Opportunity for students to judge the worth of material against stated criteria 2. Use verbs such as judge, appraise, evaluate, assess, choose, compare, critique, measure, score, revise, rate, value, and validate to guide the classification

Source: Bloom, Englehart, Furst, Hill and Krathwohl, (1956)

Table 7 shows the cognitive processes, description, and guidelines used in identifying the cognitive domain in the performance objectives, activities, and evaluation guide. The units of analysis were read many times to identify the cognitive domain verb or action used in the stated performance objective, activities, and evaluation guide.

A framework for analysing the cognitive process (Table 7) was used in coding the units of analysis. That is, each stated performance objectives, activities (teacher's activities and learner's activities) and the evaluation guide was coded within the six levels of the cognitive domain (knowledge, comprehension, application, analysis, synthesis, and evaluation). They are coded with the first alphabet or first and second alphabet for the identified level. Therefore "Knowledge was denoted by 'K'; Comprehension, 'C'; Application, 'Ap'; Analysis, 'An'; Synthesis, 'S; and Evaluation, 'E.'

The stated performance objectives of the topics and sub-topics in each level of the curriculum were coded. Each objective of the topic was coded according to the level of the cognitive domain it is measuring (see Appendix P) and for coding sheet of each curriculum in each level (see Appendix O). Examples: students should be able to: "identify food type" was coded as K; students would be able to: "describe the methods of keeping their bodies and homes clean" was coded as C; students would be able to: "illustrate the eclipse of the sun and the moon" was coded as Ap; students would be able to: "distinguish between biodegradable and non-biodegradable materials" was coded as C; and students would be able to: "collect and identify samples of plants and animals in their environment" was coded as K.

The coding was, therefore, was done according to the curriculum, the objectives were coded before the coding of the activities (teacher's activities and learner's activities) and activities before evaluation guide.

Activities (teacher's activities and learner's activities) are what the teacher and the learners should be doing in each topic to achieve the performance objectives stated. The framework for analysing the cognitive processes was also used to guide the coding process of cognitive levels in the activity schedules for teachers and students in the curriculum of each level. Each activity was coded according to the level of the cognitive domain and measured across the themes, as shown in the coding process. Some examples of the coding activities such as teacher to guide learners to: "define personal cleanliness" was coded as K, because it intended to test the knowledge level of the learner; "leads a discussion on methods of keeping bodies and homes clean" was coded as C, because it intended to test the comprehension level of the learner; "Uses charts/ pictures to show sources of clean water" was coded as Ap; because it intended to test the application level of the learner; "Guides students to group living matter as plants and animals" was coded as C because it is intended to test comprehension level of the learner and "students to collect and boil water from streams, ponds and wells" was coded as K, because it intended to test the knowledge level of the learner. The coded teachers' activities and students' activities were reviewed and counted across each level of domains and presented them in frequency distribution tables.

Table 7 was also used in coding the evaluation guide in the curriculum of each level. The evaluation guide of the curriculum at each level was coded.

According to the level of the cognitive domain, it measures across the themes as shown in the coding process. Examples: students to "list three methods of keeping their bodies and homes clean" was coded as K; "state four consequence of poor hygiene" was coded as K; "use diagrams to illustrate the life cycle of mosquito" was coded as Ap, "set up series and parallel circuits and distinguish between them" was coded as S. The coded evaluation guide was counted according to each level of the domain and presented in tables. Table 8 is the framework that was used in analysing the affective domain of learning.

Table 8- Framework for analysing the affective domain of learning

Affective domain	Description	Guideline
Receiving	Ability to be conscious of or attending to something in the environment	1. Opportunity for students to become aware of or attending to something in the environment 2. Use verbs such as accepts, attends, develops, recognises, follows, point to, asks, selects, holds, gives, chooses, locates, identifies to guide the classification
Responding	Ability to show some new behaviours as a result of experience	1. Opportunity for students to exhibit new behaviours as a result of experience 2. Use verbs such as completes, comply, cooperates, discusses, assists, answers, aids, conforms, and responds to guide the classification
Valuing	Ability to show some definite involvement or commitment	1. Opportunity for students to exhibit some definite involvement or commitment Use verbs such as demonstrates, differentiates, explains, follows, forms, initiates, invites, joins, justifies, proposes, reads, reports, shares, studies, works to guide the classification

Table 8- (Cont'd)

Affective domain	Description	Guideline
Organization	Ability to organise values into goals by comparing values, addressing contradictions between them, and establishing a specific value structure	1. Opportunity for students to organise values into priorities 2. Use verbs such as organises, compares, defends, formulates to guide the classification
Characterisation by value	Ability to act consistently with the new value	1. Opportunity for students to act consistently with the new value 2. Use verbs such as acts, displays, influences, listens, modifies, performs, practices, proposes, qualifies verifies to guide the classification

Source: Krathwohl, Bloom and Masia, (1964)

Table 8 shows the affective domain, description and guidelines used in identifying the affective domains in the activities (teacher's activities and learner's activities). The units of analysis were read many times to identify the affective domain verb used in the activities.

The framework for analysing the affective domain of learning was used to inform analysis of the affective domain in activities to be shown by teachers and students as scheduled in the curriculum of each level. Each activity was coded according to the five levels of an affective domain; it is measuring across the themes with the first and second alphabet or first, second and third alphabet for the identified level. (See Appendix Q) and for coding sheet of curriculum in each level (see Appendix O). Therefore "Receiving was denoted by 'Rec'; Responding, 'Res,' Valuing, 'Va,' Organisation, 'Org' and Characterisation by value, 'Ch.'

Some examples of the coding activities include students are to: "find out more about Satellite from home" coded as Rec, students are to "Sort foods into classes" coded as Res, "participate actively in discussions" coded as Va, "Prepare adequate diet for homes" coded as Org, and "listen, and ask questions to the visiting experts" coded as Rec. The coded teachers' activities and students' activities were reviewed and counted across each level of the domain and presented in a frequency distribution table to show their coverage toward the levels of Krathwohl taxonomy across the themes. Table 9 is the framework that was used in analysing the psychomotor domain of learning.

Table 9- Framework for analysing the psychomotor domain of learning

Psychomotor domain	Description	Guideline
Observing	Ability to watches a more experienced person or other mental activity	1. Opportunity for students to engage in the observation process 2. Use verbs such as watch, feel, hear, and smell.
Imitating	The ability of copying of a physical behaviour or work of art after taking lessons or reading about it	1. Opportunity for students to copy physical behaviour. 3. Use verbs such as Copy, follow, replicate, repeat, adhere, pour, rinse.

Table 9- (Cont'd)

Psychomotor domain	Description	Guideline
Practicing	Ability to try a specific physical behaviour severally	1. Opportunity for students to try out specific physical behaviour 2. Use verbs such as Demonstrate, complete, show, perfect, control, calibrate, dilute, titrate
Adapting	Ability to adjust in the physical activities or work of art to perfect it	1. Opportunity for students to adjust to physical activity to become perfect. 2. Use verbs such as Adopt, develop, formulate, modify, construct, solve, combine, coordinate, integrate, master

Source: Simpson (1972), Dave (1970) and Harrow (1972)

Table 9 shows the psychomotor domain guidelines used in identifying psychomotor domains in the activities. The units of analysis were read many times to identify the psychomotor domain verbs or actions used in activities. The framework for analysing the psychomotor domain of learning was used to inform the analysis of the psychomotor domain in activities to be shown by teachers and students as scheduled in the curriculum of each level. Each activity was coded according to the four levels of the psychomotor domain; it measures across the themes with either the first alphabet or first and second alphabet of identified level (see Appendix R) and for coding sheet (see Appendix O). Therefore "Observation was denoted by 'O'; Imitation, 'I,' Practicing, 'Pr' and Adapting, 'Ad.' Some examples of the coding activities include students are to "Copy chalkboard summary" coded as I, "Visit refuse to dump sites and record observation for class discussion" coded as O. Similarly, other are "Shows pictures/posters/paper clippings and films on satellite" coded as Pr, "Dissects a chicken to display its alimentary system for students' observation" coded Ad. The coded teachers' activities and students' activities were reviewed and counted across each level of the domain and presented in the frequency distribution table.

Descriptive content analysis was used to analyse all data gathered from the Basic Science curriculum of each level to describe the occurrence of the cognitive, affective, and psychomotor domains, respectively. All of the themes (You and Environment, Living and Non-living Thing, Science and Development and You and Energy) in each curriculum were subjected to descriptive content analysis.

Finally, at each level (JSS 1, JSS 2, and JSS 3), all the occurrences of knowledge, comprehension, application, analysis, synthesis and evaluation were counted in the objectives, activities, and evaluation guide. Also, the occurrences of knowledge, comprehension and application were counted under a lower level and analysis, synthesis and evaluation were counted under a higher level in the objectives, activities and evaluation guide. The calculated frequencies and percentages in the cognitive process were tabulated. All the occurrences of receiving, responding and valuing were counted under a lower level. In comparison, organisation and characterisation by value were counted under a higher level in activities (teacher's activities and learner's activities). The calculated frequencies and percentages were tabulated in the affective domain. Similarly, all the occurrences of observing and imitating were counted under a lower level while practising and adapting were counted under a higher level in (teacher's activities and learner's activities). The calculated frequencies and percentages were tabulated under the psychomotor domain.

Research question six was answered using exploratory factor analysis to determine the dominant factors in exploring science learners' socio-economic background on their academic performance in a basic science programme. Multiple regression was later performed to determine which factor greatly predicts academic performance. The socio-economic background conceptualized in this study were level of education, occupation and social class. In BSLQ the items were assigned values on a five-point Likert scale format (1=strongly agree, 2=agree, 3=undecided, 4= disagree and 5=strongly disagree). The correlation matrix and initial eigenvalue were inspected and found that the data was recommended for further analysis. The scree plot was also examined to determine the change in the shape of the plot. The nature of the factor loadings of the items on BSLQ was also determined, items loaded highly on two factors. The two factors were used to conduct regression analysis and the result was discussed.

An independent sample t-test was used to test for the hypotheses. This was because two different variables were tested. Performance means score as dependent variables and training type as an independent variable was used in Hypothesis one and performance mean score as dependent variables and using laboratory as an independent variable in Hypotheses two.

Chapter Summary

The study was planned to examine the status of teaching and learning of science in Junior Secondary Schools. The study adopted an embedded design and multi-stage sampling technique was used. Yamane formula for determining sample size was used, and 377 learners were chosen for the survey using stratified sampling. Simple random sampling was applied to each stratum (147 from JSS 1, 124 from JSS 2, and 106 from JSS 3).

Thirty-six basic science teachers were used for the survey by census, and 10 were purposively selected for classroom observation and interviews. Similarly, two zonal education directors, five principals and 10 learners were also purposively selected and interviewed. The instruments used were two questionnaires, two observation checklists, one performance test, four interview guides and a basic science curriculum. Descriptive statistics were used to analyse the data from basic science teacher's questionnaires, classroom observation, basic science curriculum and laboratory observation. Exploratory factor analysis and regression analysis were used to analysed data from basic science learner's questionnaires. Data from interviews were analysed using narrative analysis. Data from basic science performance tests were analysed using an independent t-test.

CHAPTER FOUR

RESULTS AND DISCUSSION

This chapter discusses in tabular and graphical forms all the results obtained from the study guided by the research questions and hypotheses. The answers to the research question and the hypotheses are also presented. These are followed by deductions and thorough discussions on the entire research questions and hypotheses.

Professional competence of teachers who teach basic science in junior secondary schools

Data was gathered from teachers who teach basic science in junior secondary schools to find out the professional competence they possess. For instrument validation, an exploratory factor analysis was performed on the items. Factor analysis as a statistical method was used to assess the artifacts of the instrument with the same features that can load uniquely on the same construct. Factor analysis was used to make sure that all the items in the instrument measured a particular construct; hence, the instrument was multi-dimensional with three constructs (professional knowledge, basic classroom skills, and assessment of pupils learning) before further analysis. Initially, 35 items were used to measure the professional competence of Basic Science teachers. However, after the exploratory factor analysis, five items were deleted because of lower loadings, and two items were also deleted because of cross-loadings to retain 28 items (see Appendix L).

A total of 36 Basic Science teachers responded to the BSTQ. Teachers were asked to indicate their agreement or disagreement on professional competency they possess on a four-point Likert scale (strongly agree, agree, disagree, and strongly disagree). Their responses were recorded, and the mean scores and standard deviations for the various constructs of BSTQ are provided in Tables 10, 12, and 14. Table10 presents the mean scores and standard deviation for professional knowledge as responded by 36 Basic Science teacher.

Table 10- Mean and standard deviation scores obtained from teachers responses on their professional knowledge

s/n	Items	N	Mean	Std.
1.	I use learners' prior experience to plan and build the lesson	36	3.53	.560
2.	I link content with learning experience/ real life situation	36	3.53	.560
3.	I allow learners to construct their own understanding	36	3.53	.560
4.	I demonstrate knowledge of subject matter	36	3.31	.710
5.	I motivate learners to be active participants	36	3.53	.560
6.	I am aware of the curriculum content and how it is taught	36	3.33	.894

Table 10- (Cont'd)

s/n	Items	N	Mean	Std.
7.	I align lesson objective to the curriculum and learners learning needs	36	3.39	.645

Source: Field survey (Aliyu, 2019) Note: strongly disagree=1, Disagree=2, Agree=3 and strongly agree=4

A careful look at Table 10 indicates the mean scores obtained for all teachers were greater than 3.0. This shows that all the basic science teachers generally agreed on all the seven items chosen to measure the possession of professional knowledge. Because the mean scores correspond to the agreed level in the four-point Likert scale used.

Classroom observation was also made to complement the survey data and this data was used to explain the quantitative data. TCOC was used to observe 10 teachers during their lessons. In TCOC, zero (0) was assigned to *not observed*; one (1) was assigned to item *observed once* during the lesson, two (2) was assigned to item *observed twice* during the lesson, and three (3) was assigned to item *observed thrice* during the lesson. All observations were recorded, and the mean scores and standard deviation were calculated and are provided in Tables 11, 13, and 15.

Table 11 shows the result of classroom observations made on the basic science teachers about their professional knowledge. The results revealed that basic science teachers could not allow learners to construct their understanding during the lesson. This is because the mean score for this item was 0.3, implying that the activity was not observed in all the lessons.

Table 11- Mean and standard deviation scores for classroom observation on teacher professional knowledge

s/n	Items	N	Mean	Std.
1.	Ability to use learners' prior experience to plan and build the lesson	10	3.00	.000
2.	Ability to link content with learning experience/ real life situation	10	2.60	.699
3.	Ability to allow learners to construct their understanding	10	.30	.675
4.	Ability to demonstrate knowledge of subject matter	10	2.80	.422
5.	Ability to motivate learners to be active participants	10	2.90	.316
6.	Ability to be aware of the curriculum content and how it is taught	10	2.50	.972
7.	Ability to align lesson objectives to the curriculum and learners learning needs	10	2.40	.516

Source: Field survey (Aliyu, 2019), Note: Not observed= 0, observed once=1 observed twice=2 and observed thrice=3

However, the ability to use learners' prior experience to plan and build the lesson was observed thrice during the basic science lesson. In addition, all the other abilities were observed twice. This means that the basic science teachers could only demonstrate these abilities in the two lessons observed.

The observation data obtained has not confirmed the survey results that generally portray basic science teachers to have possessed professional knowledge in all the survey items as shown in Table 11. The research findings from this category revealed that the Basic Science teachers agreed that they possessed professional knowledge to teach basic science. However, it was observed that all the basic science teachers could not allow learners to construct their understanding during the lesson. This was confirmed after the interview with the principals of the schools, who said some teachers have been unable to lead the practice to resolve them and then expand on them. Saleem, Ishaq and Mahmood (2019) In their research concluded that due to the introduction of new trends in curriculum and changes in the features of learner learning requirements, there is a great demand for teachers to continuously grow and update their professional knowledge as well as enhance their teaching abilities. The National Research Council (2000) stated that learners learn by linking new information to the factual information that they know, thus generating new interpretation. Therefore, teachers should be mindful that learners often have inadequate logical constructs as a consequence; it may take time to learn how to "portion" knowledge into comparable, retrievable groups, create bigger conceptual concepts, and link ideas (Kober, 2015).

Knowledge about instructional strategies used in this study, measured teachers' basic classroom skills in planning and engaging students in the learning process. It also helps in selecting and use of teaching activities that are related to the objectives in the learning process, use of effective classroom communication, use of classroom management and presentation. This knowledge could enable the teacher to plan and present learning programmes that could help the learners learn not only for the sake of examination but also preparing students for life, assisting the learners in moving to the next educational stage and providing learners with a good example. Table 12 presented the mean scores of the Basic Science Teachers' knowledge about instructional strategies and presentation.

Table 12- Mean and standard deviation scores for teachers' basic classroom skills before classroom interaction

S/N	S/N	N	Mean	Std.
9	I control my class	36	3.53	.560
10	I introduce and explain tasks within the experience and ability of learners	36	3.53	.560
11	I guide learners' practice	36	3.39	.688
12	I communicate clearly within learners understanding	36	3.47	.560
13	I use a variety of instructional strategies to promote learning	36	3.58	.649
14	I reinforce learners to enhance their learning	36	3.53	.560
15	I manage my class	36	3.53	.560
16	I write clearly and effectively on the board	36	3.28	.566
17	I give many examples within learners' environment	36	3.44	.607
18	I involve all learners in the lesson	36	3.53	.560
19	I design science activity for learners to learn through exploration	36	3.53	.560

Source: Field survey (Aliyu, 2019) Note: strongly disagree=1, Disagree=2, Agree=3 and strongly agree=4

In this analysis, the four-point Likert scale was considered. A careful look at the results in Table 12 revealed that the mean scores for all the items lie within the agreed level of 3 points. This indicates that the basic science teachers have possessed the skills for instructional strategies and presentations.

Table 13 shows the results of classroom observations made concerning basic classroom skills the teachers possessed. The results revealed that the teachers could not guide learners to practice during the lesson and could not design science activities for pupils to learn through exploration in their lessons. These abilities were not observed in the three lessons taught by the basic science teachers. However, the teachers were in the following areas observed twice, ability to: control the class; introduce and explain tasks within the experience and ability of learners; communicate clearly within learners understanding; reinforce learners to enhance their learning; manage the class; write clearly and effectively on the board; and give many examples within the learners' environment. Similarly, the Table indicates that the ability to use a variety of instructional strategies to promote learning and involve all learners in the lesson was observed once.

Table 13- Mean and standard deviation scores for classroom observation on teachers' basic classroom skills during teacher-learner interaction

S/N	S/N	N	Mean	Std.
9	Ability to control the class	10	2.80	.632
10	Ability to introduce and explain tasks within the experience and ability of learners	10	2.60	.516
11	Ability to guide learners' practice	10	.00	.000
12	Ability to communicate clearly within learners understanding	10	2.70	.483
13	Ability to use a variety of instructional strategies to promote learning	10	1.70	.1.160
14	Ability to reinforce learners to enhance their learning	10	2.30	.949
15	Ability to manage the class	10	2.80	.422
16	Ability to write clearly and effectively on the board	10	2.80	.422

Table 13- (Cont'd)

S/N	S/N	N	Mean	Std.
17	Ability to give many examples within the learners' environment	10	2.60	.516
18	Ability to involve all learners in the lesson	10	1.80	.789
19	Ability to design science activity for learners to learn through exploration	10	.60	.966

Source: Field survey (Aliyu, 2019) Note: Not observed= 0, observed once=1 observed twice=2 and observed thrice=3

The ability to guide learners to practice and design science activity for learners to learn through exploration is essential toward achieving the objectives of basic science and technology curriculum. The use of a guided study of teaching and learning is suggested in the exercises recommended within each subject to facilitate ability growth learning, but this has not been taken care of. Research has shown that participating students in learning increase their focus and concentration, allows them to practice higher-level critical thought skills, and facilitates positive learning experiences (Park, 2003). The Basic Science curriculum has spelt out the use of a student-centred approach. Therefore, teachers who follow a student-centred approach to direct instruction will improve the potential for student involvement, which will then allow everyone to effectively achieve the learning goals of the course. Students need to be involved in and assisted by their teachers in this process (Alexander, 2008). For learners to develop lifelong learning skills, we should encourage them to ask, check, explore and solve problems (Dike, 2000).

Table 14- presents the mean and standard deviation scores for the items on the assessment for learners' learning outcomes. Assessment for learners' learning outcomes was also investigated in this study. Out of 35 items in the instrument, nine items were constructed on the assessment for learners' learning outcomes.

During the validation of the instrument, all the nine items were loaded highly on one component, thereby retaining the items for the analysis.

Table 14- Mean and standard deviation scores on teachers' assessment of learning outcomes before classroom interaction

s/n	Items	N	Mean	St.
20	I base evaluation on instructional objectives	36	3.39	.549
21	I use different assessment strategies and tools appropriate for the content and learners	36	3.53	.774
22	I use appropriate questions	36	3.44	.809
23	I evenly distribute questions	36	3.64	.683
24	I react appropriately to learners' questions in the class	36	3.53	.560
25	I give constructive feedback to learners on their learning.	36	3.39	.871
26	I ask simple and direct question	36	3.53	.560
27	I allow learners to ask question	36	3.25	.770
28	I give learners assignments to finish at home to complement their learning	36	3.53	.560

Source: Field survey (Aliyu, 2019) Note: strongly disagree=1, Disagree=2, Agree=3 and strongly agree=4

Table 14 revealed the mean scores of the basic science teachers concerning their abilities to assess learners learning outcomes. The mean scores show that all the basic science teachers generally agreed on all the items chosen to measure the possession of teacher skills for assessment of learning outcomes. This is because the mean scores correspond to the agreed level in the four-point Likert scale used. However, this was not the case when classroom observations were made. Table 15 presents the mean and standard deviation scores for the items on the assessment for learners' learning outcomes observed during the lessons presented by ten basic science teachers.

Table 15- Mean and standard deviation scores for teachers' classroom observation on the assessment for learners learning outcomes during teacher-learner interaction

s/n	Items	N	Mean	Std.
20	Ability to base evaluation on instructional objectives	10	1.60	0.966
21	Ability to use different assessment strategies and tools appropriate for the content and learners	10	0.00	0.000
22	Ability to use appropriate questions	10	2.20	1.229
23	Ability to evenly distributes questions	10	1.90	1.197
24	Ability to react appropriately to learners' questions in the class	10	2.80	0.422
25	Ability to give constructive feedback to learners on their learning	10	0.00	0.000
26	Ability to ask simple and direct questions	10	2.40	0.966
27	Ability to allow learners to ask questions	10	2.80	0.422
28	Ability to give learners assignments to complement their learning	10	0.00	0.000

Source: Field survey (Aliyu, 2019) Note: Not observed= 0, observed once=1 observed twice=2 and observed thrice=3

The results in Table 15 show that the teachers could not use different assessment strategies and tools appropriate for the content and learners. Also, they could not give constructive feedback to learners on their learning as well as give learners assignments to complement their learning. The mean scores for these items were 0.0, implying that the activities were not observed in the three lessons. In addition, the teachers were in the following areas observed twice, ability to: use appropriate questions; to react appropriately to learners' questions in the class; to ask simple and direct questions; and to allow learners to ask questions in their lessons. However, the ability to base an evaluation on instructional objectives and the ability to evenly distribute questions in their lessons were observed once.

The refusal or inability to demonstrate any of the assessment skills during lessons might hinder learners' understanding of the lesson hence retracting learners' progress. It was also difficult for the teacher to examine themselves and give appropriate feedback. The majority of the teachers were not aware of the importance of assessment in learning, which must be demonstrated during lessons to assess learners' learning. Excellence teaching is improved by continuous evaluation of student learning (Hattie, 2003). Excellent assessment, therefore, includes tracking the learning outcomes of learners to define the shortcomings and strengths of learners and provide input to learners on their learning progress.

The results are not in accordance with Furtak et al., (2016) which claimed that teachers who have been able to plan quality training evaluation tasks and interpret ideas in line with the learning progress of their students at the same time demonstrate greater achievement. Assessment can be seen as an effective method to understand the ideas of learners and to track and evaluate learning. However, what is critical is the way teachers use this method (Black & Wiliam, 1998). Basic Science teachers should use different evaluation methods for different evaluation purposes (e.g. assessment for learning, assessment of learning, and assessment as learning) to provide learners with resources, interactions, and input that will improve their learning. The overall mean scores and standard deviations of the reported and observed lessons on the three sub-scales are shown in Table 16.

Table 16- Comparison between classroom observation and responses on the questionnaire

Category	Reported			Observed		
	N	Mean	Std.	N	Mean	Std.
Professional knowledge	36	3.4524	.37950	10	2.3571	.32472
Basic classroom skills	36	3.4848	.36558	10	2.0636	.23098
Assessment for learners' learning outcomes	36	3.4691	.29590	10	1.5222	.30112

Source: Field survey (Aliyu, 2019) Note: strongly disagree=1, Disagree=2, Agree=3 and strongly agree=4, Not observed= 0, observed once=1 observed twice=2 and observed thrice=3

Table 16 indicates the overall mean and standard deviation of reported and observed lessons of Basic Science teachers on the three sub-scales: professional knowledge, basic classroom skills, and assessment for learners' learning outcomes. The results show that all the mean scores of the reported questionnaire fall within the agreed level which represented a considerable presence of professional knowledge, basic classroom skills and assessment for learners' learning outcomes. This means that generally, basic science teachers agreed that they possessed all the knowledge and skills. But concerning the observed mean scores, the results indicated that the teacher's professional knowledge and basic classroom skills were observed twice. This means that almost all the teachers could only demonstrate the two sub-scales in their two lessons out of three lessons. However, assessment for learners learning outcomes was observed once. This is an indication that the majority of the basic science teachers did not possess the skill of assessment for learners' learning outcomes. Basic science teachers believed that they possess the measured qualities but could not demonstrate them practically (in their lessons), a worrisome situation. This situation would affect the quality of teaching and learning basic science and the objectives of basic science would not be realised.

Further descriptions and examples are illustrated in the interview with the zonal education directors, principals, and basic science teachers on their possessions of professional knowledge and skills. Reliable data was collected from these personalities concerning the professional competencies of the science teachers. The explanations given by the directors of zonal education and principals on the professional competence of teachers in teaching science are classified under this theme.

Theme: Teachers' professional knowledge and skills

Participants argued that under normal situations, a Basic Science teacher should be academically qualified, committed to teaching the subject, have knowledge of subject matter, knowledge of learners understanding, knowledge about instructional strategies and presentation for achieving the purpose and goals of science education. This knowledge could enable the teacher to consider learner characteristics and present an effective lesson, even if there were no adequate basic science teachers in the schools.

Teachers' knowledge of learners' understanding focused on learner characteristics. For the teaching of Basic Science to be effective, teaching must be within this characteristic (ability and experience of the learner). The participants' responses emphasised that the basic science teachers taught within these characteristics. However, one participant was of the view that teachers did not have enough knowledge to implement the basic science curriculum. Here are some responses obtained from participants to buttress this point, as shown in Table 17.

Table 17- Participants responses on professional knowledge, basic classroom skills and assessment for learners learning outcomes

Participant	Responses
Zonal Education Director 1	The teachers have to be professionally knowledgeable enough to teach each subject in science. They should teach within pupils' ability and experience to facilitate effective understanding in the field of science. Our teachers know what they are teaching; they can ask many questions during the lesson.
Zonal Education Director 2	Schools do not have adequate qualified, well-informed, skilful, and committed basic science teachers. But majority of those we have, they presented their lesson within learners understanding, manage their class during the lesson.
Principal 1	Teaching basic science requires qualified teachers to ensure effective instruction most teachers understand the curriculum and its content, so; my teachers use appropriate materials, give examples relevant to the content and learners learning need, and also link the content with the real situation.
Principal 2	Few of them are professional competence that they possess knowledge of instructional strategies while the majority are not professional competence or are not willing to show their commitment to their teaching.
Principal 3	With their qualification, they are professionally trained but, only a few can assess learners learning. Basic science teachers select and use appropriate instructional materials to present their lesson but there are some few problems with their assessment

Table 17- (Cont'd)

Participant	Responses
Principal 4	In all our science secondary schools, we do not have enough basic science teachers because if you acquire NCE/BSC(ED) in basic science a teacher cannot advance his carrier. So, people are running from that area of study. So virtually the number of teachers was very low. So, we have to engage other science teachers from physics, chemistry, biology, or even Agricultural Science to teach basic science. In implementing a basic science curriculum, the efficiency will be very low; hence, they did not have enough knowledge of how basic science curriculum should be taught, so there will be a problem with curriculum implementation
Principal 5	They are imparting the knowledge required, and they teach within pupils' limit

Source: Field survey (Aliyu, 2019)

Table 17 shows responses of zonal education directors and principals over the knowledge that teachers possess to teach basic science. Below are some of the responses from the participants:

Concerning the knowledge of the subject matter, participants emphasised that teaching Basic Science requires familiarity with scientific knowledge in the content where Basic Science teachers understand the facts and principles of science being taught. It allows the teacher to know the curriculum and how to teach it, present appropriate examples and select materials and method (s) better for the content to be learned.

Predominant method(s) of teaching teachers employ to teach basic science in junior secondary schools

As described in Chapter 3, interview and classroom observation data from ten teachers and interviews from two zonal education directors and five Principals were used. Many science teaching methods are used in the teaching and learning of Basic Science. To assist in the practice of knowledge transfer, Basic Science teachers should adapt acceptable teaching strategies that are ideally suited to particular goals and the level of learners. Table 18 presents the observed and reported teaching methods teachers employ in their teaching.

Table 18- Observed and reported methods of teaching used by the teachers

Teacher	Observed method	Reported method
A	Question and answer and demonstration methods	Discussion method
B	Question and answer and lecture methods	Lecture and discussion methods
C	Question and answer and lecture methods	Lecture method
D	Question and answer, demonstration and lecture methods	Discussion and demonstration methods
E	Question and answer and lecture methods	Discussion, Question and answer and lecture methods
F	Question and answer and demonstration	Teacher centred method
G	Question and answer and lecture methods	Lecture, discussion, and demonstration methods
H	Question and answer and demonstration	Question and answer and demonstration
I	Question and answer and demonstration methods	Lecture, demonstration, and discussion methods
J	Lecture method	Lecture method

Source: Field data (Aliyu, 2019)

Table 18 shows the observed and reported teaching methods teachers employ in their teaching. The selection of relevant teaching methods influences the teaching and learning of Basic Science. But it is unfortunate to note that science teacher educators may also participate in this practice of using poor teaching methods. In implementing the Basic Science curriculum objectives, appropriate teaching methods must be selected. Examples are guided discovery, inquiry, demonstration, scaffolding, role play, and cooperative learning. Table 19 presents the views of zonal education directors and principals on the methods of teaching employed by the Basic Science teachers in teaching basic science.

Table 19- Teaching methods used by Basic Science Teachers reported by Zonal Education Directors and Principals.

Interviewee	Methods of teaching
Zonal education director	Most teachers use traditional teaching methods like discussion methods, demonstration, lecture, method, etc.
Zonal education director	In most school's science teachers are using lecture methods.
Principal	Lecture method
Principal	Basic science teachers use the demonstration method in teaching
Principal	Demonstration and memorisation
Principal	The majority of basic science teachers use teacher-centred method e.g., lecture method
Principal	Demonstration, lecture method

Source: Field survey (Aliyu, 2019)

Table 19 shows the methods of teaching employed by Basic Science teachers as reported by zonal education directors and principals. It came to light that the methods of teaching used in most schools to teach basic science were lecture, demonstration, discussion, and memorisation methods.

The teaching of science has shifted from the teacher-centred method to the learner-centred method. The learner-centred method is an activity-based method where students interact in hands-on and minds-on experience that help to develop an interest in science and technology learning.

The classroom observation conducted in this study showed that almost all the teachers observed used unique methods of teaching (teacher-centred method) in all their lessons. It was observed that six teachers had adopted the use of the question-and-answer method, coupled with the lecture method (B, C, D, E, G, and J). Four teachers (A, F, H, and I) adopted the use of question-and-answer method coupled with the demonstration method in their teaching. Almost all teachers used the question and answer method to introduce their lesson. These teachers used teacher-centred methods that relied on clear teaching through lectures and teacher-led demonstrations. In more than a decade, Ahmad (2008) explained that the teaching method employed by most teachers is teacher-centred. Even though some used demonstration methods during their teaching they did not allow students to have details related to the skills being taught, and procedures were not presented systematically. Mkpa (2009) said the presentation method ensures that the learning materials, data and problems are introduced to the learner step by step, systematically and slowly. It involves discussions, questions and cues intended to direct the learner to move from one stage to the next, and offers input to the learner. In the demonstration process, the teacher should ask students questions to motivate them to participate in cognitive and psychomotor tasks, which in turn leads to a "movement response" shown by the students.

In comparing the observed methods of teaching used and the methods of teaching reported by teachers, zonal education directors, and principals, it was clear that basic science teachers predominantly use lecture method, question, and answer and demonstration methods. This finding is in agreement with Agbo, Kabang and Bash (2014) who reported that teaching basic science in schools is done through the lecture method as against the students' activity-oriented strategy. Furthermore, the predominant use of the lecture method disagrees with the view of the National

Commission for Colleges of Education (NCCE) (2002). One major problem of the teachers is that of the failure to use appropriate activity-based teaching strategies as spelt out in the basic science curriculum (Akbari & Allvar, 2010; Jekayinfa, 2007; Usman, 2007; 2010). Most of the teaching techniques employed have been identified as ineffective and boring (Ibe, 2004; Madu, 2004; Igboegwu, 2012).

Zonal education directors and principals believed that actual teaching and learning of basic science depends on the method of teaching employed by the teachers for effective instruction. The best teaching technique helps learners to understand and apply knowledge. Learners must know how and where to use the experiences and skills they have gained to describe their surroundings, as well as solve their personal or societal problems. But many learners faced challenges with inappropriate methods of teaching used by their teachers.

The learners observed were viewed uniquely as the receptors of knowledge and information. Teachers have been found to work in a particular template style (those that set an example). These teachers have taught students how to view and interpret knowledge. As a result, students learned by watching and copying the teaching method.

Instructional materials teachers employ to teach basic science in junior secondary schools

Classroom observation data from ten teachers and interview data from two zonal education directors, five principals, and 10 learners were used. The Basic Science curriculum described instructional materials for teaching as all those things, objects, materials, persons, and features that teacher need in doing an excellent job of teaching (Federal Ministry of Education, 2007). The curriculum also spelt out some instructional materials appropriate for teaching each topic. Therefore, there is a need for every teacher to select and use appropriate instructional materials for his/her lesson to connect. students' interests with the concept being taught. Table 20 presents instructional materials used in teaching, as mentioned by Zonal Education Directors, Principals, and learners during the interview.

Table 20- Instructional materials used in teaching reported by Zonal directors, Principals and learners

Participant	Instructional materials
Zonal education director	Chart, drawing, models, and real objects
Zonal education director	Charts
Principal 1	Specimen and model
Principal 2	Charts and drawings
Principal 3	Charts, drawing on chalkboard
Principal 4	Picture charts
Principal 5	Charts
Learner 1	Textbooks
Learner 2	Skeleton, charts, drawing, onboard and physical object
Learner 3	No instructional materials use
Learner 4	No instructional materials use
Learner 5	Pictures, drawing
Learner 6	Chart and model
Learner 7	Drawing on cardboard paper and charts
Learner 8	A physical object, picture, and chart

Table 20- (Cont'd)

Participant	Instructional materials
Learner 9	phone, picture, students, drawing, and laboratory materials
Learner 10	Drawing, chart, physical sample like soil, stone

Source: Field survey (Aliyu, 2019)

Table 20 shows the responses from participants during the interview conducted with regard to the instructional materials teachers employ in teaching basic science in junior secondary schools. A look at the table shows that basic science teachers employed charts, drawings, models, real objects, specimens, pictures, skeleton, phone, students, laboratory materials, soil and stone in their teaching. Two students mentioned that their teachers were not using any instructional materials during their teaching.

The interview conducted with the principals and zonal education directors revealed that there were not enough instructional materials in the schools.

"Government now is not providing the instructional materials; therefore, no enough materials and some teachers cannot improvise. So, they use the few that they have, mostly charts as said by zonal education director." One among the principal said there were not enough instructional materials, but the few we have our basic science teachers use them like picture charts, etc. Another principal also said Basic science teachers select and use appropriate instructional materials to present their lesson, but there are some few problems with their assessment. The researcher also conducted classroom observations. The results of the observations have been summarised in Table 21.

Table 21- Instructional materials used by the teachers in the observed lessons

Teacher	lesson observed	Topic	Instructional materials used
A			
	Lesson 1	Matter	Stone, water, and empty nylon filled with air
	Lesson 2	Matter	Stone, kerosene, and balloons
	Lesson 3	Matter	Stone, water, and empty nylon filled with air
B			
	Lesson 1	Branches of science	Stone desk and chart
	Lesson 2	Vectors quantity	Nil
	Lesson 3	Nutrition	Nil
C			
	Lesson 1	Digestive system	Chart
	Lesson 2	Sense organs	Drawings on cardboard paper
	Lesson 3	Water pollution	Pictures on calendar
D			
	Lesson 1	Energy	Solar panel, florescent
	Lesson 2	Air pollution	Diagrams
	Lesson 3	Sound	Speaker, teacher's voice
E			
	Lesson 1	Nutrition	Nil
	Lesson 2	Soil	Soil samples
	Lesson 3	Pollution	Nil
F			
	Lesson 1	Skeleton system	Nil
	Lesson 2	Sound	Nil
	Lesson 3	Elasticity	Rubber band
G			
	Lesson 1	Type of friction	Two pieces of wood, bolt, and nut, shoe brake
	Lesson 2	Machine	Nil
	Lesson 3	Force	Nil
H			
	Lesson 1	Thermal energy	Source of heat, spoon
	Lesson 2	Friction	Drawing on board
	Lesson 3	Adv &dis adv of friction	Lubricating oil

Table 21- (Cont'd)

Teacher	lesson observed	Topic	Instructional materials used
I			
	Lesson 1	Sense organ	Drawing on a cardboard paper, himself
	Lesson 2	State of matter	Water, stone, stick, pen
	Lesson 3	Sources of food	Nil
J			
	Lesson 1	State of matter	Stone water and empty nylon
	Lesson 2	Nutrition	Biscuit and water
	Lesson 3	Carbohydrate	Rice and cassava

Source: Field survey (Aliyu, 2019)

Table 21 shows the observed instructional materials used in the lessons of different topics across basic science curriculum in JSS1, JSS 2 and 3. It was observed that the instructional materials selected and used by the teachers in their teaching were appropriate. The selection of relevant materials influences the teaching and learning of Basic Science even though out of the 10 teachers observed, only five teachers (A, C, D, H, and J) had selected and used instructional materials for the three lessons observed. One teacher (I) selected and used instructional materials for the two lessons, and four teachers (B, E, F, and G) selected and used instructional materials for only one lesson. Therefore, a total of five teachers taught different topics without the use of instructional materials in their teaching. It can be argued the Basic Science teachers, to some extent, employed instructional materials in their teaching. However, there were some lessons that they did not use the instructional materials in teaching.

The data collected show that there were very few instructional materials available in the schools to be used in teaching basic science. Most of these instructional materials used by teachers in their lessons, as shown in Table 21, are provided by either teachers or students from their local environment. These materials include kerosene, balloons, calendar, solar panel, florescent, speaker, rubber band, wood, bolt and nut, shoe brake, spoon, lubricating oil, stick, pen, biscuit, rice and cassava. Out of these materials, the only available ones in these schools are charts, drawings on a cardboard paper, a source of heat, models and laboratory materials. It can be concluded that instructional materials available for the implementation of Basic Science programmes in Kebbi State were not adequate. Therefore, schools were poorly equipped with instructional materials, and those available were poorly maintained as observed and also stated by some teachers.

The findings corroborated with those of Taiwo (2008) who found that many schools were not equipped with enough instructional materials. Ajayi and Ayodele (2001) recognised the necessity of the provision of instructional materials to accomplish productivity in the development and management of education in the school system. The inadequate availability of these instructional materials in the basic schools may therefore hinder the effective delivery of Basic Science education.

Materials in the science laboratories for teaching basic science practical lessons in junior secondary schools

Observations were conducted in all the science laboratories in the schools under study. The observations were carried out by making use of structured observation, which involved the use of LARSEOC. There was no separate basic Science laboratory in all the schools under study but, there was Biology, Chemistry, and Physics laboratories. Therefore, apparatus, reagents, and safety equipment that were needed to be used in teaching basic science were observed. The class size, the number of each item and the state of all reagents were also noted. Table 22 presents the frequencies and percentages of the required science laboratory material/equipment for basic science practical lessons.

Table 22- Number of required Science Laboratory Material/Equipment for Basic Science Practical Lesson (N= 59)

Schools	Available	Not available
	N (%)	N (%)
Yag	35 (59.3)	24 (40.7)
Sat	46 (77.9)	13 (22.0)
Kos	29 (49.2)	30 (50.8)
Zas	36 (61.0)	23 (39.0)
Rig	37 (62.7)	22 (37.3)
Zat	22 (37.3)	37 (62.7)
Nab	27 (45.8)	32 (54.2)
Sok	35 (59.3)	24 (40.7)
But	34 (57.6)	25 (42.4)
Dag	39 (66.1)	20 (33.9)
Das	45 (76.3)	14 (23.7)
Gun	35 (59.3)	24 (40.7)
Sab	42 (71.2)	17 (28.8)
Bas	31 (52.5)	28 (47.5)
Asa	42 (71.2)	17 (28.8)

Source: Field survey (Aliyu, 2019)

Table 22 shows that only three out of 15 schools in this study were inadequately equipped with the required laboratory materials and equipment for Basic Science lessons (37.3%), (45.8%) and (49.2%). As also seen in this table, 12 schools were adequately equipped with the required laboratory materials for Basic

Science lessons with the percentages above fifty percentages. Even though the schools were adequately equipped with the required laboratory materials and equipment for a basic science lesson, only three teachers were using the laboratory space for basic science lessons only without carrying out practical lessons. Table 23 below presents the available apparatus, reagents, safety equipment, class size and the number of items available in each school.

Table 23- Common available apparatus, reagents, safety equipment, class size and number of items available in all science laboratories

Class size No. of items available in each school Apparatus	45 Yag	40 Sat	50 Kos	50 Zas	50 Rig	50 Zat	50 Nab	45 Sok	50 But	50 Dag	50 Das	50 Gun	40 Sab	40 Bas	50 Asa
1. Beaker	100	65	500	80	16	20	250	20	20	103	22	50	50	50	80
2. Bunsen burner	20	10	20	18	4	9	10	9	10	27	10	20	5	5	50
3. Pipette	10	25	300	20	2	9	120	12	20	35	11	20	3	7	25
4. Test tube	100	40	400	100	150	120	320	16	150	14	80	100	50	100	300
5. Magnifying glass	10	2	20	30	1	3	2	3	2	4	8	4	5	2	15
6. Test tube clamp	30	12	14	70	2	10	22	6	40	9	5	35	25	20	25
7. Litmus paper (blue/red strips)	5 Ps*	3 Ps	10 Ps	40 Ps	2 Ps	1 p*	3 Ps	2 Ps	5 Ps	4 Ps	2 Cs*	25 Ps	2 Ps	20 Ps	10 Ps
8. Filter paper	6 Ps	5 Ps	50 Ps	2 Ps	2 Ps	2 Ps	2 Ps	2 Ps	2 Ps	4 Ps	2 Cs	30 Ps	1 P*	20 Ps	2 Ps
9. Light bulb	3	20	50	50	2	4	23	4	8	3	12	5	3	6	25
10 Wire gauze	1	6	15	17	4	8	15	6	5	7	21	6	4	7	1
11 Spatula spoon	2	7	10	50	4	6	6	3	3	4	8	2	3	6	1
12 Burette	10	16	250	50	6	11	85	12	8	40	19	20	6	7	50
13 Retort stand	10	10	20	13	4	5	260	2	21	23	25	10	50	3	50

Table 23- (Cont'd)

Class size No. of items available in each school	45	40	50	50	50	50	50	45	50	50	50	50	40	40	50
	Yag	Sat	Kos	Zas	Rig	Zat	Nab	Sok	But	Dag	Das	Gun	Sab	Bas	Asa
Reagents															
14 Indicators (e.g. methyl orange, phenolphthalein)	4 Bs*	2 Bse*	3 Bs	20 Bs	2 Bse	1 Be*	3 Bs	1 Be	3 Bs	1 Be	2 Bs	3 Bs	1 Be	2 Bs	1 Be
15 Acids solution (e.g HCl, HNO_3, H_2SO_4)	1 Be	1 Be	1 Be	30 Bs	4 Bs	1 Be	1 Be	1 Be	1 Be	1 Be	2 Bse*	1 Be	1 Be	1 Be	1 Be
16 Base solutions (e.g NaOH, $NH_{3(aq)}$)	2 Bse	1 Be	1 Be	20 Bs	2 Bse	1 Be	1 Be	1 Be	2 Bse	1 Be	2 Bse	2 Bse	1 Be	3 Be	1 Be
17 Salts (e.g NaCl, Na_2CO_3, $CaCO_3$)	2 Bse	1 Be	1 Be	30 Bs	2 Bs	1 Be	1 Be	1 Be	2 Bs	1 Be	2 Bse	5 Bs	1 Be	2 Bs	1 Be
Safety equipment															
18 First-aid cabinet	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

Source: Field survey (Aliyu, 2019) Be*= Bottle each, Bs*= Bottles, Bse*=Bottles each, Cs*= Cartons, P*= Pocket and Ps*=Pocket

Table 23 shows the apparatus, reagents and safety equipment for teaching Basic Science found available in the science laboratories during the observation. The observation results indicated that thirteen apparatus out of the forty-eight earlier listed in the LARSEOC (see Appendix C) were found available in all schools. These are beaker, bunsen burner, pipette, test tube, magnifying glass, test tube clamp, litmus paper (blue/red strips), filter paper, light bulb, wire gauze, spatula spoon, burette, and retort stand. Regarding class size, it was observed that the number of students in each class in school Sat, Sab, and Bas was 40 each. School Yag and Sok have 45 students each in the class and school Kos, Zas, Rig, Zat, Nab, But, Dag, Das, Gun and Asa have 50 students each in the class. When correlating the number of students with the available apparatus in each school, it was found that all available apparatus was not enough for the students during practicals. For example, in school Rig, Zat, and But, only a test tube was enough for their students while school Dag had only beakers insufficiency. School Sok had no available apparatus in enough quantities for their use.

Out of the eight reagents recorded in the LARSEOC (see Appendix C), four were found available in all schools. These are indicators (e.g. methyl orange, phenolphthalein), acids solutions (e.g HCl, HNO_3, H_2SO_4), base solutions (e.g NaOH, $NH_3(aq)$) and salts (e.g NaCl, Na_2CO_3, $CaCO_3$). These reagents were enough for a series of practicals. But after the observation, some teachers confirmed that most of these reagents were expired.

As shown in Table 23, there was only one safety equipment (first aid cabinet) available in all the schools out of the three listed in the LARSEOC (see

Appendix C). Table 22 shows that most of the school laboratories were adequately equipped with the required materials/ equipment for teaching basic science practical lessons. Even though most of the laboratories were equipped, not all required apparatus, reagents, and safety equipment were available in all schools. But little was commonly available, although they are not enough for the leaners. Nevertheless, no practical work was carried out in any of the schools. The implication was that teachers had failed to convey the spirit of science to the fundamental science education goal and to ensure that students learn the method skills of science (Zengele & Alemayehu, 2016).

The finding is in harmony with the conclusion of Na'Allah (2016), who observed that most Basic Science teachers do not regularly carry out practical work during the teaching of basic science. This affects the performance of Basic Science learners because they are not exposed to scientific knowledge and skills acquired from the use of relevant laboratory materials in learning basic science. If theoretical knowledge of science is not supported by practical work, then, science teaching and learning is incomplete. According to Hofstein (2017), Laboratory seems to be the only room in the school in which certain types of skills and ability can be created. Laboratory instruction is an essential means to provide training that requires observation, detailed information and arousal of learner's interest. Working in the science laboratory provides students with the opportunity to practise science to have the richest experience that will be transferred to society as well as to their places of work. Therefore, equipping laboratories and exposing students to practical work enables students to be familiar with the science laboratory materials, understand how to experiment, and its purpose for a better understanding of the concepts. The use of the guided investigation approach for teaching and learning is suggested in the activities prescribed under each topic to facilitate the development of skills learning (Federal Ministry of Education, 2007). Therefore, Basic Science teaching should involve practical work since it is an essential ingredient to science education. Many researchers have reported that if the amount of practical work increases the quality of science subjects and students' achievement will increase (Zengele & Alemayehu, 2016).

Domains of learning in the basic science curriculum

Table 24 shows the levels of learning domains in performance objectives among the themes in the curriculum.

Table 24- Frequency distribution of domains of learning in performance objectives of JSS 1 basic science curriculum

Domains of learning	Level	Themes 1*	2*	3*	4*	Total N (%)
Cognitive						
	Knowledge	13	8	2	2	25(34)
	Comprehension	20	5	5	11	41(56)
	Application	1	0	0	0	1(1)
	Analysis	1	1	0	0	2(3)
	Synthesis	1	3	0	0	4(6)
	Evaluation	0	0	0	0	0(0)
Affective	Receiving	0	0	0	0	0(0)
	Responding	0	0	0	0	0(0)
	Valuing	0	0	0	0	0(0)
	Organisation	0	0	0	0	0(0)
	Characteristic of value	0	0	0	0	0(0)
Psychomotor	Observation	0	0	0	0	0(0)
	Imitation	0	0	0	0	0(0)
	Practicing	0	0	0	0	0(0)
	Adapting	0	0	0	0	0(0)
Total		36	17	7	13	73

Source: Field survey (Aliyu, 2019) 1*= You and environment, 2*= Living and non-living, 3*= Science and development, 4*= You and energy

There are 73 performance objectives stated in the cognitive domain of learning across the four themes in the JSS 1 Basic Science curriculum and no performance objectives on the affective and psychomotor domain of learning (Table 24). Based on Table 24 the results obtained from the analysis of performance objectives indicate that the *application* level of the cognitive domain was not involved in themes 2, 3, and 4 but involved in theme 1 presented by 1%. Similarly, *analysis* and *synthesis* levels were also not involved in themes 3 and 4. But *analysis* managed to have 3% and *synthesis* presented by 6%. However, the *evaluation* was not involved in all the themes with 0%. Also, 56% of stated objectives focused on *comprehension* and 34% of the stated objectives were on learners' ability to remember what has been learned. From this table based on figures and percentages, it was found that the stated objectives were directed toward a lower level of thinking. Table 25 presents the distribution of learning domains in the evaluation guide of the JSS 1 basic science curriculum.

Table 25- Frequency distribution of domains of learning in an evaluation guide of JSS 1 basic science curriculum

Domains of learning	Level	Themes 1*	2 *	3*	4*	Total N (%)
Cognitive						
	Knowledge	15	8	1	1	25(33)
	Comprehension	22	5	6	15	48(63)
	Application	1	0	0	0	1(1)
	Analysis	0	0	0	0	0(0)
	Synthesis	1	1	0	0	2(3)
	Evaluation	0	0	0	0	0(0)
Affective	Receiving	0	0	0	0	0(0)
	Responding	0	0	0	0	0(0)
	Valuing	0	0	0	0	0(0)

Table 25- (Cont'd)

Domains of learning	Level	Themes 1*	2 *	3*	4*	Total N (%)
	Organization	0	0	0	0	0(0)
	Characteristic of value	0	0	0	0	0(0)
Psychomotor	Observing	0	0	0	0	0(0)
	Imitation	0	0	0	0	0(0)
	Practicing	0	0	0	0	0(0)
	Adapting	0	0	0	0	0(0)
Total		39	14	7	16	76

Source: Field survey (Aliyu, 2019) 1*= You and environment, 2*= Living and non-living, 3*= Science and development, 4*= You and energy

There are 76 cognitive processes across the 4 themes in the evaluation guide of the JSS 1 basic science curriculum. Table 25 shows there was no question on the evaluation level of the cognitive process of learning across the 4 themes in the evaluation guide. The evaluation guide did not contain any affective and psychomotor domains of learning in all the 4 themes. The percentage of application-level contained in the evaluation guide was 1% and the *synthesis* level was 3%. However, 63% out of the total questions asked in the evaluation guidelines of the curriculum solicited learners' understanding of the learning concept, and 33 % elicited learners remembering what they have learned. Erinosho and Badru (2000) found that the cognitive domain is relevant and the easiest domain to measure relevant school subjects. It was discovered that about 96% of the questions asked in the evaluation guide focused on lower-level thinking.

Table 26 shows the distribution of the learning domains in the activities across the themes in a basic science curriculum.

Table 26- Frequency distribution of domains of learning in activities of JSS 1 Basic Science curriculum

Domains of learning	Level	Themes *1 *T	*1 *S	*2 T	*2 S	*3 T	*3 S	*4 T	*4 S	Total N (%) T	Total N (%) S
Cognitive											
	Knowledge	5	3	1	0	1	1	0	2	7(11.7)	6(28.6)
	Comprehension	8	1	5	0	3	0	4	2	20(33.3)	3(14.3)
	Application	11	1	2	0	4	0	5	2	22(36.7)	3(14.3)
	Analysis	0	0	0	1	0	0	1	1	1(1.6)	2(9.5)
	Synthesis	6	3	3	4	0	0	1	0	10(16.7)	7(33.3)
	Evaluation	0	0	0	0	0	0	0	0	0(0.0)	0(0.0)
Total		30	8	11	5	8	1	11	7	60	21
Affective											
	Receiving	1	3	0	0	0	0	0	0	1(25.0)	3(12.5)
	Responding	0	9	0	3	0	4	0	3	0(0.0)	19(79.1)
	Valuing	0	0	0	0	0	0	3	0	3(75.0)	0(0.0)
	Organization	0	1	0	0	0	0	0	0	0(0.0)	1(4.2)
	Characteristic of value	0	1	0	0	0	0	0	0	0(0.0)	1(4.2)
Total		1	14	0	3	0	4	3	3	4	24
Psychomotor											
	Observing	0	6	2	5	0	2	0	0	2(75.0)	13(56.5)
	Imitation	0	2	0	3	0	1	0	0	0(0.0)	6(26.1)
	Practicing	0	0	0	0	0	2	0	2	0(0.0)	4(17.4)
	Adapting	0	0	0	0	0	0	1	0	1(25.0)	0(0.0)
Total		0	8	2	8	0	5	1	2	3	23

Source: Field survey (Aliyu, 2019) *1= You and environment, *2= Living and non-living, *3= Science and development, *4= You and energy, *T=teacher, *S=student

There are 81 cognitive processes in the activities of the JSS 1 basic science curriculum. Out of these activities, 60 were teachers' activities, and 21 were students' activities. Most of the activities focused on the *comprehension* and *application* of cognitive processes. The percentages of these two levels of a cognitive domain are 33.3% and 36.7%, whereas the *knowledge* cognitive process was presented by 11.7% and *synthesis* was presented by 16.7%. In students' activities, *comprehension* and *application* cognitive processes are each represented with 14.3%. The *synthesis* was 33.3%, *knowledge* 28.6%, and the *evaluation* cognitive process was not involved in teachers' and students' activities across the themes. Based on Table 26, the total percentages that focused on the lower thinking level in the acquisition of scientific knowledge and skills in teachers' activities were 81.7% and in students' activities were 57.2%. However, 18.3% of the total teachers' activities and 42.8% of the total students' activities focused on higher thinking skills. This means that students were introduced into the acquisition of knowledge and skills beyond the application of knowledge. This shows that learners can develop cognitive and science process skills enough to be used in daily life.

There are 28 affective domains of the learning process distributed in the activities of the JSS 1 Basic Science curriculum. Out of these activities, four were in teachers' activities and 24 in students' activities. Table 26 shows that the affective domain in teachers' activities covered only *receiving* and valuing affective domain processes. The percentage of *receiving* level contained in the teacher's activities is one (25%) and *valuing* level three (75%). This means that teachers' activities focused on higher-order levels of an affective domain where teachers should develop the students' ability to judge the learned materials and express his/her belief from simple to complex in the democratic process. Furthermore, in students' activities, the percentage of involvement of *responding* was 19 (79.1%), receiving was three (12.5%) whereas the *characterization* of *value* and organization has 1(4.2%) each. *Valuing* was not involved in all the activities. To sum up, *receiving* and *responding* 91.6% of the student's activities gave to a lower level and only 8.4% to a higher level.

Table 26 also shows that there are 26 levels of the psychomotor domain highlighted in the activities within and across the themes. The result indicated that three out of 26 levels of the psychomotor domain were mentioned in teachers' activities and 23 were mentioned in students' activities. In the teacher's activities, the observing level was presented by 75.0% and 25.0% presenting the adapting level of the psychomotor processes in teachers' activities. *imitation* and *practising* levels of the psychomotor domain were not involved in all the themes in the teachers' activities. Table 26 shows that in students' activities of the JSS 1 Basic Science curriculum the observing level was represented by 56.5%, the *imitating* level has 26.1%, and the *practising* level has 17.4% whereas the *adapting* level was not mentioned in students' activities.

It was observed in the Basic Science curriculum that objectives are linked with the evaluation guide. Achievement of objectives can be measured by assessing learning at the end of the lesson or during the lesson. The findings in Tables 24, 25, and 26 in respect of the cognitive domain have shown that much emphasis was given to lower-order thinking, specifically in knowledge and comprehension, more than the higher-order thinking. This means that the JSS 1 curriculum deals with simple knowledge acquisition where learners recall, list, memorise, and repeat information. Less opportunity was given to learners to build their mental structure as well as making judgements about the value of the ideas, which necessitate some skills that go far beyond the mastering of the lowest level. Even though there is a correlation between both the lower and higher levels, the former facilitates the creation of actual information and lays the foundation for the achievement of high thinking abilities whilst the latter encourages thought and the development of other cognitive skills. Here are several priorities that mention the degree of cognitive scope in the JSS 1 basic science curriculum.

a. Identify the components of the solar system; (lower level, knowledge)
b. Explain the rotation and revolution of the earth and the moon; (lower level, comprehension)
c. Illustrate the eclipse of the sun and the moon. (lower level, application)
d. Compare the rotation and revolution of the earth and the moon (higher level, analysis)
e. Collect and assemble the plants and animals' sample (higher level, synthesis)

Activities in the curriculum were designed for teachers and learners on what should be done in each topic to achieve the performance objectives stated. I believe that if teachers coordinate various activities properly, learners learning will be better. These activities were distributed among Bloom's taxonomy, Krathwohl's taxonomy and a synthesis of the taxonomies of Simpson, Dave and Harrow to test the knowledge, skills, and attitudinal requirement for learners to interpret their environment as well as solve their problem or problems in the society. Teachers engaged students in activities that require higher cognitive skills; for example, process skills to increase their problem-solving skills. Basic science process skills can be taught, learned and transferred to new situations (Aldous, 2005). The findings in

Table 26 on the affective domain processes revealed that learners were allowed to actively participate in class discussion, question new ideas and engaged in other activities during the lesson. These will ensure learners' interest and develops their attitude toward the study of science. Here are some sample excerpts from JSS 1 Basic Science curriculum.

a. Participate in discussions and draw life cycles of vectors.

b. Partake in the demonstration of control measures.

c. Practice setting up balanced and unbalanced forces.

However, integrating the Basic Science process skills will gradually develop learner abilities to acquire skills in the context of the curriculum content that can be remembered and apply in daily life. Table 26 shows that learners were given a high opportunity of observing experience person or other mental activity in both teachers' and students' activities. The observation level of the psychomotor domain is the basic competence of the science process which was important to the growth of the other skills of the science process. This is how we learn about the world around us. Bağcı-Kılıç cited in Yilmaz (2013) found that observation of changes that occur in objects or activities, the collection of information to make decisions are the science process skills used in everyday life experiences. However, the procedure of developing science process skills, solving problems and altering connections and attitudes are dynamic. Though the opportunity for learners to adjust in the physical activity to become perfect in the curriculum was not mentioned, it was concluded that in both teachers' and students' activities, much emphasis was given to lower levels of the psychomotor domain. Table 27 below presents the integration of learning domains in JSS1 basic science curriculum

Table 27- Integration of learning domains in JSS 1 Basic Science curriculum

Domain	Lower level/ No. (%)	High level/ No. (%)	Total No. (%)
Cognitive domain	198 (87.2)	29 (12.8)	227(100)
Affective domain	23 (82.1)	5 (17.9)	28(100)
Psychomotor domain	21 (80.8)	5 (19.2)	26(100)

Source: Field survey (Aliyu, 2019)

The findings in Table 27 show the lower and higher-order cognition levels of Bloom's taxonomy, Krathwohl's taxonomy, and a synthesis of the taxonomies of Simpson, Dave, and Harrow as it is distributed in JSS 1 Basic Science curriculum. It can be seen in Table 27 that out of 227 items set to assess the cognitive processes in performance objective, evaluation guide, and activities, about 87.2% representing 198 items focused lower cognition levels and 12.8% representing 29 items focused higher-order cognition level of Bloom's taxonomy. Therefore, this has indicated that the majority of the items assessed student's mental ability at lower levels. Concerning the affective domain, out of 28 items set in the activities of the JSS1 Basic Science curriculum, 82.1% representing 23 items were involved in assessing the lower-order level and 17.9% representing five items focused on the higher-order level of the affective domain. Therefore, the affective domain used to plan activities in this curriculum also was directed toward a lower-order level of students' development of attitude. Table 27 also shows that 26 psychomotor domain processes set in the activities of the JSS 1 Basic Science curriculum, 21 representing 80.8% focused on lower/ basic process skills (observing and imitating) while five items representing 19.2% focused on higher/integrated process skills (practising and adapting) represent 19.2%.

It was found that lower-order thinking skills were the dominant thinking skills used in the JSS1 Basic Science curriculum. Also, lower-order thinking skills in Bloom's taxonomy have the highest percentage between the domains of learning. This means that Blooms' taxonomy was used more than any other taxonomies within the same lower level. Therefore, classroom instruction and assessment of learning focused on lower-order thinking skills that do not go beyond remembering, understanding, and applying knowledge and skills. It seems that instruction assessment has always placed more emphasis mostly on a low level of thought (Eshun & Mensah, 2013). Table 28 presents the distribution of learning domains in the performance objectives of the JSS 2 Basic Science curriculum.

Table 28- Frequency distribution of domains of learning in performance objectives of JSS 2 Basic Science curriculum

Domains of learning	Level	Theme *1	*2	*3	4	Total N (%)
Cognitive						
	Knowledge	14	18	1	3	36(39.1)
	Comprehension	7	15	7	20	49(53.2)
	Application	0	2	0	1	3(3.3)
	Analysis	1	0	0	1	2(2.2)
	Synthesis	0	2	0	0	2(2.2)
	Evaluation	0	0	0	0	0(0.0)
Affective	Receiving	0	0	0	0	0(0.0)

Table 28-(Cont'd)

Domains of learning	Level	Theme *1	*2	*3	4	Total N (%)
	Responding	0	0	0	0	0(0.0)
	Valuing	0	0	0	0	0(0.0)
	Organisation	0	0	0	0	0(0.0)
	Characteristic of value	0	0	0	0	0(0.0)
Psychomotor	Observing	0	0	0	0	0(0.0)
	Imitation	0	0	0	0	0(0.0)
	Practicing	0	0	0	0	0(0.0)
	Adapting	0	0	0	0	0(0.0)
Total		22	37	8	25	92

Source: Field survey (Aliyu, 2019) *1= You and environment, *2= Living and non-living, *3= Science and development, *4= you and energy

There are 92 cognitive processes distributed in the performance objective of the JSS 2 basic science curriculum. Comprehension level has 53.2% of items stated in the performance objectives, and 39.1% represented the knowledge level. The evaluation process of the cognitive domain was not stated in the performance objectives. Analysis and synthesis levels were each represented by 2.2%. This result indicates that there are many lower levels of thinking than a high level of thinking in the performance objectives of the JSS 2 basic science curriculum. Table 29 presents the distribution of domains of learning in an evaluation guide of the JSS 2 Basic Science curriculum.

Table 29- Frequency distribution of domains of learning in evaluation guide of JSS 2 basic science curriculum

Domains of learning	Level	Theme *1	*2	*3	*4	Total N (%)
Cognitive						
	Knowledge	10	17	6	4	36(40.0)
	Comprehension	11	20	3	18	52(58.0)
	Application	0	1	0	1	2(2.0)
	Analysis	0	0	0	0	0(0.0)
	Synthesis	0	0	0	0	0(0.0)
	Evaluation	0	0	0	0	0(0.0)

Table 29- (Cont'd)

Domains of learning	Level	Theme *1	*2	*3	*4	Total N (%)
Affective	Receiving	0	0	0	0	0(0.0)
	Responding	0	0	0	0	0(0.0)
	Valuing	0	0	0	0	0(0.0)
	Organisation	0	0	0	0	0(0.0)
	Characteristic of value	0	0	0	0	0(0.0)
Psychomotor	Observing	0	0	0	0	0(0.0)
	Imitation	0	0	0	0	0(0.0)
	Practicing	0	0	0	0	0(0.0)
	Adapting	0	0	0	0	0(0.0)
Total		21	38	9	23	90

Source: Field survey (Aliyu, 2019) *1= You and environment, *2= Living and non-living, *3= Science and development, *4= You and energy

Table 29 shows 90 cognitive processes distributed in the evaluation guide of the JSS 2 Basic Science curriculum within the themes. Knowledge and comprehension were the main cognitive processes emphasised in the evaluation guidelines of the curriculum. This shows that *comprehension* has 58%, and *knowledge* has 40%. The percentage recorded on questions assessing *application* level in the evaluation guide of JSS 2 basic science curriculum is 2%**.** No question was set to assess *analysis*, *synthesis*, and *evaluation* levels. Therefore, only items that covered lower-level thinking were involved. Also, there was no question on affective and psychomotor domains of learning in the evaluation guide of the JSS 2 Basic Science curriculum. Table 30 deals with the distribution of learning domains in the activities of the JSS 2 Basic Science curriculum.

Table 30- Frequency distribution of domains of learning in the activities of JSS 2 Basic Science curriculum

Domains of learning	Level	Themes *1 *T	*1 *S	*2 T	*2 S	*3 T	*3 S	*4 T	*4 S	Total N (%) T	Total N (%) S
Cognitive											
	Knowledge	0	0	6	7	0	1	2	3	8(11.6)	11(36.7)
	Comprehension	7	1	15	5	2	0	12	1	36(52.2)	7(23.3)
	Application	4	1	7	2	1	1	3	3	15(21.7)	7(23.3)
	Analysis	0	0	0	0	0	0	3	1	3(4.3)	1(3.3)
	Synthesis	2	0	2	4	0	0	3	0	7(10.1)	4(13.3)
	Evaluation	0	0	0	0	0	0	0	0	0(0.0)	0(0.0)
Total		13	2	30	18	3	2	23	8	69	30
Affective											
	Receiving	0	2	0	0	2	0	0	0	2(50.0)	2(5.4)
	Responding	0	6	0	11	0	3	0	10	0(0.0)	30(81.1)
	Valuing	0	0	0	3	0	0	0	1	0(0.0)	4(10.8)
	Organisation	1	0	0	0	0	0	0	0	1(25.0)	0(0.0)
	Characteristic of value	0	0	1	1	0	0	0	0	1(25.0)	1(2.7)
Total		1	8	1	15	2	3	0	11	4	37
Psychomotor											
	Observing	0	2	0	3	0	0	0	2	0(0.0)	7(38.9)
	Imitation	0	3	0	0	0	0	0	0	0(0.0)	3(16.7)
	Practicing	0	0	1	4	0	0	1	2	2(50.0)	6(33.3)
	Adapting	1	1	1	0	0	0	0	1	2(50.0)	2(11.1)
Total		1	6	2	7	0	0	1	5	4	18

Source: Field survey (Aliyu, 2019) *1= You and environment, *2= Living and non-living, *3= Science and development, *4= You and energy, *T=Teacher and *S=Student

In Table 30 there are 69 cognitive processes in teachers' activities and 30 cognitive processes in students' activities that summed up to 99 cognitive processes in the activities of the JSS 2 Basic Science curriculum. Table 30 indicated that in teachers' activities, *comprehension* level was 36(52.2%), *application*-level with 15(21.7%), *knowledge* level 8(11.6%), *synthesis* level has 7(10.1%), and then *analysis* level with 3(4.3%). Likewise, in students' activities, *comprehension* and *application* recorded 7(23.3%) each, *knowledge* level 11(36.7%), *synthesis* 4(13.3%), and *analysis* level had 1(3.3%). The *evaluation* level was not mentioned in the activities. In both activities, the emphasis was made on lower levels of the cognitive domain than a higher level of the cognitive domain.

Table 30 also shows that there were four levels of the affective domain in teachers' activities and 37 in students' activities distributed across the themes. Out of four levels in teachers' activities, two were mentioned in the *receiving* level, and one each was mentioned in the *organisation* and *characterisation of value*, respectively. Out of 37 levels of the affective domain in students' activities, 30 were involved in the *responding* level, four in *valuing* level, two were mentioned in *receiving* level, and one at the *characterisation of value* of the affective domain. It shows that much attention was given to lower levels of the affective domain than a higher level.

Besides, there were four psychomotor domain levels in teachers' activities and 18 in students' activities of the JSS 2 Basic Science curriculum. In teachers' activities, two activities were involved in the *practising* level, and also two activities were mentioned in the *adapting* level of the psychomotor domain. Whereas in students' activities of the JSS 2 basic science curriculum, six activities were mentioned at the *practising* level, seven in *observing* level and three in *imitation*, and two at *adapting* levels of the psychomotor domain. Therefore, the psychomotor domain in activities of JSS 2 Basic Science curriculum emphasised higher thinking skills more than lower thinking skills.

From Tables 28 and 29, *comprehension* and *knowledge* were much emphasised in the performance objectives and evaluation guide. Table 30 also revealed such trends to some elements of the application of knowledge and the ability of learners to integrate the required knowledge into a whole. In this, learners were moving toward building the mental and intellectual skills that will occur over time and prepare them for the learning of higher-order thinking skills. Table 30 indicated that learner interest and attitude were motivated. Questions were highly involved in the activities that engaged learners to participate in classroom discussions and other activities outside the classroom for them to demonstrate their belief in a democratic process, which ensures learners' communication skills. Learners practising skills were also highlighted to engage them to acquire the most needed skills to be used in daily activities. Here are some sample excerpts from the JSS 2 Basic Science curriculum.

a. Carry out an activity on water boiling and filtration;
b. Short drama sketches on the influence of drugs and their consequences;
c. Measure pulse rate and breathing rate before and after exercise; and
d. Measure height to determine work done by a falling object.

Table 31 below presents the integration of learning domains in JSS 2 Basic Science curriculum

Table 31- Integration of learning domains in JSS 2 Basic Science curriculum

Domain	Lower level/ No. (%)	High level/ No. (%)	Total/ No. (%)
Cognitive	265 (92.7)	21(7.3)	286(100)
Affective	34(82.9)	7(17.1)	41(100)
Psychomotor	10(45.5)	12(54.5)	22(100)

Source: Field survey (Aliyu, 2019)

The findings in Table 31 show the lower and higher-order cognition levels of Bloom's taxonomy, Krathwohl's taxonomy, and a synthesis of the taxonomies of Simpson, Dave, and Harrow as it is distributed in JSS 2 basic science curriculum. It can be seen that out of 286 items set to assess the cognitive domain, 265 represented by 92.7%, were involved in the lower level of thinking, and 21 were highlighted to a higher level of thinking, representing 7.3%. It has indicated that the majority of the items were set to assess the acquisition of knowledge at lower levels. In the affective domain, out of 41 activities set for this curriculum, 34 representing 82.9%, assessed lower levels of the affective domain, and seven activities representing 17.1%, focused on a higher level of the affective domain. Therefore, the affective domain used in this curriculum was directed toward a lower level of students' development of attitude. Similarly, out of 22 activities involved in the psychomotor domain, 10 representing 45.5% was on lower/ basic process skills in the activities planned, and 12 on focused higher/integrated process skills, represents 54.5%.

To summarise it up in this curriculum, lower/basic levels covered cognitive and affective domains and a high-level skill was emphasised at the psychomotor domain. Lower order thinking is the foundation of knowledge and skills acquisition that move into higher-order thinking. This means that JSS 2 Basic Science curriculum exposed students to learning from simple to complex, as Saat (2004) concluded in his research that acquisition of science process skills happens in stages. After learning of basic science process skills, an introduction to new skills learning experience, as the level progresses, could make a significant contribution to the improvement of students mastering of integrated science process skills. Piaget has established theories to understand learning intellectual growth that can be used to describe the relationship between cognitive domain and science process skills. Piaget (1966) found that learning cognitive structures differ depending on the interaction between the individual and the environment. The acquisition of scientific knowledge, as addressed by affective and cognitive domains and psychomotor domains, addressed science process skills (SPS). These skills are the cognitive skills that scientists use to develop expertise and solve challenges and achieve results. This finding was supported by Fafunwa (2004) as he suggested that there is no link between education and development in terms of values in information and skills from the way students were exposed to cognitive and skills-based domains at all levels. This knowledge and skills lead to an increase in the ability to master the learned materials for them to arrive at a reasonable conclusion.

The finding is also in agreement with Sari, Sudargo, and Priyandoko (2018) who suggested that if science process skills are high, then, the concept of comprehension also increased. Therefore, science process skills supported comprehension materials to be learned. Table 32 examines the domains of learning present in the performance objective of the JSS 3 basic science curriculum.

Table 32- Frequency distribution of domains of learning in performance objectives of JSS 3 Basic Science curriculum

Domains of learning	Level	Theme *1	*2	*3	*4	Total N (%)
Cognitive						
	Knowledge	11	11	3	5	30(38.0)
	Comprehension	18	14	3	7	42(53.0)
	Application	0	0	0	2	2(3.0)
	Analysis	0	0	0	1	1(1.0)
	Synthesis	0	2	0	2	4(5.0)
	Evaluation	0	0	0	0	0(0.0)
Affective	Receiving	0	0	0	0	0(0.0)
	Responding	0	0	0	0	0(0.0)
	Valuing	0	0	0	0	0(0.0)
	Organisation	0	0	0	0	0(0.0)
	Characteristic of value	0	0	0	0	0(0.0)
Psychomotor	Observing	0	0	0	0	0(0.0)
	Imitation	0	0	0	0	0(0.0)
	Practicing	0	0	0	0	0(0.0)
	Adapting	0	0	0	0	0(0.0)
Total		29	27	6	17	79

Source: Field survey (Aliyu, 2019) *1= You and environment, *2= Living and non-living, *3= Science and development, and *4= You and energy

Table 32 shows 79 cognitive processes distributed in the performance objective of the JSS 3 basic science curriculum among the themes. Table 32 also indicated that 53.0% of performance objectives involved *comprehension* level, 38.0% involved *knowledge* level, 5.0% synthesis, 3.0% *application*, and 1.0% at the *analysis* level. The *Evaluation* level of the cognitive, affective and psychomotor domains was not mentioned in the performance objective. This means that higher emphasis was made on the knowledge and skills of a lower order than the knowledge and skills of a higher order. The distribution of domains of learning in an evaluation guide of the JSS 3 basic science curriculum was presented in Table 33.

Table 33- Frequency distribution of domains of learning in evaluation guide of JSS 3 Basic Science curriculum

Domains of learning	Level	Theme *1	*2	*3	*4	Total N (%)
Cognitive						
	Knowledge	11	11	3	5	30(39.0)
	Comprehension	17	14	3	7	41(54.0)
	Application	0	0	0	2	2(3.0)
	Analysis	0	0	0	1	1(1.0)
	Synthesis	0	0	0	2	2(3.0)
	Evaluation	0	0	0	0	0(0.0)
Affective	Receiving	0	0	0	0	0(0.0)
	Responding	0	0	0	0	0(0.0)
	Valuing	0	0	0	0	0(0.0)
	Organisation	0	0	0	0	0(0.0)
	Characteristic of value	0	0	0	0	0(0.0)
Psychomotor	Observing	0	0	0	0	0(0.0)
	Imitation	0	0	0	0	0(0.0)
	Practicing	0	0	0	0	0(0.0)
	Adapting	0	0	0	0	0(0.0)
Total		28	25	6	17	76

Source: Field survey (Aliyu, 2019) *1= You and environment, *2= Living and non-living, *3= Science and development, *4= You and energy

Table 33 shows 76 cognitive processes distributed in the evaluation guide of the JSS 3 basic science curriculum among the themes. *Comprehension* was presented by 54.0% of the questions set to measure learning, and 39.0% was represented by *knowledge* level type of questions, *application* and *synthesis* have 3.0% each. The *evaluation* level of the cognitive domain, affective domain, and psychomotor domain was not mentioned in the evaluation guidelines of the curriculum. The distribution of domains of learning in activities of JSS 3 Basic Science curriculum was presented in Table 34.

Table 34- Frequency distribution of domains of learning in activities of JSS 3 Basic Science curriculum

Domains of learning	Level	Theme *1 *T	*1 *S	*2 T	*2 S	*3 T	*3 S	*4 T	*4 S	Total N (%) T	Total N (%) S
Cognitive											
	Knowledge	1	1	4	0	0	0	5	7	10(18.2)	8(30.8)
	Comprehension	4	0	7	0	2	0	4	2	17(30.9)	2(7.7)
	Application	5	0	5	2	0	0	6	2	16(29.1)	4(15.4)
	Analysis	1	1	2	3	0	0	0	0	3(5.5)	4(15.4)
	Synthesis	2	2	2	3	1	0	2	2	7(12.7)	7(26.9)
	Evaluation	1	0	1	0	0	0	0	1	2(3.6)	1(3.8)
Total		14	4	21	8	3	0	17	14	55	26
Affective											
	Receiving	1	3	0	2	1	0	1	0	3(30.0)	5(20.8)
	Responding	0	6	0	6	0	3	0	2	0(0.0)	17(70.8)
	Valuing	0	0	4	0	1	0	0	0	5(50.0)	0(0.0)
	Organisation	1	0	0	0	0	0	1	0	2(20.0)	0(0.0)
	Characterisation of value	0	1	0	1	0	1	0	0	0(0.0)	2(8.3)
Total		2	9	4	9	2	4	2	2	10	24
Psychomotor											
	Observing	0	2	0	3	0	0	0	2	0(0.0)	7(38.9)
	Imitation	0	3	0	0	0	0	0	0	0(0.0)	3(16.7)
	Practicing	0	0	1	4	0	0	1	2	2(50.0)	6(33.3)
	Adapting	1	1	0	0	0	0	0	1	2(50.0)	2(11.1)
Total		1	6	2	7	0	0	1	5	4	18

Source: Field survey (Aliyu, 2019) *1= You and environment, *2= Living and non-living, *3= Science and development, *4= You and energy, *T=Teacher and *S=Student

Table 34 shows that about 55 cognitive processes were involved in teachers' activities and 26 cognitive processes in students' activities total 81 cognitive processes all in activities of JSS 3 Basic Science curriculum. It can be seen from this Table in teachers' activities that the percentage of involvement of *comprehension* level is 17(30.9%), *application* 16(29.1%), *knowledge* 10(18.2%), and *synthesis* 7(12.7%). Also, Table 34 indicates that at students' activities, *knowledge* was presented with 8(30.8%), *synthesis* has 7(26.9%), *application* and *analysis* levels each represents 4(15.4%). This indicated that the level of thinking and acquisition of skills are moving toward collecting data, formulating a hypothesis for problem-solving in day-to-day life as well as showing an increase in the complexity of cognitive skills from simple to more complex.

Table 34 also presents 10 affective domains in teachers' activities and 24 affective domains for students' activities across the themes. Out of 10 affective domains in the teacher's activities, five activities were involved at the valuing level and three involved in receiving, and two at organisation levels. Also, 17 out of 24 affective domains in students' activities were involved at the responding level, five activities were mentioned in receiving, and two activities at the characterisation of value. Table 34 also shows that students' activities were positioned around the lower level and teachers' activities were positioned around a high level of the affective domain.

Similarly, Table 34 shows four psychomotor processes in teachers' activities and 18 psychomotor processes in students' activities. Out of four psychomotor processes in teachers' activities, two activities were set to engage and assess the skills at the *practicing* level while the other two were to engage and assess the skills at the *adapting* level. Besides, out of 18 psychomotor domains in students' activities, seven activities engaged learners to acquire skills at the *observing* level, three activities at the *imitation* level, six activities at the *practicing* level, and two activities were mentioned at the *adapting* level. Therefore, in looking at these, more activities were set to engage learners to acquire lower skills than the high skills in all the activities of the JSS 3 Basic Science curriculum. Table 35 below presents the Integration of learning domains in JSS 3 Basic Science curriculum

Table 35- Integration of learning domains in JSS 3 Basic Science curriculum

Domain	Lower level N/ (%)	Higher level N/ (%)	Total/ N (%)
Cognitive	206 (86.6)	32 (13.4)	238 (100)
Affective	25 (73.5)	9 (26.5)	34(100)
Psychomotor	26 (66.7)	13(33.3)	39(100)

Source: Field survey (Aliyu, 2019)

The findings in Table 35 shows the involvement of learning domains in JSS 3 Basic Science curriculum. It can be seen that out of 238 items set to assess cognitive domain, 206 representing 86.6%, focused on the lower level of thinking, and 32, representing 13.4%, focused on a higher level of thinking. Therefore, the majority of the items were set to assess the acquisition of knowledge at lower levels. In the affective domain, it was seen that out of 34 items specified, 25 representing, 73.5% involved in the lower level of the affective domain, and nine items representing, 26.5% involved in a higher level of the affective domain. However, it was also seen that out of 29 items from a psychomotor domain in this curriculum, 26 items represented by 66.7% engaged learners in the acquisition of lower/ basic process skills in the activities planned in the curriculum, and 13 items represented by 33.3% engaged learners in the acquisition of higher/integrated process skills.

The findings of the content analysis of JSS 1 and JSS 3 Basic Science curriculum are in agreement with the claims of Ajiboye (2009), who found that teaching and assessment of students by most high school teachers were conducted at lower levels of cognition. Teaching at this level of cognition would not expect students to solve problems at higher levels of cognition. The lower-order thinking is the foundation of skills required for higher-order thinking. However, Katam and Kosgei (2018) submitted that in the classroom process, teachers regularly use a lower level of the cognitive domain (knowledge and comprehension) and rejecting an equally significant higher degree of awareness. For Beers (2006), teachers often plan for higher stages of comprehension but eventually wind up evaluating lower levels of information and understanding. Also, the findings were supported by Sari, Sudargo, and Priyandoko (2018) research on the connection between the skills of the scientific method, the understanding of the concept and the scientific attitude to the regulation of instructional resources, where it was concluded that there was a major connection between the skills of the science process and the understanding of the concept. There was also an important link between the understanding of the concept and the scientific attitude. Also, there was an agreement with the research conducted by Ijaiye, Alabi and Fasasi (2011) which revealed that most of the questions were found to relate to the lower level of recall and comprehension, whereas the higher-order questions are so few. Digests (1988) stated that as part of education reform, higher cognitive process skills (analysing, synthesising and evaluation) are necessary more than those of recalling and remembering, hence higher-order thinking usually devoted to problem-solving and decision making. However, this was not in agreement with the finding.

Acquiring knowledge and skills in understanding the basic concepts to be learned, there is the need for transition from lower to high levels of thinking. Lower levels of thinking skills were the foundation of knowledge and skills acquisition that required moving into high levels of thinking in all the domains of learning. It was found that in JSS 1 and JSS 3 Basic Science curriculum, low levels of Bloom's taxonomy and Krathwohl's taxonomy were much more developed than high levels. For JSS 1 Basic Science curriculum is acceptable but, for JSS 3 there should be a shift on emphasis to more of high level in all the domains or among them to enable the learner to make informed decisions and learn to live effectively within the global community. This is because if a child only acquired low level/order thinking skills, he/she will not be equipped for actual life situations.

In the JSS 2 Basic Science curriculum, cognitive and affective domains were developed to focus on lower levels of thinking. But in the psychomotor domain, the emphasis was shifted to a higher level of thinking. It contributes to the development of learners' mental and physical abilities and competencies. Therefore, as for the JSS 2 curriculum, the integration is reasonable for a learner to enhance meaningful learning. If teachers attached essential to not only cognitive development but also science process skills then, the interest of learners will be motivated to love science, learn science, and create changes within themselves and the environment. The paradigm has been shifted towards the development of human capital that requires meeting the present and future challenges of globalisation and the knowledge economy.

Colvill and Pattie (2003) describe the importance of the thinking skills in the Basic Science curriculum as the scientific process skills are connected to the development of new scientific knowledge. The 1971 Flehinger research cited in Aldous (2005) confirms this claim by figuring out a strong positive correlation between the level of process skills and the level of knowledge processing for experimental subjects. Students with a high level of process skills gained a substantially greater knowledge of the subject than students with a low level of process skills.

Dominant factors in exploring science learners' socio-economic background on their academic performance in basic science programme

Data was gathered from learners to identify the dominant factor(s) of parental socio-economic backgrounds such as level of education, occupation and social class that influence their academic achievement in the Basic Science programme. To get a better understanding of data collected, exploratory factor analysis was chosen in this study to help to explain the differences in responses in the data collected. Many factors could determine the influence of parental socio-economic background on learners' academic performance. Three factors have been conceptualised in this study to see whether they are enough or are dominant factors to influence academic performance.

The suitability of the data for factor analysis was considered. The sample size of this study was 377 against 300 as the least number suggested by Tabachnick & Fidell (2001) for factor analysis. Inspection of the generated correlation matrix indicated the existence of multiple coefficients of 0.3 and above, as recommended by Tabachnick and Fidell (2001). Bartlett's test of sphericity in this study was statistically significant, and the Kaiser-Meyer-Olkin (KMO) index was 0.896. The initial eigenvalues and total variance explained by each item in the instrument composed of three factors of the socio-economic background. Table 36 below shows how items loaded on the various factors and the variance explained by all possible factor loadings concerning the three factors of the socio-economic background.

Table 36- Total variance explained by each item in the instrument composed of three factors of socioeconomic background

	Initial Eigenvalues			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.990	33.263	33.263	4.544	30.294	30.294
2	2.293	15.285	48.548	2.365	15.763	46.057
3	.879	5.859	54.407	1.252	8.350	54.407
4	.805	5.364	59.770			
5	.729	4.858	64.629			
6	.717	4.781	69.410			
7	.643	4.289	73.698			
8	.626	4.172	77.870			
9	.578	3.855	81.725			
10	.534	3.557	85.282			
11	.523	3.487	88.770			
12	.493	3.289	92.059			
13	.450	3.003	95.062			
14	.395	2.631	97.693			
15	.346	2.307	100.000			

Extraction Method: Principal Component Analysis
Source: Field survey (Aliyu, 2019)

Table 36 shows the factors extracted from the data to explain the differences between the responses with their eigenvalues. Both the strength and weakness of each factor extracted was revealed. To determine the components (factors) extracted, the extraction method, principal components analysis revealed the existence of two components with eigenvalues exceeding 1 (4.990 and 2.293), explaining 33.263% and 15.285% of the variance, respectively. According to the eigenvalue rule, only factors with an eigenvalue of 1.0 or more are retained for further investigation (Tabachnick & Fidell, 2001). This indicated that the two factors could be retained. Three factors have been conceptualised in this study. However, only two factors have been identified by the Kaiser criterion, and a screen plot was used for further checks to determine the specific variables to be maintained to explain the impact of the socio-economic background on learner's academic performance in Basic Science.

Primarily, the screen plot is a graph with eigenvalues at the vertical axis and several factors at a horizontal axis. As the number of factors increases from left to right eigenvalues decrease. The screen test involves analysing the graph of the eigenvalues and searching for a natural bend or a breakpoint in the data where the curve is flattened. The data point above the "break" (not counting the point at which the break occurs) are typically the number of variables to be preserved. It could be unknown, though, whether there are data points clustered near to the bend (Costello & Osborne, 2005). Figure 3 shows the graphical representation for the screen-test.

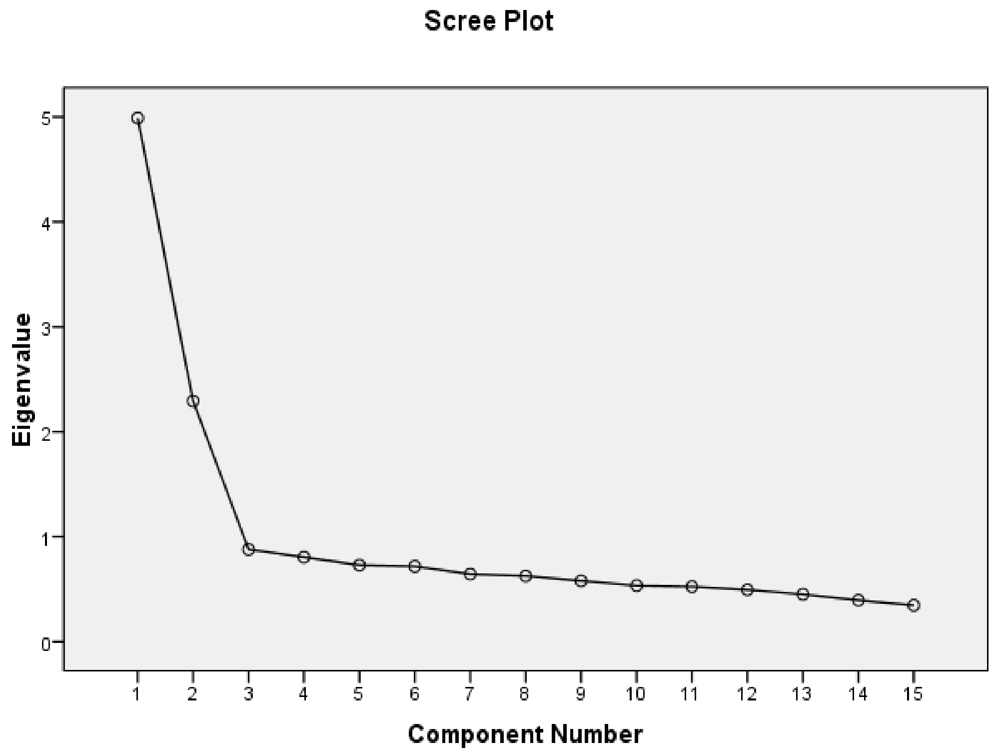

Figure 3: Screen plot showing number of factors to be retained

Source: Field survey (Aliyu, 2019)

An inspection of the screen plot revealed that there was a change (or elbow) in the shape of the plot at component three, and that only two components were above this point and loaded uniquely on the screen plot, so the two components were retained for further investigation. Cattell (1966) recommended the retention of all variables above the elbow or split in the plot, as these factors contribute most to the interpretation of the variance in the data set. The next output considered was the table of communalities, which is presented below in Table 37.

Table 37- Communalities of items on instrument used

Item	Initial	Extraction
st1	1.000	.533
st2	1.000	.555
st3	1.000	.507
st4	1.000	.551
st5	1.000	.600
st6	1.000	.625
st7	1.000	.469
st8	1.000	.594
st9	1.000	.521
st10	1.000	.530
st11	1.000	.530
st12	1.000	.511
st13	1.000	.598
st14	1.000	.518
st15	1.000	.518

Extraction Method: Principal Component Analysis.
Source: Field survey (Aliyu, 2019)

Table 37 revealed the correlation between items and their factors after extraction was strong on the particular factor labelled based on common characteristics. But only one item was moderate though it was related to the other items because its item loading was above 0.40. This shows how much of the difference in the item responses have been considered for by the extracted factors. A high value in the table of communalities simply means that the items had a lot of characteristics in common and low values would mean that the items have little in common with each other. Since two factors were retained for the final analysis, the factors were rotated, using Varimax rotation to see the pattern of loadings in a manner that is easier for interpretation. Table 38 shows the items and their corresponding factor loadings

Table 38- Rotated Component Matrix using Varimax with Kaiser Normalisation showing Loadings of each Item

	Component	
	1	2
Item 1	.748	
Item 2	.775	
Item 3	.723	
Item 4	.755	
Item 5	.745	
Item 6	.795	
Item 11		.706
Item 12		.699
Item 14		.730
Item 15		.737

Source: Field survey (Aliyu, 2019)

With the removal of five items from the 15 items, because of cross loading, the final analysis shown in Table 38 indicates loadings of 10 items among two components after varimax rotation. About six items were loaded individually on component one, and also four items were individually loaded on component two. It was noted that items one, two, three, four, five and six were the items that loaded uniquely on component one. Whereas items 11, 12, 14 and 15 were loaded uniquely on component two.

Similarly, the table revealed that all the items that were loaded on the first component had a high loading above 0.7, which has to do with the parental level of education. This tells us that the parental level of education is one of the dominant socio-economic factors that influence learners' performance in basic science. Under this factor item, six has the highest loading, followed by item two, four, one, five, and then three, respectively. Item two, which was among the highest loadings, read as *"My parents' level of education enables them always to demand my academic progress report."* All the four items loaded on the second component had strong loadings and were directly related to the social class factor. Under this factor, item 15 had the highest loading, followed by items 14, 11 and then 12. The highest loading had a loading of .737 and reads, *"My parents' social class allows them to discuss my area of difficulties in basic science."* These two factors (components) extracted were tagged as levels of education and social class based on the items characteristics loaded on each factor (component).

Multiple regression was conducted to see which factor (level of education and social class) greatly predicts the learner's academic performance. Multicollinearity was determined and it indicated a perfect linear relationship between the two independent variables. It was shown that the tolerance value for each of the independent variables was .992 and the VIF value for each was 1.008. The tolerance values were above 0.1 and the VIF values were less than 10, thus the data set did not indicate multicollinearity. Pallant (2005) and Ringle, Wenda and

Becker (2015) recommended that the value of Tolerance should be above .10 or a VIF value of above 10, indicating multicollinearity. The assumptions were not violated.

In the results, it is shown that only 3.5% of the level of education and social class explain a significant amount of the variance in the dependent variable in basic science. R^2=.035 (Adjusted R^2= .030, F (2, 374) =6.765, p< .05).

Table 39- Summary of the model in multiple regression analysis for the socio-economic background (level of education and social class) in Basic science

Model Summary					Change Statistics				
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change
1	.187	.035	.030	3.48541	.035	6.765	2	374	.001

a. Predictors: (Constant), social class, level of education

Source: Field survey (Aliyu, 2019)

Similarly, the regression analysis shows that all the independent variables are relevant toward influencing learner's performance in Basic science hence p< .05. Table 40 indicates that the regression model predicts the dependent variable significantly (Sig = .001, so p<.0005).

Table 40- Analysis of Variance of Level of education and social class to Learners' performance in Basic Science

ANOVA						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	164.360	2	82.180	6.765	.001
	Residual	4543.374	374	12.148		
	Total	4707.735	376			

a. Dependent Variable: performance

b. Predictors: (Constant), social class, level of education

Source: Field survey (Aliyu, 2019)

Table 41- Coefficients in multiple regression analysis for the socio-economic background (level of education and social class) in Basic science

Model		Unstandardized Coefficients B	Unstandardized Coefficients Std. Error	Standardized Coefficients Beta	t	Sig.
1	(Constant)	13.782	.790		17.435	.000
	Level of education	-.582	.179	-.166	-3.254	.001
	Social class	-.248	.175	-.072	-1.419	.157

a. Dependent Variable: performance
p< .05
Source: Field survey (Aliyu, 2019)

It can be seen from Table 41 that one independent variable (level of education) has significantly contributed to the performance of students even though the contribution was negative but it made the largest contribution to the learner's performance and significantly predict the learner's performance (Beta= -.166, t (376) =-3.254, p< .05). This means that level of education provides the largest contribution to explaining the performance when the variance is explained by all other variables in the model measured. This indicated that as the parental level of education increases the performance of their children declines. This implies that parents with a lower level of education are more concerned with improving their children's success at school than parents with a high level of education. It was noted that parents with lower education often have more time to prepare their children for school and encourage them to take part in various learning activities at home. Topor, Keane, Shelton and Calkins, (2010) stated that the influence of parents toward their children's performance has not been established well among high educated. However, social class did not significantly predict the performance

(Beta= -.072, t (376) =-1.419). The Beta value for the social class was slightly lower indicating that it made less contribution. Therefore, the regression equation would be:

Performance= level of education (-.582) + social class (-.248) + 13.782

This means that when the level of education increases by 1% the learner's performance will also increase by 58.2%. However, this shows that learner's performance in basic science was greatly influenced by the level of education of their parent. However, when considered singly, the level of education significantly contributed to the learner's performance in Basic science even though the B value was negative (B=-.582, p< .05). The outcome displays that social class made less contribution toward learner's performance in Basic science as B=-.248.

It is essential to say that the factors of a socio-economic background consisting of levels of education, occupation and social class initially conceptualised in this research are not enough to determine the basic science performance. Hence the results have shown that only 3.5% of the independent variables (level of education and social class) explain a significant amount of the variance in the dependent variable. It could be, there are other parental socio-economic factors which were not captured in this research

Performance of basic science learners taught by trained teachers and those that are taught by untrained teachers in junior secondary school

Hypothesis 1a, 1b and 1c were tested using independent t-test analysis at 0.05 level of significance for JSS 1, 2, and 3. Out of 377 about 147 learners from JSS 1, 124 learners, and 106 learners from JSS 3 wrote the test. The total scores of

BSPT were 20 marks, and scores that were obtained from the administration of BSPT ranged from 5-19 marks. Table 42 presents independent samples t-test

Table 42- Independent samples t-test for null hypotheses 1

Hypothesis	Variables	N	$\overline{X}$	SD	t	df	Sig(2-tailed)	Decision
H_O 1a	Taught by trained teachers	90	13.54	3.04	3.94	145	.000	rejected
	Taught by untrained teachers	57	11.49	3.13				
H_O 1b	Taught by trained teachers	79	8.47	3.44	-3.93	122	.000	rejected
	Taught by untrained teachers	45	10.58	2.49				
H_O 1c	Taught by trained teachers	57	10.21	2.73	-1.89	104	.061	accepted
	Taught by untrained teachers	49	11.35	3.44				

Source: Field survey (Aliyu, 2019)

An independent-samples t-test was conducted to compare the performance of learners taught by trained teachers and those taught by untrained teachers in JSS 1, 2 and 3. The results indicated that there was a statistically significant difference in scores for learners taught by trained teachers and those taught by untrained teachers where p≤ =0.05 for both JSS 1 and 2, so the null hypothesis was rejected. Consequently, there is a significant difference between both groups after the same performance test is given to them. The magnitude of the difference in the means was moderate in JSS 1(eta squared =0.096), while that of JSS 2 was large (eta squared=0.112). However, the results also indicated that there was no statistically significant difference in scores for learners taught by trained teachers and those taught by untrained teachers in JSS 3 where p>0.05. Based on this finding, at this level, the null hypothesis was accepted. Comparing the three results, one can say that trained teachers have a significant impact on the performance of basic science learners at JSS 1. But at JSS 2, learners taught by untrained teachers performed better as their mean score is 10.58 higher than the mean scores of learners taught by trained teachers, which is 8.47 The reasons were that JSS 2 learners had more knowledgeable and experienced untrained teachers, those can demonstrate the basic classroom skills that when they teach, learners will understand better than the trained teachers they have.

However, at JSS 3 there is no significant difference; hence performance may not necessarily depend on the teacher. According to Baker et al., (2010) a variety of variables have been found to have a significant impact on student learning progress, aside from the teachers to whom their performance would be linked.

The trained teachers support the effectiveness of the teaching and learning process that ensures an effective classroom performance of the learner. Trained teachers have gone through many of the factors shaping quality teaching that has an impact on the learning process. Therefore, teachers' performance in the lesson has a direct bearing on the learners' performance. Though untrained teachers can teach lessons, they have less impact on learners' learning. Hence, they have not benefitted from any training on professional development in teaching that would enhance their professional knowledge, skills and attitudes so they might not improve the learning of students and their performance in general. This is why learners taught by trained teachers most of the time performed higher than those taught by untrained teachers. This was confirmed by the study of Banerjee (2016) who found that trained teachers are more successful in their success than untrained teachers. The findings in JSS 1 and 2 are in agreement with (Farooq & Shahzadi, 2006), They contrasted the efficacy of qualified teachers and untrained teachers in the field of mathematics and concluded that there was a substantial gap between the success of students in mathematics taught by trained and untrained teachers. Also, Bressoux, Kramarz, and Prost, (2005) found that there is a difference between the scores of students taught by trained and untrained teachers. However, the finding in JSS 3 indicated that there was no difference between the scores of students taught by trained and untrained teachers. This is not in agreement with any of the previously cited studies.

Performance of basic science learners who use science laboratories and those that do not use science laboratories in junior secondary school

Hypothesis 2a, 2b and 2c were also tested using independent t-test analysis at 0.05 level of significance for JSS 1, 2, and 3. The total scores of BSPT were 20 marks, and learners' total scores ranged from 5-19 marks. Table 43 presents independent samples t-test results.

Table 43- Independent samples t-test for null hypotheses 2

Hypothesis	Variables	N	$\overline{X}$	SD	t	df	Sig(2-tailed)	Decision
H_O 2a	Use science laboratory	39	14.41	2.78	3.935	145	.000	rejected
	Do not use science laboratory	108	12.15	3.18				
H_O 2b	Use science laboratory	31	15.06	2.46	9.166	122	.000	rejected
	Do not use science laboratory	93	9.63	2.97				
H_O 2c	Use science laboratory	28	12.79	2.38	4.395	104	.000	rejected
	Do not use science laboratory	78	10.00	3.03				

Source: Field survey (Aliyu, 2019)

An independent-samples t-test was conducted to compare the performance of learners who use science laboratories and those who do not use science laboratories in JSS 1, 2 and 3. The results indicated that there was a statistically significant difference in scores for learners who use science laboratories and those who do not use science laboratories in JSS 1, 2 and 3 respectively with $p<.05$. The magnitude of the difference in the means was large (JSS 1 eta squared =0.17, JSS 2 eta squared=0.40, JSS 3 eta squared=0.17). It is concluded that the teaching of basic science using science laboratories has a significant impact on learners. Those who used science laboratories performed better than those that did not use science laboratories.

From the interview conducted, learners generally stated that they were not doing practical lessons. However, others said that they sometimes have their basic science lesson in Biology, Chemistry or Physics laboratory. Okebukola (2005) reported that during laboratory work, learners are presented with experiences predisposing them to the development of the science skills required for the discovery of new knowledge. Though they were not involved in practical lessons, they had their normal lessons in the science laboratories that had a significant impact on their performance. This finding is in line with Ojulari (2007) who concluded in his analysis that there is a connection between the availability of educational facilities and success in the field of science.

The analysis found significant factors related to teaching and learning science, especially basic science. The findings of this study have a wider implication for educators and other stakeholders in education. It is argued that if the domains of learning are not developed from lower to high at a level, the learners will not learn the knowledge and skills effectively irrespective of how well instructional practices are designed. Understanding learner characteristics have implications for teaching. Teachers need to be familiar with learners' socio-economic backgrounds and the influence that parents need to give toward the education of their children to be able to reduce the gap between socially favoured and deprived learners. Parents, as stakeholders in the education of their children, need to understand the academic needs of their children in terms of science textbooks, extra lessons, guiding them to do homework/ assignment. Others include supervise their school work, demand for their academic progress and the consequence of these on their academic performance. The teaching and learning of basic science will be unfavourably affected when the assessment for learning is not well done. Teachers' PCK and attitude to teaching play a significant role in meaningful learning and improve learners' performance. Students get discouraged from loving and pursuing science when teachers do not engage them in practical lessons. When teachers do not use the appropriate methods that involve the students in the active teaching-learning process, the students become passive. They turned to rote learning and memorisation of concepts to pass an examination. Science educational activities in teaching provide the learner with an opportunity to study science in real-life situations. If teachers do not use inquiry-based methods in teaching at the basic education level, then it is not a strong development to the study of science at this level. This is because the misuse of this aspect of the curricula could be unfavourable to the learners' scientific development. Therefore, teachers should pay attention to methods they were instructed to use in the Basic Science and Technology teacher's guide.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This chapter contains a summary of the research work, the conclusions drawn from the entire findings of the work, and recommendations and suggestions for further studies.

Summary

The research was carried out to examine the status of teaching and learning of science in junior secondary schools in Kebbi State, Nigeria. Literature that is relevant to the study was reviewed, which covers teacher professional knowledge, teaching methods, instructional materials, laboratory equipment, basic science curriculum, socio-economic background and assessment. There were six research questions and two hypotheses that guided this study. An embedded mixed methods design was used for the study. Data for the study were obtained, using two forms of questionnaire, two forms of observation checklists, four forms of interview guides, performance tests, and the basic science curriculum. The research questions were answered, using descriptive statistics, exploratory factor analysis, regression analysis, narrative analysis, and content analysis, while an independent t-test was used to answer the hypotheses. The population of the study was made up of all basic science teachers and learners from JSS1, JSS 2, and JSS 3, 38 teachers, and 6821 learners. Yamane's (1967) mathematical formula for determining a sample size was used, and a total of 377 sample size was selected, and 36 teachers were used. The sample of the learners was selected through stratified and random sampling techniques. About 147 learners from JSS 1, 124 learners from JSS 2, and 106 learners from JSS 3 were sampled. Descriptive statistic was used to analyse the data from basic science teachers' questionnaires, classroom observation, Basic Science curriculum, and laboratory observation.

Key Findings

The Key findings in this study are:

1. Majority of basic science teachers in this study were trained teachers (63.9%), while untrained teachers had a representation of (36.1%); all teachers had a mean score of 4.75 teaching experience. Only 31 males (86.1%) and five females (13.9%) participated in the study. The number of Basic Science teachers are too small, as observed and stated by a zonal education director in an interview.
2. Basic science teachers did not fully understand the basic science curriculum they were expected to implement because of the challenges associated with the teaching and learning basic science identified from the participants during their teaching. These challenges are:
    a) Teachers could not allow learners to construct their understanding during the lesson;
    b) They could not guide learners' practice and design science activity for learners to learn through exploration;
    c) They could not assess learners' learning outcomes; and

d) There was a lack of using a guided inquiry method of teaching and learning to promote learning and skills development. Teachers therefore predominantly, used lecture, discussion, and demonstration method.

3. Schools were poorly equipped with instructional materials. Those available were poorly maintained as observed and also stated by some teachers. The only available ones in the schools under study were charts, drawings on a cardboard paper, models, and laboratory materials.
4. Qualitative data of the study revealed that there were very few apparatuses, reagents and safety equipment generally available to all schools.
    a. Beaker, Bunsen burner, Pipette, Test tube, magnifying glass, Test tube clamp, Litmus paper (blue/red strips), Filter paper, Light bulb, Wire gauze, Spatula spoon, Burette, and Retort stand were the only available apparatus and were not enough during the practical lessons because of class sizes. The average class sizes were 40, 45 and 50 learners per class (see Table 23)
    b. Indicators (e.g., methyl orange, phenolphthalein), acids solution (e.g HCl, HNO_3, H_2SO_4), Base solutions (e.g NaOH, $NH_{3(aq)}$) and Salts (e.g NaCl, Na_2CO_3, $CaCO_3$). were available (see Table 23), but after the observation, some teachers confirmed that most of these reagents expired.

c. The first-aid cabinet was the only safety equipment found available in all the schools (see Table 23)

d. It was found that only three teachers were using a laboratory for basic science lessons and no practical activities at all.

5. Lower-level thinking skills were the more dominant thinking skills in the JSS1 and 3 Basic Science curriculum than higher-level thinking skills for the three domains of learning (see Table 27 and 35). It was discovered that in JSS 2 basic science curriculum, lower-level thinking skills covered cognitive and affective domains while the psychomotor domain was covered by high level thinking skills (see Table 31). JSS 2 curriculum looks to be an enhancement over the JSS 1 curriculum in terms of its emphasis on skills acquisition. Lower order thinking is the foundation of knowledge and skills acquisition that move into higher-order thinking. JSS 2 basic science curriculum has the potential to develop the science process skills of learners. The emphasis on skills in the curriculum is significant because it offers learners the opportunity to acquire skills for their daily lives.

6. It was found out that as the parental level of education increases the performance of their children declines. However, it is shown that only 3.5% of the level of education and social class explain a significant amount of the variance in the dependent variable in basic science. But 3.5% is very low to explain the causes of learners' performance in basic science.

7. There was a statistically significant difference in scores for pupils taught by trained teachers and those taught by untrained teachers in JSS1 and JSS 2.
8. There was no statistically significant difference in scores for learners taught by trained teachers and those taught by untrained teachers in JSS 3.
9. There was a statistically significant difference in scores for learners who used science laboratory and those who did not use science laboratory in JSS 1, 2 and 3.

Great effort was made to collect empirical data that may lead to program improvement and re-planning of science teaching and learning in Kebbi State, Nigeria. The study provided a realistic image of teaching and learning basic science in our junior secondary schools. The study provided a basis for teachers to take action and improve their teaching of basic science as justified by changes in the teaching and learning situation. Many previous studies identified inadequate materials resources, laboratories, and unqualified teachers as the pressing challenges affecting science teaching and learning; this study is unique in the sense that it adds to the list of teachers' professional competencies as another important challenge affecting science teaching and learning.

Conclusions

The findings of this study yield the following conclusions about the teaching and learning of science in junior secondary schools. The analysis of demographic data on the teacher sampled has shown that about 23(63.9%) were trained. It was expected that all teachers were supposedly trained before starting their job for effective instruction. There was evidence of the inabilities of basic science teachers to demonstrate some of the basic classroom skills and assessment for learners' learning outcomes. The approach teachers had adopted had little or no time to design science activities for extra exploration to guide learners' practice. The curriculum was designed to use an inquiry-based teaching and learning approach in mind, as seen by the activities listed under each topic to enhance learning and skills training. Basic science teachers did not adequately assess the learners' learning outcomes, which help to improve learning. For example, the teachers could not use different assessment strategies and tools, give constructive feedback to learners on their learning, and give them the assignment to complement their learning. It was stated in the teacher's guide that teachers should provide enough take-home assignments to enable students to continue with learning science and technology at home, especially during the weekends. Assessment of learning in Basic Science should not be an end to itself but also a process of improving science teaching and learning.

The schools were poorly equipped with instructional materials, and those available were poorly maintained. The importance of instructional materials to the prediction of quality teaching and learning of Basic Science requires that government and school administrators provide enough instructional materials for a conducive teaching atmosphere for learners to learn Basic Science. Since instructional materials develop learners' interest and attitude towards learning. Therefore, tremendous effort should be made in ensuring that schools are well equipped with instructional materials for quality teaching and learning. In learners' responses to the interview, these were a negative response to the involvement of any practical work. However, a significant difference in the performance of learners who used science laboratory and those who did not use science laboratory was found in all the levels.

Based on the findings, it is indicated that out of the three components of parental socio-economic background (level of education, occupation and social class) initially conceptualised in this study, it happened that two components that is, level of education and social class were confirmed to be dominant factors after exploratory factor analysis. These two factors made a statistically significant contribution to learner's performance in basic science. Also, there are positive multiple correlations (R= 0.035) among the dependent variable and independent variables even though it is very low. It is shown that level of education was the most predictor of learner's performance in basic science. The result shows that as the level of education increases, the learners' performance decreases. The model also shows that when the level of education increases by 1% the learner's performance will also increase by 58.2%. A significant difference in scores for learners taught by trained and untrained teachers in performance was found in JSS 1 and 2, but not found in JSS 3.

Recommendations

From the findings of this study, the following recommendations are listed:

1. The government should recruit qualified professional teachers as the number of current basic science teachers is too small. Principals, in collaboration with zonal education directors, should lobby the Ministry of Basic and Secondary Education to post newly trained and qualified teachers to their schools.
2. Basic science teachers should be taken through in-service training, seminars, and workshops on how to perform an assessment of and for

learners learning outcomes to enable them to function effectively in their role as teachers.

3. There is the need to provide adequate instructional materials to all schools in the State to promote effective teaching and learning science.
4. There should be regular supervision of classroom activities to ensure those appropriate teaching methods are used for teaching basic science. Any inappropriate selection or use of teaching methods by a teacher, which is not in agreement with the contents and learners as stated in the teacher's guide, such teachers should be advised and called to order. Therefore, the Ministry of basic and secondary education supervisory units, zonal education offices, and principals should ensure that Basic Science teachers keep abreast of guided inquiry teaching strategies.
5. Basic science teachers should develop the habit of using laboratory materials in teaching basic science. Principals should encourage teachers in using the laboratory for a practical lesson to match theory to practice for a proper understanding of science.
6. Science teachers should make a drastic effort to gain knowledge about teaching and learning groups of students from a different socio-economic background to improve learner's performance in basic science.
7. The curriculum developers should ensure adequate and equal distribution of levels of learning domains in the curriculum as to correspond with the level of progression of learners to maintain in-depth, connection and

relevance learning experience for the young learners to realize the essential goals of 9-years basic education.

8. Parental socio-economic background provide support for teachers and learners to work in the classroom. Therefore, it is recommended that many factors of parental socio-economic background could be used to determine learners' performance in Basic Science.

Suggestions for Further Research

The following suggestions for further studies are put forward: -

1. The study could be replicated in other political zones in the country, using large samples of teachers to find out the status of teaching and learning science so that a more generalisation could be made.
2. To improve teaching and learning in the way that curriculum offers, it is essential that textbooks be consistent with the aims of the curriculum and balanced in the learning domains. Therefore, there is the need for a separate content analysis of basic science in relation to the recommended textbooks.
3. Further studies will be required to look at the impact of technological skills on basic science teachers' practices and students' learning.

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APPENDICES

Appendix A

BASIC SCIENCE TEACHERS' QUESTIONNAIRE (BSTQ)

Section A: Demographic information

This questionnaire is intended to collect information on teaching of basic science based on three areas: teacher basic knowledge, basic classroom skills and assessment for learners learning, each trained teacher is expected to practice during his/her teaching. Please respond to all the items by placing a tick (√) in the appropriate box (☐).

School……………………………………………………………………

Gender

Male ☐

Female ☐

Academic Qualification

National diploma ☐

High National Diploma ☐

Bachelor of Science ☐

Master of Science ☐

Master of Philosophy ☐

Other (specify) ……………………………………

Professional Qualification

Nigerian Certificate in Education ☐

Bachelor of Science (Education) ☐

Post Graduate Certificate in Education ☐

Post Graduate Diploma in Education ☐

Master of Education ☐

Other (specify) ……………………………………

Teaching experience

1 – 4 years

5 – 8 years

9 – 12 years

13 – 16 years

17 – 20 years

Above 20 years

Class you are teaching

JSS 1

JSS 2

JSS 3

Section B

Please respond to each statement by placing a tick in the blank space where appropriate

Strongly agree (SA); Agree (A); Disagree (D) and Strongly Disagree (SD)

S/N	STATEMENTS	SA	A	D	SD
1.	I use learners prior experience to plan and build the lesson				
2.	I link content with learning experience/ real life situation				
3.	I base evaluation on instructional objectives				
4.	I allow learners to construct their own understanding				
5.	I control my class				
6.	I introduce and explain tasks within the experience and ability of learners				
7.	I guide learners' practice				
8.	I demonstrate knowledge of subject matter				
9.	I use different assessment strategies and tools appropriate for the content and learners				
10.	I communicate clearly within learners understanding				
11.	I use a variety of instructional strategies to promote learning				
12.	I use appropriate questions				
13.	I motivate learners to be active participants				
14.	I reinforce learners to enhance their learning				

15.	I manage my class				
16.	I evenly distribute questions				
17.	I write clearly and effectively on the board				
18.	I react appropriately to learners' questions in class				
19.	I give constructive feedback to learners on their learning.				
20.	I ask simple and direct question				
21.	I allow learners to ask question				
22.	I select appropriate instructional objectives				
23.	I align lesson objectives to the curriculum and learners learning needs				
24.	I am aware of the curriculum content and how it is taught				
25.	I give learners assignments to finish at home complement their learning				
26.	I give many examples within learners' environment				
27.	I teach my class as a whole not as a part				
28.	I design science activity for learners to learn through exploration				

Appendix B

TEACHERS' CLASSROOM OBSERVATION CHECKLIST (TCOC)

This classroom observation checklist is categorized into three areas. Each trained teacher is expected to practice during his/her teaching. These categories of areas are: teacher basic knowledge, basic classroom skills and assessment for learners learning.

School……………………………………………………………………….

Class…………………………………………………………………………

Date…………………………………………………………………………

Time…………………………………………………………………………

Use the following and comment to each observable item

0. Not observed 1. observed once 2. observed twice 3. observed thrice

Appendix B

s/n	Category	Teacher 1			Teacher 2			Teacher 3		
Teacher basic knowledge		L1	L2	L3	L1	L2	L3	L1	L2	L3
1.	Ability to use learners prior experience to plan and build the lesson									
2.	Ability to link content with learning experience/ real life situation									
3.	Ability to allow learners to construct their own understanding									
4.	Ability to demonstrate knowledge of subject matter									
5.	Ability to motivate learners to be active participants									
6.	Ability to select appropriate instructional objectives									
7.	Ability to be aware of the curriculum content and how it is taught									
8.	Ability to align lesson objectives to the curriculum and learners learning need									
Basic classroom skills										
9.	Ability to control my class									
10.	Ability to introduce and explain task within the experience and ability of learners									
11.	Ability to guide learners' practice									
12.	Ability to communicate clearly within learners understanding									
13.	Ability to use a variety of instructional strategies to promote learning									
14.	Ability to reinforce learners to enhance their learning									
15.	Ability to manage my class									
16.	Ability to write clearly and effectively on board									
17.	Ability to give many examples within learners' environment									
18.	Ability to teach my class as a whole not as a part									
19.	Ability to design science activity for pupils to learn through exploration									
Assessment for learners learning										
20.	Ability to base evaluation on instructional objectives									

21.	Ability to use a different assessment strategies and tools appropriate for the content and learners									
22.	Ability to use appropriate questions									
23.	Ability to evenly distributes questions									
24.	Ability to react appropriately to leaners questions in the class									
25.	Ability to give constructive feedback to learners on their learning.									
26.	Ability to ask simple and direct question									
27.	Ability to allow learners to ask question									
28.	Ability to give learners assignments to finish at home combines their learning									

Appendix C

LABORATORY APPARATUS, REAGENTS AND SAFETY EQUIPMENT OBSERVATION CHECKLIST (LARSEOC)

School………………………………………………………

Date…………………………………………………………

Time…………………………………………………………

Class size……………………………………………………

	Apparatus	Available	No. of items	Not available
1.	Beaker			
2.	Bunsen burner			
3.	Magnetic bar			
4.	Pipette			
5.	Burette			
6.	Round bottom flask			
7.	Funnel			
8.	Volumetric flask			
9.	Retort stand			
10.	Test tube			
11.	Magnifying glass			
12.	Test tube clamp			
13.	Resistor			
14.	Condenser			
15.	Capacitors			
16.	Chemical balance			
17.	Spring balance			
18.	Microscope			
19.	Litmus paper (blue/red strips)			
20.	Filter paper			
21.	Glass prism			
22.	Thermometer			
23.	Hydrometer			
24.	Light bulb			
25.	Wire gauze			
26.	Stirrer			
27.	Resistance box			
28.	Height scale			

29.	Inclined plane set with pulley			
30.	Separating funnel			
31.	Starch powder			
32.	Spatula spoon			
33.	Watch glass			
34.	Elastic bell			
35.	Rheostat			
36.	Measuring cylinder			
37.	Convex lens			
38.	Concave lens			
39.	Voltmeter box			
40.	Battery			
41.	Turning fork			
42.	Pendulum clock			
43.	Ammeters			
44.	Wind vane			
45.	Rain gauge			
46.	Barometers			
47.	Droppers			
48.	Meter rules			
Reagents				
49.	Indicators (e.g. methyl orange, phenolphthalein)			
50.	Iodine solution			
51.	Fehling's solution			
52.	Million's reagent			
53.	Acid solutions (e.g HCl, HNO_3, H_2SO_4)			
54.	Base solutions (e.g $NaOH$, $NH_{3(aq)}$)			
55.	Salts (e.g $NaCl$, Na_2CO_3, $CaCO_3$)			
56.	Buffer, pH 10, pH 4, pH 7			
Safety Equipment				
57.	Safety glasses			
58.	First aid cabinet			
59.	Gloves			

Appendix D

BASIC SCIENCE LEARNERS' QUESTIONNAIRE (BSLQ)

This questionnaire is intended to collect information on Parental Socio-economic status on students. The information given will be used for the purpose of this research only. Kindly tick where appropriate or write in the space provided. Do not write your name on this questionnaire

SECTION A: DEMOGRAPHIC INFORMATION

School…………………………………………………………………………….

Gender:

Male ☐

Female ☐

Class

JSS one ☐

JSS two ☐

JSS three ☐

Parent's social class

Upper Class ☐

Middle Class ☐

Lower Class ☐

Parental occupation

Business ☐

Farmer ☐

Civil servant ☐

Others…………………

Fathers' level of educational

Uneducated ☐

Primary level ☐

Secondary level ☐

College/university ☐

Mothers' level of educational

Uneducated ☐

Primary level ☐

Secondary level ☐

College/university ☐

SECTION B: Influence of parents on pupil's academic performance

Strongly Agree (SA), Agree (A), Undecided (U), Disagree (D), Strongly-Disagree (SD)

S/N	Statement	SA	A	U	D	SD
1.	My parents' level of education encourages my science background					
2.	My parents' level of education enables them always to demand for my academic progress report.					
3.	My parents' level of education enables them to give me extra-training that make me to perform better in school.					
4.	My parents' level of education allows them to guide me in doing homework and assignments.					
5.	My parents' level of education encourages them to provide some of the recommended science text book and other learning materials to me					
6.	My parent's occupation encourages my study of science					
7.	My parent's occupation always allows me to attend to my academic needs					
8.	My parental occupation enhances my learning activities both at home and in school					
9.	My parent's occupation shapes my science learning ability					
10	My parents' occupation encourages me to express my feeling freely in class					
11	My parents' social class influences my aspiration towards learning science					

12	My parents' social class allows them to visit my school for inquiries on my academic performance.					
13	My parents social class allows them to supervise my study at home					
14	My parent social class influence my academic performance					
15	My parents' social class allows them to discuss my area of difficulties in science.					

Appendix E

INTEVIEW SCHEDULE FOR TEACHERS

Section A

The study is aimed at examining the status of teaching and learning of science in junior secondary schools in Kebbi State, Nigeria. I assure you that you are being interviewed confidentially, and that your participation is voluntary.

Demographic and background information

- Date……………………………………………………………….
- Time…………………………………………………………….
- Place…………………………………………………………….
- Highest educational background

………………………………………………………………………………

- What is your rank?
- When did you first start teaching? ....

Section B

1. What professional competence do teachers who teach basic science in science secondary schools possess?
2. What predominant method(s) of teaching do teachers employ to teach in science secondary schools?
3. What instructional materials do teachers employ in teaching basic science in science secondary schools?

SECTION C

1. Are you aware of the basic science curriculum?

- If yes do you have a copy?

2. Is the textbook you are using approved by the government?
    - If No which text book are you using?
    - Is it based on the curriculum?
3. Do you know there is a teaching manual/guide for teaching basic science curriculum?
4. Do you have access to basic science teaching manual/guide?
    a. If Yes do you use it?
        - If No why don't you use it?

    b. If No why don't have access to it?
5. In the absence of teaching manual/guide, what do you use?
    - Why are you using it instead of the one provided?

Appendix F

INTEVIEW SCHEDULE FOR EDUCATIONAL ZONAL DIRECTOR

Section A

The study is aimed to examine the status of teaching and learning science in junior secondary schools in Kebbi State, Nigeria. I assure you that you are being interviewed confidentially, and that your participation is voluntary.

Demographic information

- Date……………………………………………………………….
- Time……………………………………………………………….
- Place……………………………………………………………….
- Highest educational background

…………………………………………………………………………………………

When did you first start working at zonal educational office? ....

Section B

1. What professional competence do teachers who teach basic science in science secondary schools possess?
2. What predominant method(s) of teaching do teachers employ to teach in science secondary schools?
3. What instructional materials do teachers employ in teaching basic science in science secondary schools?

Appendix G

INTEVIEW SCHEDULE FOR PRINCIPALS

Section A

The study is aimed to examine the status of teaching and learning science in junior secondary schools in Kebbi state, Nigeria. I assure you that you are being interviewed confidentially, and that your participation is voluntary.

Demographic information

- Date……………………………………………………………….
- Time……………………………………………………………….
- Place……………………………………………………………….
- Highest educational background

……………………………………………………………………………………

When did you first start teaching? ....

When you did first become principal?

Section B

1. What professional competence do teachers who teach basic science in science secondary schools possess?
2. What predominant method(s) of teaching do teachers employ to teach in science secondary schools?
3. What instructional materials do teachers employ in teaching basic science in science secondary schools?

Appendix H

INTEVIEW SCHEDULE FOR LEARNERS

Section A

The study is aimed to examine the status of teaching and learning science in junior secondary schools in Kebbi state, Nigeria. I assure you that you are being interviewed confidentially, and that your participation is voluntary

Demographic information

- Date…………………………………………………………………….
- Time……………………………………………………………………
- Place……………………………………………………………………
- Class……………………………………………………………………
- Sex………………………………………………………………………

Section B

1. What instructional materials do teachers employ in teaching basic science in science secondary schools?
2. Do you usually do practical work during science lesson?

Appendix I

BASIC SCIENCE PERFORMANCE TEST (BSPT)

This test has three subscales; these are JSS1, JSS2 and JSS3. Each subscale contains twenty questions with 30 minutes time frame. Students of each subscale are expected to attempt all questions. Each question is followed by four option letter A to D.

JUNOIR SECONDARY SCHOOL (JSS) 1

1. Which of the following food substances provides the greatest amount of energy to the body?
   A. Carbohydrate
   B. Fats
   C. Proteins
   D. Water soluble vitamins
2. Which of the following human activities pollutes air?
   A. Bush burning
   B. Fish farming
   C. Forest conservation
   D. Harvesting of crop
3. How many states of matter do we have?
   A. 2
   B. 3
   C. 4
   D. 5
4. Which of the following is not among the benefits of energy?
   A. Burning of houses
   B. Cooking
   C. Heating homes
   D. Moving cars

5. The rate of transfer of heat in substances differ because heat energy is transfer through ………………
   A. conduction, convection and radiation
   B. evaporation and resistor
   C. magnetic force
   D. radiation, conduction and insulation
6. Which one of the following is not a source of renewable energy?
   A. Coal
   B. Sun
   C. water
   D. Wind
7. The force which pulls objects towards the centre of the earth is called…………
   A. Adhesion
   B. Cohesion
   C. Force of gravity
   D. Magnetic force
8. Which one of the following is NOT a disadvantage of friction?
   A. Generating heat in machines
   B. Helping us to sharpen our cutlasses
   C. Reducing the efficiency of machines
   D. Wearing off of machines parts
9. Choose one of the following substances that sublimes when heated?
   A. Camphor
   B. Iron Fillings
   C. Shea butter
   D. Sulphur
10. The basic unit of matter is the …………………………………
   A. Atom
   B. Element
   C. Ion
   D. Proton
11. When matter changes state from gas to liquid there is a/an…………
   A. decrease in mass

B. decrease in volume
C. increase in pressure
D. increase in temperature

12. Which of the following substances exist in all the three states of matter?
A. Alcohol
B. Milk
C. Petrol
D. Water

13. The process by which living things increase in size and weight is………
A. excretion
B. growth
C. movement
D. sensitivity

14. To an egg albumen add few drops of million's reagent. A white precipitate is formed which when heated turns red. This is the test for ………
A. carbohydrate
B. fats and oil
C. proteins
D. water

15. Air pollution is cause by the …………… into the atmosphere.
A. Released of water vapour
B. Released of sewage
C. Released of poisonous smokes and gases
D. Released of refuse

16. Heavily polluted water cause………………
A. Asthma
B. Cholera
C. Colon cancer
D. Measles

17. Which institution in Nigeria is responsible for controlling environmental pollution?
A. Environmental Protection Agency
B. Environmental Protection Authority
C. Food and Drug Board
D. Nigeria Standard Organization

18. Inability of body to do work is as a result of lack of …….
A. health
B. energy
C. force
D. magnet

19. What type of energy is possessed by a mango hanging on a branch of a tree?
    A. Electrical energy
    B. Gravitational energy
    C. Kinetic energy
    D. Potential energy
20. Which of the following is not a characteristic of all living organisms?
    A. Feeding
    B. Photosynthesis
    C. Reproduction
    D. Respiration

JUNOIR SECONDARY SCHOOL (JSS) 2

1. The structure which helps fish to breathe in water is the………………
   A. buccal cavity
   B. gills
   C. heart
   D. kidney
2. Which of the following characteristics of forest habitat is false?
   A. Annual rainfall is high
   B. Grasses are the most abundant species
   C. Humidity is high
   D. Temperature is low
3. It is a safe measure to wear goggles when handling substances that……
   A. are corrosive
   B. are highly flammable
   C. are poisonous
   D. emit sparks
4. One hazardous substance that may be obtained from car exhaust fumes is…….
   A. carbon (iv) oxide
   B. carbon monoxide
   C. Sulphur (iv) oxide
   D. water
5. The energy that a body has due to its position or state of motion is……….
   A. heat energy
   B. kinetic energy
   C. mechanical energy
   D. potential energy

6. The energy possessed by a body at rest is……………………
   A. kinetic energy
   B. light energy
   C. nuclear energy
   D. potential energy
7. Kinetic theory assumes that particles of a gas are in constant…………
   A. change
   B. motion
   C. position
   D. shape
8. Heat is transferred along an iron rod by……………….
   A. conduction
   B. convection
   C. radiation
   D. reflection
9. The S.I. unit of heat is the…………….
   A. Joules
   B. Kelvin
   C. Newton
   D. Pascal
10. Crude oil can be best separated into its various components by………
    A. chromatography
    B. fractional crystallization
    C. fractional distillation
    D. Sublimation
11. …………… is a change that does not occur in a girl at the age of puberty?
    A. Hair grows in pubic area
    B. Menstruation begins
    C. The breast develops
    D. The teeth become whiter

12. When detecting the odour of a substance it is not advisable to bring the substance very close to your nose because some chemicals are…………………………………
    A. have some pungent smell
    B. highly flammable
    C. poisonous
    D. volatile
13. Which of the following gases is not hazardous even when present in large quantities?
    A. Carbon monoxide
    B. Hydrogen sulphide
    C. Methane
    D. Nitrogen
14. Which of these methods would you use to put out the fire if someone's clothing catches fire in the kitchen?
    A. Add cold oil
    B. Carbon dioxide gas.
    C. Fire blanket
    D. Sand bucket
15. Why wood and rubber are insulator is because ……….
    A. of the condensation
    B. of the conduction
    C. of the radiation
    D. they do not allow heat to passthrough them
16. The boiling point of water is…………………………………………
    A. $78\,^0C$
    B. $90\,^0C$
    C. $100\,^0C$
    D. $273\,^0C$
17. When the brakes of a bicycle in motion are applied for a long time the wheels become hot. This is because of a change of energy from……………….
    A. electrical energy to heat energy
    B. kinetic energy to heat energy
    C. potential energy to heat energy
    D. sound energy to heat energy

18. When guava is falling from a tree, its potential energy is changed to……………………
    A. chemical energy
    B. heat energy
    C. kinetic energy
    D. sound energy
19. Pathogens are ……………. that causes communicable/infectious diseases in man
    A. rodents
    B. flies
    C. microorganism
    D. vertebrates
20. A boy who is seventeen years old is considered…………………………
    A. an adolescent
    B. an adult
    C. an infant
    D. as being old

JUNOIR SECONDARY SCHOOL (JSS) 3

1. Which of the following characteristics is NOT heritable?
   A. Armed robbery
   B. Blood group
   C. Height
   D. Shape of nose
2. The material that contains the traits that are passed on from parents to offspring is……
   A. cytoplasm
   B. genes
   C. mitochondria
   D. vacuole
3. The most common cause of flooding in any environment is………………
   A. excessive drought
   B. excessive rainfall
   C. breakdown of dams
   D. poor drainage system
4. Which of the following is a drug control agency?
   A. Basic Science Agency
   B. Biological Science Student's Association.
   C. Medical Student's Association
   D. National Agency for Food and Drug Administration and Control
5. The cutting down of trees in a large area and the destruction of forest by people is called……...
   A. deforestation
   B. erosion
   C. flooding
   D. forestation

6. The resources from living things are……………………
   A. coal and gold
   B. dairy products and food crop
   C. limestone and dyes
   D. water and tin
7. Why is office pin attracted by magnet?
   A. Because it is made of aluminium spoon
   B. Because it is made of copper wire
   C. Because it is made of gold necklace
   D. Because it is made of iron ore
8. How many poles has the bar magnet?
   A. 1
   B. 2
   C. 3
   D. 4
9. Conduction of electricity is associated with metals because of the movement of………
   A. atoms
   B. free electrons
   C. free protons
   D. ions
10. Examples of solid mineral include the fallowing EXCEPT………………..
   A. coal
   B. coca cola
   C. limestone
   D. tin
11. Identical twins look alike because they develop from……………………
   A. one ovum fertilized by one sperm
   B. one ovum fertilized by two sperms
   C. two ova fertilized by one sperm at the same time
   D. two ova fertilized by two sperms at the same time.

12. Ear is a sense organ use for……………………………………………….
    A. hearing
    B. seeing
    C. smelling
    D. testing
13. Which of the following electronic devices is used to control the size of current flowing in an electronic circuit?
    A. Capacitor
    B. Diode
    C. Resistor
    D. Transistor
14. The rays of light travelling from air into glass are …………………. towards the normal.
    A. converge parallel rays
    B. diverge parallel rays
    C. reflected
    D. refracted
15. When forest gets destroyed who will be affected………………….
    A. Businesses
    B. Church and mosque
    C. Industries
    D. Plant and animal
16. Which of the following metals is strongly attracted by magnets?
    A. Aluminium
    B. Copper
    C. Pure iron
    D. Steel
17. Desertification can be cause by………………………………………
    A. cutting of trees
    B. ice melting
    C. ozone layer
    D. volcano activity
18. Seasoning of timber is the process of ……………………….
    A. adding glaze
    B. adding preservatives
    C. burning timber
    D. removing water

19. Which of the following statements about radioactive rays is correct?
    A. It causes cancers
    B. It causes disbalance among different minerals in the soil
    C. It causes genetic changes in the animals
    D. It hinders blood circulation
20. A bar magnet is must effectively demagnetize by …………….
    A. bringing its north pole in contact with the north pole of a very strong magnet
    B. heating the magnet
    C. placing it in a N – S position and hitting it with a hammer
    D. subjecting it to an electric current from a battery

Appendix J

JSS 1 PERFORMANCE TEST MARKING SCHEME

ANY CORRECT ANSWER REQUIRES ONE MARK

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

JSS 2 PERFORMANCE TEST MARKING SCHEME

ANY CORRECT ANSWER REQUIRES ONE MARK

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

JSS 3 PERFORMANCE TEST MARKING SCHEME

ANY CORRECT ANSWER REQUIRES ONE MARK

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

Appendix K

JSS 1 BSPT Item analysis

item	Correct upper group	Correct lower group	Difficulty (p)	Discrimination (d)
1	10	5	0.75	0.5
2	8	3	0.55	0.5
3	9	2	0.55	0.7
4	10	2	0.60	0.8
5	8	2	0.50	0.6
6	7	2	0.45	0.5
7	10	3	0.65	0.7
8	8	1	0.45	0.7
9	10	4	0.70	0.6
10	9	4	0.65	0.5
11	10	0	0.50	1.0
12	9	1	0.50	0.8
13	8	2	0.50	0.6
14	10	5	0.75	0.5
15	10	5	0.75	0.5
16	10	2	0.60	0.8
17	10	5	0.75	0.5
18	10	3	0.65	0.7
19	10	3	0.65	0.7
20	6	1	0.35	0.5

JSS 2 BSPT Item analysis

ITEM	Correct upper group	Correct lower group	Difficult index	Discrimination index
1	8	1	0.45	0.7
2	4	1	0.25	0.3
3	10	0	0.50	1
4	8	1	0.45	0.7
5	10	5	0.75	0.5
6	9	5	0.70	0.4
7	10	4	0.70	0.6
8	9	2	0.55	0.7
9	3	6	0.45	0.3
10	8	3	0.55	0.5
11	10	5	0.75	0.5
12	10	7	0.85	0.3
13	8	3	0.55	0.5
14	10	3	0.65	0.7
15	8	3	0.55	0.5
16	9	5	0.70	0.4
17	10	3	0.65	0.7
18	9	0	0.45	0.9
19	10	4	0.70	0.6
20	10	4	0.70	0.6

JSS 3 BSPT Item analysis

item	Correct upper group	Correct lower group	Difficulty (p)	Discrimination (d)
1	8	2	0.50	0.6
2	10	5	0.75	0.5
3	7	2	0.45	0.5
4	9	3	0.60	0.6
5	9	3	0.60	0.6
6	8	2	0.50	0.6
7	8	3	0.55	0.5
8	9	4	0.65	0.5
9	8	3	0.55	0.5
10	9	1	0.50	0.6
11	9	5	0.70	0.4
12	7	2	0.45	0.5
13	8	5	0.65	0.3
14	8	5	0.65	0.3
15	9	3	0.60	0.6
16	9	5	0.70	0.4
17	8	3	0.55	0.5
18	9	4	0.65	0.5
19	10	5	0.75	0.5
20	10	4	0.70	0.6

Appendix L

Rotated Component Matrix[a]

	Component		
	1	2	3
Item1			.635
Item 2			.551
Item 3		.648	
Item 4			.851
Item 5	.876		
Item 6	.626		
Item 7	.665		
Item 8			.842
Item 9		.601	
Item 10	.808		
Item 11	.610		
Item 12		.870	
Item 13			.434
Item 14	.572		
Item 15	.330		
Item 16	-.378		.455
Item 17	.763		
Item 18		.837	
Item 19	.342		
Item 20	.495		
Item 21		.784	
Item 22		.860	
Item 23		.722	
Item 24		.645	
Item 25			.377
Item 26			.400
Item 27			.527
Item 28			.652
Item 29		.648	
Item 30			.308
Item 31			
Item 32			.338
Item 33	.874		
Item 34	.612		
Item 35	.861		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.

Appendix M

Rotated Component Matrix[a]

	Component		
	1	2	3
Item 1		.751	
Item 2		.752	
Item 3		.825	
Item 4		.610	
Item 5		.770	
Item 6			.671
Item 7			.734
Item 8			.651
Item 9			.686
Item 10			.700
Item 11			
Item 12			
Item 13	.977		
Item 14	.969		
Item 15			
Item 16	.447		
Item 17	.977		
Item 18	.555		

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization.

a. Rotation converged in 4 iterations.

APPENDIX N

Crosstabs

Case Processing Summary

	Cases					
	Valid		Missing		Total	
	N	Percent	N	Percent	N	Percent
RATERA * RATERB	8	100.0%	0	.0%	8	100.0%

RATERA * RATERB Crosstabulation

			RATERB			Total
			TEACHER BASIC LNOWLEDGE	BASIC CLASSROOM SKILLS	ASSESSMENT FOR LEARNERS LEARNING	
RATERA	TEACHER BASIC KNOWLEDGE	Count	5	0	0	5
		Expected Count	3.8	.6	.6	5.0
	BASIC CLASSROOM SKILLS	Count	1	1	0	2
		Expected Count	1.5	.2	.2	2.0
	ASSESSMENT FOR LEARNERS LEARNING	Count	0	0	1	1
		Expected Count	.8	.1	.1	1.0
Total		Count	6	1	1	8
		Expected Count	6.0	1.0	1.0	8.0

Symmetric Measures

		Value	Asymp. Std. Error[a]	Approx. T[b]	Approx. Sig.
Measure of Agreement	Kappa	.742	.237	2.918	.004
N of Valid Cases		8			

a. Not assuming the null hypothesis.

b. Using the asymptotic standard error assuming the null hypothesis.

Appendix O

Coding sheet

Dimension of Learning domain	Code	Description
Cognitive		
	K	Knowledge
	C	Comprehension
	Ap	Application
	An	Analysis
	S	Synthesis
	E	Evaluation
Affective		
	Rec	Receiving
	Res	Responding
	Va	Valuing
	Org	Organization
	Ch	Characterization by value
Psychomotor		
	O	Observing
	I	Imitation
	Pr	Practicing
	Ad	Adapting

Appendix P

Examples of performance objectives and their cognitive process

Performance objectives	Cognitive processes
Students should be able to:	
Define personal cleanliness	knowledge
Describe the methods of keeping their bodies and homes clean	Comprehension
Group food into classes based on nutrient content	Synthesis
Plan an adequate diet for a home	Synthesis
State the source of the earth energy	Knowledge
Uses chart to illustrate the natural cycles	Application
Distinguish between biodegradable and non-biodegradable materials	Comprehension
List ways in which a community/ school can dispose refuse	Knowledge
Explain the need for environmental sanitation	Comprehension
Locate where to get immunization	Knowledge
Recognize irresponsible sexual behavior as a major cause of the spread of HIV /AIDS	Knowledge
Classify drugs and their sources	Comprehension
Illustrate the eclipse of the sun and the moon	Application
Collect and identify samples of plants and animals in their environment.	Knowledge
Prepare a plant album	Synthesis
Initiates and guide discussion on activities of living things	Application
Name forms of energy	Knowledge
Give examples of renewable and Non- renewables energy	Comprehension
Measure and calculate gravitational force when mass and height are provided	Application
Demonstrate balance and unbalanced forces	Comprehension
Analyses the consequences of contracting diseases or infections.	Analysis
Discuss the different methods of pollution control	Comprehension

Appendix Q

Examples of activities and their affective processes

Activity	Affective processes
Participate in discussion and write down points on digestion and absorption of food.	Valuing
Take students to visit different habitats.	Receiving
Follow teacher's instruction to carry out listed measurements	Receiving
Selects students of different heights, weights, and sizes to stand before the class	Receiving
Demonstrates physical and chemical changes.	Valuing
Leads class discussion on: changes in non-living matter example of physical and chemical changes.	Responding
Compare: themselves with their baby brothers and sisters at home; - themselves with their teacher and parents.	Organization
Perform activities that lead to changes in non-living things.	Characterization by value
Study and practice solving similar problem	Characterization by value
Initiates and leads discussion to show that energy transfers occur when work is done	Valuing

Appendix R

Examples of activities and their psychomotor processes

Activity	Psychomotor processes
Measure temperature differences between two cans, one painted black and other not painted, that are equidistant from a source of heat	Practicing
Dip one end of metal spoon in hot water and state their observations	Observing
Copy chalkboard summaries	Imitation
Observe films and pictures	Observing
Demonstrate simple reflex action e.g kneel jerk.	Practicing
Write the symbols of common elements and formulae of common compounds	Imitation
Draw a map of Nigeria showing distribution of solid minerals	Imitation
Dissects a chicken to display its alimentary system for students' observation	Adapting

Appendix S

Run MATRIX procedure:

Krippendorff's Alpha Reliability Estimate

	Alpha	LL95%CI	UL95%CI	Units	Observrs	Pairs
Ordinal	.8927	.7319	1.0000	15.0000	3.0000	45.0000

Probability (q) of failure to achieve an alpha of at least alphamin:

alphamin	q
.9000	.6058
.8000	.1348
.7000	.0122
.6700	.0027
.6000	.0007
.5000	.0000

Number of bootstrap samples:
10000

Judges used in these computations:
Observer Observ_1 Observ_2

Examine output for SPSS errors and do not interpret if any are found

------ END MATRIX -----

Appendix T

UNIVERSITY OF CAPE COAST
COLLEGE OF EDUCATION STUDIES
FACULTY OF SCIENCE AND TECHNOLOGY EDUCATION
DEPARTMENT OF SCIENCE EDUCATION

Tel: 03320 96801/96951
Email: dse@ucc.edu.gh
Website: www.ucc.edu.gh

University Post Office
Cape Coast
Ghana

Your Ref:
Our Ref: DSE/S.3/V1/252

29th June, 2018

The Honourable Commissioner,
Ministry of Education

Thro'

The Director of Science
Kebbi State
Nigeria

Dear Sir,

LETTER OF INTRODUCTION – MR. AMINU ALIYU

We write on behalf of **Mr. Aminu Aliyu** with student reg. number **ED/SCP/16/0006** currently on the Doctor of Philosophy (Science Education) programme of the Department of Science Education – University of Cape Coast.

Mr. Aliyu is conducting a research on the topic: "**The Status of Teaching and Learning of Science in the Basic Schools in Kebbi State, Nigeria**" and is required to collect relevant data, conduct achievement tests for selected students in JSS 1,2, 3, and observe classroom teaching and laboratory facilities.

This Letter therefore seeks to introduce and humbly request that you grant him permission and assistance in conducting his research in your state.

Thank you in anticipation of your unflinching support.

Yours faithfully,

HEAD
DEPT. OF SCIENCE EDUCATION
UNIVERSITY OF CAPE COAST
CAPE COAST

Dr. Eugene Johnson
HEAD

Appendix U

KEBBI STATE OF NIGERIA

MINISTRY FOR BASIC AND SECONDARY EDUCATION

GWADANGWAJI SECRETARIAT COMPLEX, BIRNIN KEBBI

P.M.B. 1070, B/KEBBI

Tel: 068 320610, 068320617

Our Ref:.. Date: 22ND NOVEMBER, 2018

The Director,
Zonal Education Office,

LETTER OF INTRODUCTION IN RESPECT OF MR. AMINU ALIYU

I am directed to write on behalf of Mr. Aminu ALiyu a student of Cape cost College of Education Faculty of Science and Technology Education (University of Cape Cost) Ghana.

The above named is conducting a research on the topic "The status of teaching and learning of science in the Basic Schools in Kebbi State".

You may kindly accord him all the necessary assistance he may require.

Thanks.

Hassan M. Ibrahim
Director Science and Technology

Appendix V

KEBBI STATE GOVERNMENT
MINISTRY OF EDUCATION
ZONAL EDUCATION OFFICE
ARGUNGU

P.M.B. 1003
TEL:550550

Our Ref.................................Your Ref.................................Date. 23/11/2018

The principal,

RE: INTRODUCTION LETTER

I am directed to introduce you Mr. Aminu Aliyu a PhD student from Department of Science Education at University of Cape Coast, Ghana.

He is conducting his Doctoral research in the field of science teaching and learning on a research topic " **The Status of Teaching and Learning of Science in the Basic Schools in Kebbi State, Nigeria** " and required to collect relevant data to his research topic for the purpose of academic research only.

Kindly help him in whatever area he may need your assistance

Thank you

ZONAL DIRECTOR
ZONAL EDUCATION OFFICE
ARGUNGU
DATE 23/11/2018