INSTRUCTIONAL TIME, TEACHER QUALITY AND SUBJECT SPECIALISATION AS DETERMINANTS OF PUPILS' ACHIEVEMENT IN BASIC SCIENCE AND TECHNOLOGY IN OGUN STATE PRIMARY SCHOOLS

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ABSTRACT

Low achievement in the sciences at secondary schools over time has been a source of concern to Nigerians. Addressing this problem would demand building a good foundation in Basic Science and Technology (BST) right from primary schools. Researchers have reported that teacher factors do have effect on pupils' achievement in BST. However, some aspects of the quality, characteristics and classroom practices of the teacher that may influence their achievement have not been extensively studied. This study, therefore, constructed and tested a nine-variable model (school location, gender, subject specialisation, instructional time, content knowledge, pedagogical skills, attitude and classroom interaction) to provide a causal explanation of primary school pupils' achievement in BST.

The study adopted a survey research design. The multistage sampling technique was used to obtain a representative sample of teachers and pupils across the 20 Local Government Areas of Ogun State. Schools were stratified into rural and urban. The proportionate stratified sampling technique was used to select 148 out of the 14, 751 BST teachers (49 males, 99 females). Also, 3, 052 pupils in the selected teachers' classrooms participated in this study. Six validated instruments were used: Teachers' Time Management Observational Scale (r=0.81); Pedagogical Skills Observational Scale (r=0.84); Teacher-Pupils Interaction Observation Scale (r=0.82); Teachers' Attitude to BST Scale (0.71); Teachers' BST Content Knowledge Test (r= 0.96) and Pupils' BST Achievement Test (r=0.92). Data were analysed using multiple regression and path analyses at $p < 0.05$ level of significance.

There was no significant mean difference (0.02) between the hypothesised and the reproduced correlation coefficients. Hence, the hypothesised and parsimonious models can be assumed to be the same in explaining factors that influenced BST achievement. Out of the eight variables, only four had direct causal influence: school location (0.09), teachers' pedagogical skills (0.10), attitude to BST (0.18) and classroom interaction (0.18). Six of the eight variables had indirect effect on BST achievement: school location, teacher's gender, subject specialisation, instructional time, content knowledge and pedagogical skills. However, only three of the six variables contributed significantly to the prediction of BST pupils' achievement; instructional time (0.20), content knowledge (0.05) and pedagogical skills (0.10). Teachers' instructional time and content knowledge had indirect influence only. Instructional time and pedagogical skills had the greatest standardised total effects (0.20) respectively on pupils' achievement in BST. The other variables with significant total influence were classroom interaction (0.18), attitude (0.18), school location (0.12) and content knowledge (0.05).

School location, teachers' pedagogical skills, attitude to Basic Science and Technology and interaction with pupils had significant influence on achievement. Qualified teachers should be recruited and equitably distributed across schools irrespective of location to engender effective learning. Instructional time management should be emphasised in the pre-service science teacher curriculum. Pre-service teachers should be motivated to develop positive attitude towards the teaching of Basic Science and Technology. Educational stakeholders should also regularly organise science update courses for BST teachers so as to improve on their content knowledge.

Key words: Basic Education, Achievement in Basic Science and Technology, Instructional time, Classroom interaction, Pedagogical skills.

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CERTIFICATION

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DEDICATION

This research work is dedicated to my Lord and Saviour Jesus Christ and the sweet memories of my late father, Dr. Jonathan Adekolapo Rowaiye. Painfully, he did not stay around long enough to see the fulfilment of this dream.

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CHAPTER ONE
INTRODUCTION

1.1 Background to the Problem

Primary education is the second stage of formal education following after the pre-primary classes and it aims at achieving basic literacy and numeracy among all children. This stage of education is usually given in institutions for children aged 6 - 11 years. In most countries, of which Nigeria is one, it is compulsory for children to receive primary education, though in many jurisdictions it is permissible for parents to provide it. Primary education is the foundation upon which other levels of education are laid (Aaron, 2003). Basic education programme in Nigeria is made up of nine years; three years in lower basic section, three years in upper basic and three years in the junior secondary section. As stated in section 3, sub section 16 of the National Policy on Education (FRN, 2004), basic education is compulsory, universal and free. The primary education is the foundation for other levels of education. The major goals of primary education are achieving basic literacy and numeracy amongst all pupils, as well as establishing foundations in science, mathematics, geography, history and other social sciences. Pupils spend six years in primary schools and graduate with the first school-leaving certificate.

The importance of science lies not only in its contributions to scientific and technological development but also in its usefulness in the day-to-day human interactions at home, business place, politics, sports, medicine, agriculture, engineering, the social and natural sciences and in all human endeavours. The foundation of life is grounded in Science and Science is as basic, as important as acquiring the skills and knowledge needed to read and write, use mathematical ideas, apply technology, understand the social sciences and appreciate the fine arts. The teaching of Elementary science in Nigerian primary schools now called Basic Science and Technology exposes pupils to a variety of experiential activities, which are designed to develop scientific knowledge, attitude and skills. It lays the groundwork for pupils to become competent and productive thinking citizens who objectively seek solutions to problems and design and implement appropriate strategies for problem solving. Towards this end, Basic Science and Technology lessons help pupils to become scientifically literate by providing them with a comprehensive knowledge base of facts, concepts, conceptual networks and skills. Science is generally referred to as the ‘know why' while technology can be described as the practice of any or the applied science that has practical value and/or industrial use. Scientific breakthroughs bring about technological development in the society.

Technology as a study covers the human ability to shape and change the physical world to meet needs, by manipulating materials and tools with techniques. The goal of technology education is to teach the knowledge and techniques to develop technological literacy which is accomplished by bringing laboratory activities to pupils. Rohaan (2009) opined that the need for technology education in primary schools is four fold. First, children of this era grow up in a world full of technology. It is of great importance that education offers them the opportunity to develop technological literacy, i.e., the ability to use, manage, assess, and understand technology, and provide them with a broad and realistic view of technology in order to 'survive' in today's technological society. Second, children are naturally interested in how and why things work. It is a task of education to keep this curiosity alive and motivate them to deepen and broaden their knowledge. Third, technology education is highly suitable to create a rich and attractive learning environment. And finally, a negative attitude towards technology as a study or career, which many students between 12 and 18 years old have, is expected to change in a positive direction when starting to teach technology in primary schools.

It is reasoned that pupils in primary schools still have a natural curiosity for science and technology, but primary school teachers often lack the ability and confidence to develop this curiosity with exciting science and technology lessons and hands-on activities. [Organization for Economic Cooperation and Development, (OECD, 2005)]. The nation's public education system has almost migrated from the situation when there are entrance examinations into secondary schools; it is assumed that there would be full (100%) transition from the middle basic to the upper basic level. Therefore the foundation laid in Basic Science and Technology would have implication for the study of sciences in the secondary schools.

Teaching is a complex activity that involves careful preparation and planning objectives and activities on an hourly, daily, and weekly basis. The teacher is the yardstick that measures the achievements and aspirations of the nation. The worth and potentialities of a country get evaluated in and through the work of the teacher. The people of a country are the enlarged replica of their teachers. Teachers are the real nation builders. The teacher is the pivot of any educational system. On him rests the failure or the success of the educational system. If the teachers are well educated, if they are intellectually alive and take keen interest in their job, then, success is ensured. On the other hand, if they lack training in education and if they cannot give their heart to their profession, the system is destined to fail. Hence, the teacher is a vital component of the school system.

Gbagi (2011) blamed teachers for poor performance of candidates in public examinations in the country, noting that 'teachers are not doing enough to educate their students' and that failure in

examinations has nothing to do with the government. Ayedun (2011) in line with Gbagi asserted that learners' failure is essentially the teachers' failure. It is not the government who is employed to teach the students in our schools; not the parents, it is also not the students who are expected to teach themselves in our schools. The teachers are the ones solely employed to teach the students. The teachers have the sole authority, the sole responsibility and the sole accountability for the education of the students in our schools.

Olukoya (2011) however argued that the students' failure was not their teachers' fault. He added that the performance of a candidate in any examination was a function of many factors. Many factors have been found to be responsible for the success or otherwise of pupils in school work, they are, school, home, teacher, pupils, government etc. it is the totality of everybody's contribution. Teachers are often the obvious scapegoat in a situation where a pupil is under- performing. They are the visible faces of education. Teachers believe however, that what a teacher can achieve is always limited or furthered by certain other aspects of the pupil's life and environment. Teachers then need to be determined to seek better ways of educating the learners in schools in spite of all the governmental and societal shortcomings. Without such determination, any improvement intervention would only be palliative. Even when there are numerous impediments in the ways of teachers to do their work, yet it is still possible to strive to excel beyond the ordinary with determination. There are many ways the teachers can go about improving the educational process they operate and enhance the success of the pupils' learning experience.

The differences between schools can be explained by the different structures that surround the different types of schools. The location of schools can be termed as rural and urban. The location of the school could influence the level of academic achievement of pupils. Dunne in McCracken and Barcinas(1991)concluded that urban students have higher educational aspirations than rural students. Jekayinfa (2008) indicated that there was a significant difference in the level of difficulties of some social studies topics as perceived by students in the rural and urban locations.

Owoeye (2000) opined that school location has a significant effect on the academic performance of the pupils. Trickett in Freeman and Anderman (2005) found that learners in urban schools were significantly more focussed on mastering the material or skill required in their school work than those in rural settings. According to Reeves and Bylund (2005), one prominent study finds that students in rural schools perform less well than their urban counterparts, but other studies using the same national data set have reached divergent conclusions. This however contradicts some findings which noted that, school location has no significant effect on academic performance of

pupils [Onah & Ugwu 2010; Yussuf & Adigun 2010]. Research does not provide clear evidence that rural schools are inferior to urban schools.

In most parts of the world, women and girls continue to be under-represented in fields of study and employment related to science and technology (Amusan, 2011). Socio-cultural barriers were identified as being among the greatest impediment to women's access to scientific and technological education, often due to unconscious influences in the home from parental/family opinions, cultural and social norms. The ability of girls and women is often called into question: girls are discouraged from taking scientific and technical courses, since it is generally thought that they are too difficult and therefore appropriate only for men. These negative social attitudes create a lack of self-confidence among girls and women in their ability and motivation to opt for science. Among the fewer females who are in the field of science education, fewer still, see themselves as capable of teaching science effectively. Amusan and Odunuga (2012) noted that teachers' gender contributed positively to the attitude of teachers to the teaching of BST, which might in turn affect pupils' achievement in BST.

Most classroom teachers find that they have a preference for one or more of the subjects that they teach. It has been argued that we can no longer reasonably expect primary school science teachers to be subject matter generalists, they must specialize. A highly crowded primary school curriculum means generalist teachers would only have a breadth but not a depth of science knowledge. It is pertinent to state that a professional Basic Science and Technology teacher in primary schools is a professionally prepared teacher in contents and methods of teaching primary science, thereby acquiring a professional certificate in Science Education with special reference to any of the science subjects or in combination with other science subject e.g. Integrated Science, Biology, Physics, Chemistry, Computer Science, Mathematics etc.

In many primary schools, each class has a teacher who stays with them for most of the week and will teach them the whole curriculum. In addition to BST, primary school teachers are expected to have knowledge for multiple disciplines. At one end of the spectrum, each primary school teacher is responsible for BST instruction; at the other end, only BST specialists can be adequately prepared to handle such a task (Schwartz & Gess-Newsome, 2008). Some primary schools, in a bid to address this supposed defect, departmentalize the class curriculum. Some primary schools now have their classes manned by two teachers with subjects split along the divide of science and arts. One could take the pupils Mathematics, Basic Science and Technology, Computer science, Health education while the other handles English language, Social studies, Religious knowledge, Writing etc. in a contained classroom.

Subject specialisation has been known to be related to pupils' achievement. Research has accumulated linking learners' achievement to the qualifications of teachers, (Goldhaber & Brewer; Mayer, Mullens & Moore, 2000). Most primary school teachers come from a non Science & Technology backgrounds, not having had specific professional training in Science & Technology, the teachers are then required to teach the subject for which they lack competence. According to Darling-Hammond (2000), a specific teacher characteristic such as academic major is associated with increased gains in student achievement. A study by Ferguson and Womack (1993), found that subject matter major in the National Teacher Examination explained some of the differences in the ratings of the classroom performance by both supervisors and subject-matter specialists. Monk (1994) found that unlike with mathematics, having a science major was positively associated with gains in student achievement. Hawk, Coble, and Swanson in Alexander and Fuller (2004), found that students with mathematics teachers assigned infield (that is, mathematics teachers with major in mathematics) scored higher and had greater gains than students with mathematics teachers assigned out-of-field (that is, mathematics teachers who do not have mathematics as their subject major). Goldhaber and Brewer (2000) also found that students with teachers possessing degrees in mathematics had greater gains in achievement than students with teachers with non-mathematics degrees, but found no such results for science. However, Wenglinsky (2000) found that teachers with a major or minor in the subject area that they are assigned to teach produce greater gains in student achievement in both mathematics and science. Druva and Anderson in Imhanlahimi and Aguele (2006) also concluded that there is a positive relationship between teachers' science coursework and student performance.

Slavin (2003) stressed that quality teachers need to know amongst others, how to use class time effectively. Organization in their classrooms is important for such teachers because they allow the central focus of classroom time to be on teaching and learning, reinforcing their focus on instruction through their allocation of time to the teaching and learning process. Time is one of the most challenging constraints a teacher faces in trying to achieve curricular goals and meet the needs of all pupils, while managing the administrative tasks that are a necessary responsibility of the job. According to Stronge (2007), teachers spend about 70 percent of their classroom instruction time on the core curriculum. The remaining 30 percent is spent on completing such tasks as collecting money for the school fund-raiser, enforcing classroom rules and procedures, participating in fire drills and school-wide assemblies, and listening to school-wide announcements. A study of U.S. mathematics lessons revealed that lessons were interrupted by a public announcement 29 percent of the time (Hiebert, Hollingsworth, Jacobs, Gallimore & Givvin, 2005). Nonetheless, effective teachers do manage to maximize instruction by their thoughtful and careful use of time.

The effective teacher prioritises instruction, a process that is accomplished partially through allocation of time. Use of time can be optimized in the classroom by careful planning. Establishing a pattern so that pupils can anticipate academic transitions reduces the loss of instructional time. Effective teachers handle administrative tasks quickly and efficiently, prepare learning materials in advance, organize clear and smooth in-between classes' transitions and limit disruptions and interruptions through appropriate behavioural management techniques. The more time pupils spend involved in learning activities, the more they learn. That is, there is a relationship between the amount of time pupils are actively engaged in learning activities and their achievement, (Mastropieri & Scruggs, 2000). The ability of the teacher to organize or manage and thereby spend quality portion of the allocated time for instruction may therefore affect the achievement of the pupils.

When school schedules maximize the amount of time available for learning; when instructional time is devoted in large part to academic subjects; when classroom time is well managed; and when curriculum and instruction are appropriate and motivating, pupils can be expected to learn. At the school level, strategies such as better time management and increasing the proportion of time spent on academic subjects can help to maximize the amount of time available for pupils learning. Teachers should strive to make the subject scheduled time the same as the subject instructional time. The closer the instructional time is to the scheduled time, the greater the achievement, it is presumed. Most teachers schedule and allocate the appropriate amount of time for learning, but few teachers actually ensure that their pupils are engaged and actively occupied with activities geared towards the learning of the subject during the allocated time. It is therefore important that efficient classroom organisation and management procedures are in place. Steps to effective management can thus be stated:

i) Set time limits for transitions and reinforce adherence to limits

ii) Begin class at the sound of the bell

iii) Pupils should know that they should be in their seats when the bell rings

iv) Limit the number of times pupils can go to the toilet, open their lockers, etc.

It is believed that everyone, especially children will learn if taught relevant content within an appropriate time, in a conducive atmosphere, by well disposed teachers.

According to Okpala and Ellis (2005), teacher quality is very hard to define. The definition of teacher quality ranges from a focus on what teachers know and do in their classrooms, to how

knowledge should be acquired. Teacher quality is widely recognised as the single most important factor in student achievement, more important than class size, availability of materials, resources and physical plant, Kelly (2008). In fact, it is the most important school-related factor influencing student achievement. Teacher quality is the crucial driving force for improving student achievement and thus, promoting a nation's economic competitiveness in the global society. Teacher quality matters. The quality teacher recognizes academic instruction as central to his or her role. Although such teachers believe that students must be challenged but also realize that students need to experience success. The quality of teachers determines the quality of education says Akinwunmi and Ayeni (2003), research has concluded that pupils exposed to high quality instruction learn more than other pupils. Quantitative analyses indicate that measures of teacher preparation and certification are by far the strongest correlates of student achievement (Goldhaber & Brewer, 2000; Darling-Hammond, 2008).

To teach all students according to recommended standards, teachers need to understand the subject matter deeply and flexibly so they can help pupils create useful cognitive maps, relate one idea to another, and address misconceptions. Teachers need to see how ideas connect across fields and to everyday life. This kind of understanding provides a foundation for pedagogical content knowledge that enables teachers to make ideas accessible to their pupils. In Shulman's theoretical framework (1987), teachers need to master two types of knowledge: (a) content, also known as "deep" knowledge of the subject itself, and (b) knowledge of the curricular development. In Ingersoll's model, (1996), teacher quality is defined as a measure of teacher qualifications, teaching practices, and teacher preparation. Teacher qualifications include such components as content knowledge, pedagogical skills, teaching credentials and verbal abilities.

Teacher quality has been variously misunderstood and ill-defined by many scholars (Goldhaber, 2002; Rockoff, 2004; Darling-Hammond, 2005). Attributes such as subject speciality, degree level and certification type, teaching experience or general academic proficiency measured by standardized test scores or the selectivity of the college from which teachers graduated are often used as proxies for teacher quality. The importance of teacher quality in pupils' achievement cannot be overemphasised but the evidences on what constitute teacher quality are mixed.

From the above definitions, having quality teachers fundamentally involves having teachers with knowledge of content and pedagogical skills, knowledge of the curriculum and effective supervision and classroom management as well as reflection to improve the learning outcomes of the learners. In agreement with Shulman (1987), therefore, quality teachers would possess:

a. Content knowledge, which is the teacher's content background in the subject they teach.

b. Right attitude, which is the teacher's positive way of presenting learning materials to the pupils in a way that will whip up their interest in the subject.

c. Pedagogical skills, which embrace the principles and strategies of classroom management and organization.

d. Classroom interaction, which talks of the interaction between the teacher and the pupils in the classroom.

Quality teachers are experienced and have elaborate systems of knowledge of their subjects (Woolfolk, 2001). They need to know their subject matter thoroughly (Slavin, 2003). A teacher who is not well grounded in his subject matter would not have the ability and confidence to transmit knowledge in the classroom.

Teachers have the opportunity to leave an indelible impression on their pupils' lives. School experiences mould, shape, and, can influence how children view themselves and learn inside and outside of school. These school memories have the potential to last a lifetime in pupils' minds and can play a consequential role with present and future decisions. The effective attitude and actions employed by teachers can ultimately make a positive difference on the lives of their pupils. Attitude of the teacher to Basic Science and Technology can also serve to encourage or discourage pupils. Teachers with positive attitude toward Basic Science and Technology will encourage similar attitude in their pupils and vice versa.

A teacher's attitude relates to all facets of his or her performance in classroom. For example, the attitude of a teacher towards Basic science and technology will determine the measure of the teacher's attractiveness or repulsiveness to the teaching of the subject. This could invariably influence the pupils' achievement in that subject. At the primary level, teachers are expected to transmit the essence of scientific methods and to awaken the interest and enthusiasm of their pupils, but this would be difficult if they themselves are uncertain about the subject and their knowledge of it, some of which the pupils can sense. Thus the roles of the individual pupil, parent, school, teacher, the nature of science itself, gender difference, etc. cannot be ignored. These factors not only influence the attitude of the individual but also influence the direction, either positively or negatively (Yoloye, 1999). It follows therefore, that to have better pupils' performance in BST, there is need to motivate the teachers to have positive attitude towards the subject.

Content pedagogy refers to the pedagogical (teaching) skills teachers use to impart the specialized knowledge/content of their subject area(s). Pedagogy is when the teacher selects strategies to match pupils' needs. Effective teachers display a wide range of skills and abilities that lead to creating a learning environment where all pupils feel comfortable and are sure that they can succeed both academically and personally. Knowledge of content must be balanced with a solid grounding in effective teaching strategies, especially when we hope that teachers will improve the performance of pupils who have been failing or struggling. Eby in Okpala and Ellis (2005) stated that quality teachers should use a wide variety of instructional methods, experiences, assignments and materials to ensure that pupils are achieving all sorts of cognitive objectives. Quality teachers are aware of the preconceptions and background knowledge that pupils typically bring to each subject and of strategies and instructional materials that can be of assistance. In addition, they understand and solve the possible difficulties likely to arise in the classroom and modify their practice accordingly. Their instructional repertoire allows them to create multiple paths to knowledge, in general, and to the subjects they teach, in particular.

Experience has shown that many primary school teachers talk down to their pupils rather than talk to them. Most of their pupils are actually scared of them. Many primary school teachers seldom realize that how they teach, how they behave and how they interact with pupils can be more paramount than what they teach. Teaching is an interaction course that takes place between the teacher and pupils. Darling-Hammond (2008); Gordon, Kane and Staiger (2006) believe that the teacher's relational quality with learners has an important role in effectiveness of his teaching and the standard for measuring the effectiveness of the teachers that is creating the learning.

While researchers tend to agree that teacher quality is an important determining factor in influencing student outcomes, there is little consensus about the relationship between specific teacher attributes and teacher effectiveness. Commonly used criteria for certification, recruitment, screening, and selection of teachers (i.e., certification status, degree, and experience levels) are not strongly correlated with learners' achievement (Goldhaber & Brewer, 2000).

1.2 Statement of the Problem

The prevailing low enrolment in Science and Technology related courses in tertiary institutions over time have been known to evolve from the poor background of learners in science and technology education at lower levels of their education. Even though stakeholders in education had made efforts to improve the quality of Science and Technology education in terms of content

delivery, by retraining the teachers in various workshops and seminars, yet there has been no remarkable improvement in the enrolment.

A number of researchers have argued that some teacher related factors are powerful predictors of pupil performance. Teacher variables have been known to be important in determining achievement of pupils, but researchers have not been able to conclusively and consistently agree on the specific teacher attributes that influence pupils' achievement in BST. The strength and direction of the influence have not been conclusive. More importantly, variables such as knowledge of teachers and subject specialisation have not been studied along with allied teacher variables at primary school level to establish the strength and direction of such influences. This study therefore sought to provide a causal explanation of achievement of primary school pupils in BST in terms of teacher variables, such as, school location, gender, subject specialisation, instructional time, content knowledge, pedagogical skills, attitude to BST as a subject and its teaching, and classroom interaction.

1.3 Research Questions

The following research questions guided the study:

1. What is the pattern of relationships (correlations) in the model consisting of school location, teacher's gender, subject specialisation, instructional time, content knowledge of Basic Science and Technology, pedagogical skills, attitude to BST as a subject and its teaching, interaction with their pupils and pupils' achievement in Basic Science and Technology in Ogun State Primary Schools?
2. Is the model describing the causal effects among the variables (school location, teacher's gender, subject specialisation, instructional time, content knowledge of Basic Science and Technology, pedagogical skills, attitude to BST as a subject and its teaching, interaction with their pupils and pupils' achievement in Basic Science and Technology in Ogun State Primary Schools) consistent with the observed correlations among these variables?
3. If the model is consistent, what are the estimated direct, indirect and total causal effects among the variables?
4. What is the relative importance of each exogenous and endogenous variable on the pupils' achievement in Basic Science and Technology?

1.4 Significance of the Study

The researcher considers the work as significant in the sense that the outcome is expected to provide empirical basis for a better understanding of the causal relationship between instructional time, teacher quality and subject specialisation and achievement in Basic Science and Technology in Ogun State primary schools. Education stakeholders would likely develop (based on the causal modelling outcome), a more effective theory and technique for boosting Basic Science and Technology teaching and learning. Also, considering the paucity of empirical studies that provide causal explanation of achievement in primary basic science and technology in terms of instructional time, teacher quality and subject specialisation, the results would be a valuable addition to literature.

Research works needed to identify the classroom practices associated with high pupil achievement and targeting these practices in teacher education and professional development would provide a pathway to improve the quality of instruction for all pupils. Quality of teaching in our nation's schools would therefore be improved when valid and reliable measures are developed for observing and assessing teacher effectiveness. With these tools, educational administrators could provide more targeted feedback to help teachers focus their time on the practices that produce effective learning. The results of the study would also provide empirical basis for organizing workshops for various stakeholders in education (e.g teachers, policy makers, school administrators etc.) on factors that affect pupils' achievement in Basic Science and Technology.

1.5 Scope of the Study

The study population was limited to public primary school pupils and teachers in the twenty Local Government Areas of Ogun State, Nigeria. The teacher variables studied were, school location, gender, subject specialisation, instructional time, BST content knowledge, pedagogical skills, attitude to teaching BST, classroom interaction and pupils' achievement in BST.

1.6 Definition of Terms

Operational Definition of Terms

The following terms are operationally defined to reveal the meaning they portray in this study:

1. **Instructional time:** It is the fraction of the 35 minutes allotted in schools for Basic science and technology, actually spent on relevant academic activities by each BST teacher observed.

2. **Teacher Quality:** It is the teachers' attitude to BST as a subject and its teaching, teacher's BST content knowledge, pedagogical skills and teacher-pupils classroom interaction.

3. **Teachers' attitude:** It is the attitude (negative/positive) of the teachers to BST as a subject and also its teaching measured with an attitudinal scale comprising 20 items, scored with 0 as minimum and 80 as maximum.

4. C**ontent knowledge:** It is the teachers' knowledge of the subject, BST, measured with a BST content knowledge test, making use of 40 items and scored minimum 0 and maximum 40. Sixteen (16) was taken as the pass mark. This cut-off was taken by making use of the performance norm obtained during validation

5. **Pedagogical skills:** It is the measure of effectiveness of teachers' practices in BST classroom, measured on a scale of minimum 0 and maximum 100 using a pedagogical skills observation schedule.

6. **Classroom interaction:** It is the degree of interaction between the BST teacher and the pupils, where teachers who interact more with their pupils had more 2, 5, 7, and 8 codes; while those who had little classroom interaction had more 1, 4, 9, 10 and 12 codes.

7. **Teacher Specialisation:** It is the different subject area majors studied at the NCE level by the basic science and technology teachers in the sampled schools and coded from 1 to 27.

8. **School location:** It is the area in which the sampled schools are located and can be either rural or urban as determined by the Ogun State Universal Basic Education Board.

9. **Pupil Achievement:** It is the performance of the pupils measured with a BST achievement test, making use of 30 items, scored minimum 0 and maximum 30. Twelve (12) was taken as the pass mark. This cut-off was taken by making use of the performance norm obtained during validation.

Conceptual Definition of Term

Basic Science and Technology (BST): It is a subject taught and learned at the lower (1-3) and middle basic (4-6) classes. The subject curriculum gets split into two, for two subjects, namely, Basic Science and Basic Technology at the upper basic classes.

CHAPTER TWO

LITERATURE REVIEW

2.0 Introduction

The Nigerian educational system took its root from the traditional system of the pre - colonial era. This was a period of indigenous education in which traditional education activities were practiced in various vocations like farming, weaving, blacksmithing, pot making, traditional medicine, hunting, etc. Learning at that time was characterized by apprenticeship and much of unrealized and unexplained science and technology were practiced. There was no formal curriculum but the training was relevant to the needs of the society. Some authors described the training as somehow primitive and localized (Ajeyalemi, 2008), because it was informal. Essentially, the science that was regarded as informal and indigenous was practiced in the pre-colonial era. It was stimulating, informative and useful. It provided a lead way for understanding, interpreting and relating with the world and nature. The limitations however are numerous especially in its inability to provide adequate scientific explanations for causes and events observed in the natural world. The science practice lacked documentation and it was conservative and authoritarian.

This era ushered in western education with the advent of missionaries in Nigeria. It was through this that the informal or crude science became reformed as the formal science and technology. There was better understanding that transformed individuals and Nigeria as an entity from the world of yesterday to western world characterized by increasing discoveries, inventions and innovations. This development also paved the way for the integration of science and technology into the curricula of schools. The science that is formal involve a systematic study of natural phenomena and its study allows pupils to experience the richness and the excitement of the natural world as they engage in inquiry, critical thinking and the demonstration of skills. The scientific enterprise is one that is challenging and innovative. It blends with technology which focuses on inventions and problem solving. Consequently, the harmonious interplay of science, technology and society is the springboard for sustainable development. It equally facilitates and enhances industrial and technological progress among the people and within a nation. This consciousness stems into global agitations for literacy in science and technology.

Learners benefit tremendously in the learning process due to several factors. Teachers play a very important role in the learning process. Teaching is a complex problem solving activity and teacher quality is a complex topic, and very hard to define. The definition of teacher quality ranges from a focus on what teachers know and do in their classroom, to how knowledge should be acquired. But research has concluded that students exposed to high quality instruction learn more than other students (Darling-Hammond, 2000; Goldhaber & Brewer, 2000). One of the goals of

institutions of learning is to hire quality teachers that will produce quality pupils. Research studies on teacher quality provide convincing evidence that quality teachers matter, but the evidence on what constitutes a quality teacher are mixed (Hanushek & Rivkin, 2001; Sanders & Rivers, 1996; Darling-Hammond, 2000).

2. 1Theoretical Background

Many researchers have tried to put together classroom or school-based models that describe the teaching-learning process in the bid to provide answers to the two questions addressed in educational psychology: (1) "Why do some students learn required knowledge and skills taught in school, while others do not?" (a criterion-referenced evaluation question) and (2) "Why do some students learn more than other students?" (a norm-referenced evaluation question.). Models have been used extensively in educational psychology to help clarify some of the answers researchers have found that might shed light on such questions as, "How do students learn effectively?" Or, "What is happening in this classroom that facilitates learning better than in another classroom?" Some of these models are discussed as follows:

Carroll's Model

Carroll (1963) states that time is the most important variable to school learning. A simple equation for Carroll's model is:School Learning = f(time spent/time needed)**.**

Carroll explains that time spent is the result of opportunity and perseverance. Opportunity in Carroll's model is determined by the classroom teacher; the specific measure is called allotted or allocated time (i.e., time allocated for learning by classroom teachers.) Perseverance is the student's involvement with academic content during that allocated time. Carroll proposed that perseverance be measured as the percentage of the allocated time that students are actually involved in the learning process and was labelled engagement rate. Allocated time multiplied by engagement rateproduced the variable Carroll proposed as a measure of time spent, which came to be called engaged time or time-on-task. Carroll proposed that these specific teacher and student behaviours and student characteristics were the only variables needed to predict school learning; he did not include the influences of family, community, society and the world that other authors have included.

Proctor's Model

Proctor (1984) provides a model that updates this view by including important teacher and student behaviours as predictors of student achievement. It is derived from other teacher- and

classroom-based models but is redesigned to emphasize teacher expectations. Proctor states that it is possible for a self-fulfilling prophesy (as researched by Rosenthal & Jacobson, 1968) to be an institutional phenomenon and the climate of a school can have an effect on the achievement of its learners. The attitudes, the norms, and the values of an educational faculty and staff can make a difference in achievement test scores. The paradigm most influencing Proctor's model is that of a social nature and not of a teacher/student one-on-one relationship. The other models include the variables that provide the focus for this model, but show these variables in a more subordinate manner.

Proctor's (1984) model begins with the factor of the School's Social Climate. Some of the variables included in this would be attitudes, norms, beliefs, and prejudices. This school climate is influenced by a number of factors, including such student characteristics as race, gender, economic level, and past academic performance. The student characteristics also influence teacher attitudes and teacher efficacy. According to McIlrath and Huitt (1995) more recent studies support Proctor's (1984) position that student self-image and behaviour are affected by teacher efficacy. The next category of variables is the interaction among the individuals involved in the schooling process. The interactions in Proctor's (1984) model include the school's overall policy on allowing time for children to learn or promoting other forms of student-based help when needed. This could include quality of instruction (as in Carroll's (1963) model) or teacher classroom behaviours (as in Cruickshank's (1985) model). These behaviours have an effect on student classroom performance (especially academic learning time and curriculum coverage) and self-expectations.

Finally, the student's achievement level in Proctor's (1984) model is an outcome of all previous factors and variables. It is hypothesized that there is a cyclical relationship among the variables. In Proctor's model, the main concept is that achievement in a specific classroom during a particular school year is not an end in itself. It is refiltered into the social climate of the school image and the entire process begins all over again. Proctor's model implies that change can be made at any point along the way. These changes will affect school achievement, which will continue to affect the social climate of the school.

Cruickshank's Model

The model by Cruickshank (1985) is more classroom and teacher-based; he was heavily influenced by models created by Mitzel, Biddle, and Flanders. Mitzel contributed the concept of classifying variables as "product, process, or presage" (Cruickshank, p. 17).Product is learning on the part of the student (change in behaviour) whileprocess involves interaction between student and

teacher. Presage is the teacher's intelligence, level of experience, success and other teacher characteristics. Presage is supposed to affect process and then, of course, process will affect the product. Flanders (as cited in Cruickshank, 1985) offered the variables of teacher and student classroom talk and devised an instrument which focused on this behaviour.

Gage and Berliner's Model

Gage and Berliner (1992) developed a model of the instructional process that focuses on those variables that must be considered by the classroom teacher as she designs and delivers instruction to students. This model attempts to define more precisely what is meant by "quality instruction" and presents five tasks associated with the instruction/learning process. The model is classroom and teacher-based and centres on the question, "What does a teacher do?" A teacher begins with objectives and ends with an evaluation. Instruction connects objectives and evaluations and is based on the teacher's knowledge of the students' characteristics and how best to motivate them. If the evaluations do not demonstrate that the desired results have been achieved, the teacher re-teaches the material and starts the process all over again. Classroom management is subsumed under the rubric of motivating students. Gage and Berliner suggest that the teacher should use research and principles from educational psychology to develop proper teaching procedures to obtain optimal results.

Huitt's Model

Huitt (1995) identifies the major categories of variables that have been related to school achievement. The model is not only school, classroom, teacher, and student-based, but includes additional contextual influences as well. Huitt's model attempts to categorize and organize all the variables that might be used to answer the question, "Why do some students learn more than other students?" One important addition in this model is the redefinition of Academic Learning Time. It had long been recognized that Carroll's conceptualization of time spent measured the quantity of time engaged in academics, but was lacking in terms of the quality of that time. Fisher et al in Proctor's (1984) had added the concept of success as an important component of quality of time spent and coined the term Academic Learning Time (ALT) which they defined as "engaged in academic learning at a high success rate." Huitt's (1995) model adds variables related to context and student and teacher characteristics and shows a relationship among the categories of Context (family, home, school, and community environments), Input (what students and teachers bring to the classroom process), Classroom Processes (what is going on in the classroom),and Output (measures of learning done outside of the classroom). These categories appear superimposed in the model since it

is proposed they are essentially intertwined in the learning process. Output or Outcome category is the most important and the focus of Huitt's model. The most often cited Output measures are scores on standardized tests.

Each of the above models identifies important factors related to school learning and contributes important information as we attempt to answer the question "Why do some students learn more than others?" Over a period of years, the models have been examined, reviewed, revised and edited to fit into the modern society. From Carroll (1963) to Huitt (1995), we see teachers and school systems, families, communities and entire countries having an influence on students' school learning. None of the variables appears to be so influential that attention need only be drawn to that particular factor in order to produce the kinds of educational changes desired (McIlrath & Huitt 1995).

Also, Huitt (2003) developed a transactional model of the teaching and learning process. He classified the variables such that they can be classified into four categories.

A Transactional Model of the Teaching/Learning Process	
Context	All those factors outside of the classroom that might influence Teaching and learning
Input	Those qualities or characteristics of teachers and student that they bring with them to the classroom experience
Classroom Processes	Teacher and student behaviours in the classroom as well some other variables such as classroom climate and teacher/student relationships
Output	Measures of student learning taken apart from the normal instructional process.

The transactional model made use of variables outside the classroom setting.

Goe (2007) examining past studies developed a new framework for determining teacher quality. The need for this framework stemmed from an effort to make sense of the many ways in which researchers had been measuring teacher quality over the years. The framework consists of four distinct but related ways of looking at teacher quality - teacher qualifications, teacher

characteristics, teacher practices and teacher effectiveness which are grouped into three categories, input, process and outcomes as follows:

Input

- Teacher qualifications - Are among the resources they bring to the classroom and are considered important in establishing who should be allowed to teach.
- Teacher characteristics - Are immutable or assigned characteristics of the teachers

Process

- Teacher practices - Are classroom practices, what the teachers actually do in the classroom

Outcomes

- Teacher effectiveness (measured by pupils' test scores)

This study adapted the Goe 2007 theoretical framework. Categorising the variables into three, the following is obtained:

Input

School location

Teachers' gender

Teachers' subject area specialisation

Teachers' BST content knowledge

Teachers' attitude to BST teaching

Process

Instructional time

Teachers' pedagogical skills

Classroom interaction

Output

Pupils' achievement in BST

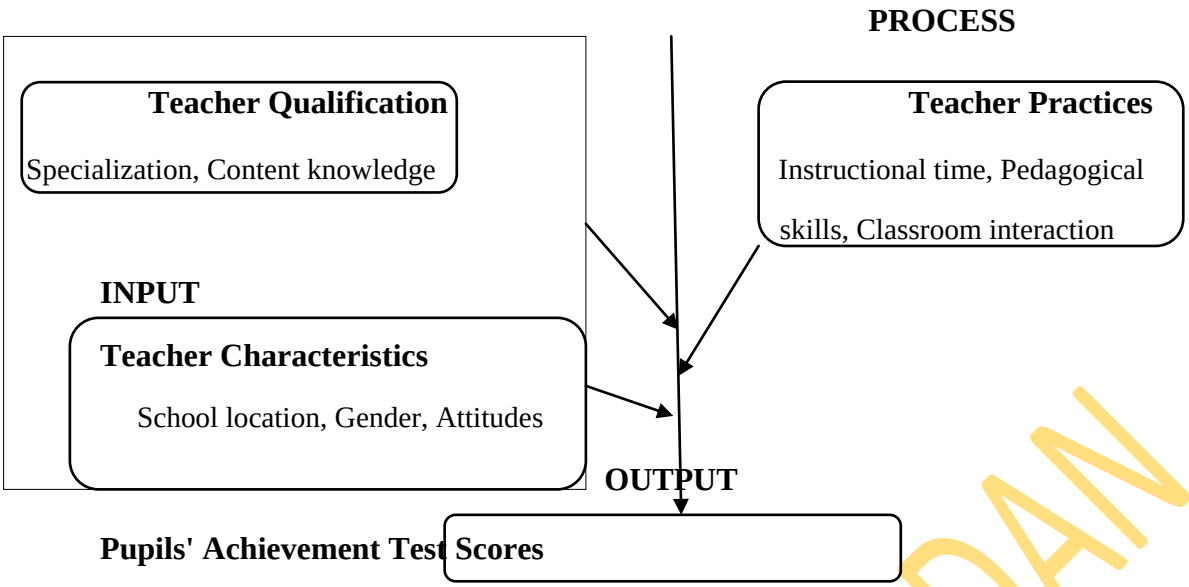


Figure 1: **Graphic Representation of the Conceptual Framework of the study**

2.2 Goals and Objectives of Primary Education

Primary education is the second stage of compulsory education. It is preceded by pre-school or nursery education and is followed by secondary education. In North America, this stage of education is usually known as elementary education and is generally followed by middle school. In most countries, it is compulsory for children to receive primary education, though in many jurisdictions it is permissible for parents to provide it. The transition to secondary school or high school is somewhat arbitrary, but it generally occurs at about eleven or twelve years of age. The major goals of primary education are achieving basic literacy and numeracy amongst all pupils, as well as establishing foundations in science, mathematics, geography, history and other social sciences. Typically, primary education is provided in schools where the child will stay in steadily advancing classes until they complete it and move on to high school/secondary school. Children are usually placed in classes with one teacher who will be primarily responsible for their education and welfare for that year. This teacher may be assisted to varying degrees by specialist teachers in certain subject area often mathematics, science, music or physical education. The continuity with a single teacher and the opportunity to build up a close relationship with the class is a notable feature of the primary education system. Traditionally, various forms of corporal punishment have been an integral part of early education. Recently this practice has come under attack, and in many cases been outlawed, especially in Wsetern countries.

A primary school is an institution in which children receive the first stage of compulsory education known as primary or elementary education. Primary school is the preferred term in the United Kingdom and many Commonwealth Nations, and in most publications of the United Nations Educational, Scientific, and Cultural Organization (UNESCO). In some countries, and especially in

North America, the term elementary school is preferred. Children generally attend primary school from around the age of four or five until the age of eleven or twelve. Primary education begins at the age of six for the majority of Nigerians. Students spend six years in primary school. Subjects taught at the primary level include mathematics, English language, Islamic knowledge studies, Bible knowledge, Computer science, Basic Science and Technology and one of the three main native ethnic languages (Hausa-Fulani, Yoruba, and Igbo). Private schools would also offer French, and art. Primary school students are required to take a Common Entrance Examination to qualify for admission into the Federal and State Government schools. The Universal Basic Education (UBE) came as a replacement for Nigeria's universal primary education scheme of the 6-3-3-4 system of primary education. The 9-3-4 system of education was designed in conformity with the Millennium Development Goals (MDGs) and Education For All (EFA). The UBE involves 6 years of primary School and 3 years of junior secondary school, culminating in 9 years of uninterrupted schooling, and transition from one class to another is automatic but assessed through continuous assessment. The Universal Basic Education Commission (UBEC) law section 15 stipulates a 9-year formal schooling.

"Goals" and "Objectives" are educational purposes directly related to school and classroom outcomes respectively. Goals are expression of purposes specified for achievement at each level of education. For example there are goals of primary education, secondary education, tertiary education in the National Policy on Education (2004). These goals are stated at various educational levels, to achieve part of the aims of the subject and the behavioural objectives stated for each lesson. These two types of objectives though may not be at the same level but they are assessable at the classroom level (Abimbola, 1993). When the purpose of education for a country is being discussed, the term "aim of education" may be used. The general objectives or aims of education can be summarized as the all-round development of human nature so that people are able to use their talents to the optimum capacity of their inborn potentialities. In so doing, the individuals become useful to his country, to his society, his family and to himself.

Nigeria has been classified over the years among the developing nations of the world. That is, among those nations that is not as technologically advanced as Europe, United States of America and the Russia. These countries are known to be largely illiterate and poor. They lack medical facilities especially when compared with the technologically advanced countries. The aims of education in these countries will be how to eradicate these problems. The aims of education in developing countries have been summarized by Jekayinfa (2008) as follows:

1. Learning to live according to the old traditions of the people (society).

2. Learning to live according to the traditions of other countries in order to imbibe their religion, their culture, their social life e.g. clothing, language, hair-do's and so on.

3. Learning to live modern life of technologically advanced countries.

Nigeria, Ghana, Uganda, Kenya and Lesotho, all in Africa, have a common trend. All of them were colonies under European countries which became independent after serving their masters for a number of years. These countries and some others have been striving for a stable government, dynamic economy and education that can deliver the goods. This is the root of the aims of education in developing countries stated below:

1. To promote national unity and international understanding;

2. To remove social inequalities, poverty, high-way robbery, hunger, diseases, squalor; illiteracy ignorance, superstition, pride and fear;

3. To provide individual happiness and pleasure, self- realization, public morality and aesthetic development;

4. To train for good citizenship, health improvement, vocational competence, industrial and commercial developments and adult literacy;

5. To produce adequate manpower for economic development so that there could be less dependence on expatriates;

6. To create a society with high moral standards;

7. To eradicate the problem of economic and technological dependence on the advanced countries of the world; and

8. To promote public enlightenment and civilized behaviour. Jekayinfa (2008).

The purpose of education in Nigeria includes unparalleled development of science and its application to industry and technology for better living. According to the National Policy on Education (FRN, 2004), the goals and objectives of primary education are to:

a. inculcate permanent literacy and numeracy, and ability to communicate effectively;

b. lay a sound basis for scientific and reflective thinking;

c. give citizenship education as a basis for effective participation in and contribution to the life of the society;

d. mould the character and develop sound attitude and morals in the child;

e. develop in the child the ability to adapt to his changing environment;

f. give the child opportunities for developing manipulative skills that will enable him to function effectively in the society within the limits of his capacity;

g. provide the child with basic tools for further educational advancement, including preparation for trades and crafts of the locality.

2.3 The Nigeria National Policy on Science and Technology

The Nigerian educational system took its root from the traditional system of the pre - colonial era. This was a period when learning was characterized by apprenticeship and much of unrealized and unexplained Science and Sechnology were practiced. There was no formal curriculum but the training was relevant to the needs of the society. Some authors described the training as somehow primitive and localized (Ajeyalemi, 2008), because it was informal. The scientific enterprise is one that is challenging and innovative. It blends with technology which focuses on inventions and problem solving. Consequently, the harmonious interplay of Science, Technology and Society is the springboard for sustainable development. It equally facilitates and enhances industrial and technological progress among the people and within a nation.

This consciousness stems into global agitations for literacy in science and technology. The national policy on education and the national policy on Science and Technology made good provisions for Science and Technology education. Government through the education policy empowered the Early Childhood Care and Education (ECCE), the Basic Education, the senior secondary education, technical and scientific education and tertiary education with robust plan for science and technology education in the programmes. (FGN, 2004). Education was conceived as an instrument *"par excellence"* in achieving national unity, objectives and goals. The policy derives its philosophy from the five main national goals which are;

a) a free and democratic society

b) a just and egalitarian society

c). a great and dynamic economy

d). a land full of bright opportunities for all citizens.

While adopting education as instrument par excellence, the federal government gave premium on the importance of science and technology and in line with global perspectives of science for all, made provisions for science and technology education in the national policy on education. Meanwhile, the aims and objectives of Nigerian education according to the policy include;

i) the inculcation of national consciousness and national unity

ii) the inculcation of right type of values and attitudes for the survival of the individual and the Nigerian society.

iii) the training of the mind in the understanding of the world around

iv). the acquisition of appropriate skills, abilities and competencies both mental and physical as equipment for the individual to live in and contribute to the development of the society.

The item (iii) of the above listed is a strong pointer to government positive disposition to Science and Technology education which was brought to light in further policies and programmes. The federal government specified the goals of science education in the policy and states as follows;

> *Special provisions and incentives shall be made for the study of the sciences at each level of the National education system. For this purpose, the functions of all agencies involved in the promotion of the study of sciences shall be adequately supported by government. In addition, Government shall popularize the study of the sciences and the production of adequate number of scientists to inspire and support national development (FGN, 2004).*

It further states that *"Science and Technology shall continue to be taught in an integrated manner in the schools to promote in the students, the appreciation of basic ideas". (FGN, 2004).* These are clear indications that the national policy on education gives premium to science and technology education. The place of Science and Technology in the 9-3-4 programme is amplified in the lower basic (primary 1 - 3) and middle (primary 4 - 6) education classes where basic science and technology is one of the core subjects. Bold steps are taken by government and stakeholders in

education and in Science and Technology to improve the quality of Science and Technology education in terms of delivery and content. There is no gainsaying that prominence must be given to science and technology in schools. It must be rich and elaborate enough to provoke the love and interest of students. It is in pursuance of this that government formulated some policies and initiated some programmes that will enhance the status of Science and Technology education which gear towards the achievement of global standards.

The policy on Science and Technology is prepared for a 25 year time frame with a provision for revision at 5 - year intervals. Its basic philosophy emphasizes Nigeria's commitment to the creation of an independent, integrated and self sustaining economy. The policy declares that education shall emphasize science at all levels. Meanwhile, the objectives of the federal government in the policy as it relates to education is *'to re-orient the entire society towards scientific thinking in order to develop new technology and adapt existing ones to improve societal well- being and security"* (FGN, 2004). Aside the federal government national policy, state governments also have ministries of Science and Technology with science and technology policies that suits their local needs. This compliments government efforts at national level.

In order to aid the effective implementation of the national Science and Technology policies for the education sector, the National Policy on Science and Technology section 2:3 states the following strategies for the implementation of the objectives;

i). Evolving programmes for the recognition, encouragement, development and promotion of scientific and technological talents at all levels

ii). Making it possible for the average child to have early contacts with the concepts and materials related to Science and Technology.

iii). Ensuring a sound foundation during the first six years of the 6-3-3-4 educational structure through:

a). entrenchment of science teaching in the primary school curriculum

b). provision of adequate teaching laboratory aids.

c). provision of well trained, well motivated science teachers.

d). introduction of gainful practical activities such as model making, handicrafts, gardening and farming.

Science and Technology are avenues through which man interacts and explains the universe, seeks to understand the world and make it a better place. Unfortunately, these cannot be achieved if and when the required human resources are unavailable. Science and Technology is the instrument that sustains advancement and there is a global race in which neither Nigeria nor any other country should lag.

2.4 Teaching as a Profession

Teaching has been defined by Wells in Fakoya (2009) as cluster of activities such as explaining, deducing, questioning, motivating, taking attendance, keeping record of works, students' progress and students' background information. Teaching involves imparting verifiable facts and beliefs; it encourages students' participation and expression of their own views. The business of teachers is to help students to achieve higher standards of knowledge, ability, skills, and moral character. If teachers do their work well, then their work is of great value to others, not simply in a particular time, but also in the future.

Teachers are more than workers. They are also members of a profession. Their occupation renders definite and essential services to society. As a profession, however, teaching has had a long and difficult history. Its social and cultural functions have never been critically challenged, but nevertheless the public has not adequately supported teaching. Some teachers are dissatisfied with, and even depressed about their professional standing (Fakoya, 2009). They feel the work load is too heavy, and the recognition and appreciation are too limited. They think that they do not have sufficient opportunities to advance in their careers and that they have no power to control the content and form of their work. The intellectual foundation of teaching, include body of knowledge and systematic delineation of body knowledge, educational theory and pedagogy.

A profession requires a lengthy period of academic and practical training. Training and certification are essential parts of a profession. There must be some specification of the nature of the training through state regulations. Teaching certainly fulfils this criterion. Teaching possesses two very appealing traits. First, it deals with the young, with those whose minds and characters are forming. The teacher shares the parents' responsibilities and joy of direct involvement in promoting the healthy and balanced mental and moral life of children. Second, teaching provides opportunities for intellectual development. It brings those who pursue it into intimate contact with books, experiments, and ideas. It stimulates the desire for increased knowledge and for wider intellectual

contacts. Thus, in teaching, intellectual development is something which fits directly into the demands of the work. Regardless of development status, the teaching force in most countries has never enjoyed full professional status. However, the status of teachers as a developing profession is becoming evident in Nigeria.

Another problem that is militating against teaching as a profession is the commitment or attitude of the teachers to the profession. In the case of teaching, life commitment to the task of teaching is not apparent as in other professions. There are a number of factors that contribute to this state of affairs. One of these factors is the general notion of teaching as a second-choice profession with many of the teachers only committing themselves to it at a late stage when they know that they cannot have their earlier chosen profession (Obanya in Amusan, 2004).Majority of the teachers at the initial stage of their teaching career did not expect to stay in teaching for more than a few years. They consider it as a stepping stone to other occupations. This invariably affects their commitment to the profession. The code of ethics indicates how members of the profession should behave. Nigerian teachers have an ethical code of conduct. Professionalization occurs when enforcement is possible and vigorous **(**Ankomah 2005**).**

2.5 Teacher Quality

To Abimbade, (1999) teachers are said to be effective when their teaching can lead to students' learning. Nothing has been taught until it has been learnt and this happens when the teacher succeeds in causing a change in behaviour in the learner. It is therefore important that the teacher must see teaching as an attempt on his own part to transfer what he has learnt to his students. According to Rice (2003), teacher quality matters. In fact, it is the most important school-related factor influencing pupil achievement. A number of researchers have argued that teacher quality is a powerful predictor of pupil performance. In her analysis of teacher preparation and learner achievement across states, Darling-Hammond (2000) reports that "measures of teacher preparation and certification are by far the strongest correlates of student achievement in reading and mathematics..." She contends that measures of teacher quality are more strongly related to learner achievement than other kinds of educational investments such as reduced class size, overall spending on education, and teacher salaries.

In contrast to the approach used by Darling-Hammond, which equates teacher quality with specific qualifications, Rivkin, Hanushek, and Kain in Rice (2003) identify teacher quality in terms of learner performance outcomes. Their research identifies teacher quality as the most important school-related factor influencing learner achievement. They conclude from their analysis of 400,000

students in 3,000 schools that, while school quality is an important determinant of learner achievement, the most important predictor is teacher quality. In comparison, class size, teacher education, and teacher experience play a small role. Hanushek in Rice (2003) estimates that the difference between having a good teacher and having a bad teacher can exceed one grade-level equivalent in annual achievement growth. Likewise, Sanders in Rice (2003) and Sanders and Rivers (1996) argue that the single most important factor affecting student achievement is teachers, and the effects of teachers on student achievement are both additive and cumulative. Further, they contend that lower achieving students are the most likely to benefit from increases in teacher effectiveness. Taken together, these multiple sources of evidence-however different in nature-all conclude that quality teachers are a critical determinant of pupil achievement. In the current policy climate of standards-based reform, these findings make a strong case for gaining a better understanding of what really accounts for these effects. In other words, what is teacher quality?

The specific characteristics that constitute an effective teacher are hotly debated. Teacher quality is extremely difficult to define, and therefore measure. As a result, most studies resort to measurable teacher inputs such as certification, academic degrees, and years of experience. Some studies that have correlated teacher test scores on basic skills tests and college entrance exams with the scores of their students on standardized tests have found that high-scoring teachers are more likely to elicit significant achievement in student than their lower-scoring counterparts (Ferguson, 1998; Ferguson & Ladd, 1996). The specific characteristics that constitute an effective teacher are hotly debated. Deep content-area knowledge is also an attribute of teachers that seems to have a positive impact on learner achievement (Monk, 1994). This appears especially true for science and mathematics teachers, teachers need to be well-versed in their subjects. The review points out, however, that the research is not detailed enough to clarify how much subject matter is critical for teaching specific course levels and grades. There is also the importance of pedagogical coursework or field experiences for teachers, although courses focused on how best to teach a particular subject may contribute to effective teaching (Allen, 2003).

Quality teaching has been defined as "teaching that maximizes learning for all students" (Glatthorn & Fox, in Adedeji, 2008). Quality teaching leads to teachers' commitment to their pupils and their learning. They should believe all students can learn, treat students equitably and recognize individual differences and account for these differences in their practice. Teachers should know the subjects they teach and how to teach those subjects to pupils. They should develop pupils' critical and analytical thinking skills, understand the preconceptions students have about their subject area and teach pupils how to pose and solve their own problems. Teachers must be responsible for

managing and monitoring student learning and create environments that engage pupils and use time effectively. Sustained improvements in primary science and technology will depend on improved teacher capability.

2.6 School Location and Achievement of pupils

Mulken (2005) noted that, teachers in rural schools may teach less than their counterparts in urban areas. Any trip away from the rural area, to visit a doctor, to collect pay, to visit family or where teachers walk long distances to school, they may tend to start late, and finish early. As transport difficulties often make supervision visits from inspectors less frequent in isolated schools, there is little to prevent a gradual erosion of the instructional time. In some cases they also have difficulty in accessing books and materials. In addition, because the parents tend, in general, to be less educated, they are less likely to monitor the quality of teaching, or to take action if the teaching is of poor quality.

This means that those children in rural areas are the most difficult to engage in education and also have lower quality educational provision. It is hardly surprising then, that rural areas show lower participation in education, and lower attainment. However, urban schools are characterised by disciplinary problems, large class size, lack of time for individual interaction, lack of students' participation in extracurricular activities (Lomotey & Swanson in Freeman & Anderman, 2005). Disciplinary problems and large class size especially, is known to have implication for effective use of instructional time.

In Morocco, rural school locations were positively correlated with school closures, time spent in management and off task behaviours. This is consistent with earlier research in United State which showed that in rural areas pupils have less instructional time (Abadzi, 2007). Teachers in schools located in rural locations mostly travel early to and late from their schools. Compared to teachers in urban located schools, their rides to and fro their schools also tended to be more arduous, traversing poorer roads and more hilly or mountainous terrain (Howley, Howley, & Shamblen, 2001). Such long rides reduced the number and variety of household activities and reduced teachers' sleep time, recreational time, academic attentiveness, and extracurricular participation (Spence, 2000). Even where the teachers reside in these rural locations, they, many a times have to shuttle to and fro their work station and family residences. The overall effect of this would be tiredness in class, leading to poor utilisation of instructional time.

There is usually less number of teachers in rurally located schools; therefore teachers have learners of more instructional levels in a contained classroom, while being responsible for many or

all classroom needs. Teachers need to ensure that learners actually use enough instructional time in productive ways. Research emphasizes that time is quite easily lost in transitions--starting up, changing activities, moving from place to place, and putting things away.

However, according to Dodendorf in Reck (1990) learners who attend rural schools often approach each other for help and learn by teaching each other, such collaborative learning can provide a way to capitalize both on learners' variety and on their cooperative spirit. The characteristics of small schools can be a teacher's ally. In rural schools, one teacher, using a variety of successful techniques, can exert influence across the entire range of variables that cumulatively lead pupils toward high achievement.

The differences between schools can be explained by the different structures that surround the different types of schools. The location of schools can be termed as rural and urban. The location of the school could influence the level of academic achievement of pupils. Owoeye (2000) opined that school location has a significant effect on the academic performance of the pupils. Noting that because of this, parents enrol their children into rural schools on the basis of better performance. Some researchers have suggested that urban schools are not as affluent as they once were, and that rural schools have improved considerably (Kannapel & DeYoung, 1999). However, Trickett in Freeman and Anderman, 2005 found that learners in urban schools were significantly more focussed on mastering the material or skill required in their school work than those in rural settings. This however contradicts some findings which noted that, school location has no significant effect on academic performance of pupils [Onah & Ugwu (2010); Yussuf & Adigun (2010)]

The relationship between school location and student academic achievement in science has been widely reported. Adepoju, (2001) found that learners in urban schools manifest more brilliant performance than their rural counterparts. Also, Ogunleye (2002) Ndukwu (2002) and Odinko (2002) reported a significant difference in the achievement of students in urban peri-urban areas. However, Daramola cited in Ogunleye (2002) did not found any significant difference in the urban and peri-urban schools.

Parents in rural areas often have a lower level of education, and may attach a lower value to schooling. The perceived lack of relevance of schooling may be enhanced by a rigid curriculum, often designed for a context (and sometimes culture) removed from that in rural areas. Rural schools rarely adapt the curriculum to make use of local examples, or to link the curriculum to local needs. Even where parents place a value on schooling, they may be less able to help their children learning.

Parents in rural areas are less likely to be educated themselves, and so have less ability to provide support for their children. Some report that they are embarrassed to discuss school topics with their children, because of their own lack of knowledge. Further, homes in rural areas are often ill-equipped to meet the needs of children to study, and often lack facilities like electricity (Taylor & Mulhall, 2001).

In summary, children in rural areas may be considered more difficult to educate. They are likely to have less parental encouragement to go to school, and more alternative demands on their time, such as helping with agricultural tasks. When they attend school, they may find the curriculum less relevant to their lives, and find less support for their learning from the home environment. On the supply side, governments may find it more difficult to supply quality education services in rural areas. In many African countries, of which Nigeria is one, teachers prefer to teach in urban areas. As a result, rural schools may be left with empty posts, or have longer delays in filling posts. Even if posts are filled, rural schools may have fewer qualified teachers. (Mulkeen, 2005). Research has also shown that schools located in remote areas tend to have higher teacher absenteeism; and a relationship between teachers absence and student performance. (Kremer et al., 2005). These factors could combine to weaken the quality of teaching and achievement in rural areas.

The problem of teachers is often considered as a problem of teacher numbers. While there is no doubt that many countries face challenges of teacher supply, there are equally serious challenges of teacher deployment. In many countries there are qualified teachers in urban areas who are under-utilized, while there are unfilled posts in rural areas. This pattern of simultaneous surplus and shortage is strong evidence that the problem of teachers for rural schools will not be solved simply by providing more teachers. There is a need for policies that will ensure that the teacher reach the schools where they are needed.

Research does not provide clear evidence that rural schools are inferior to urban schools. According to Reeves and Bylund (2005), one prominent study finds that students in rural schools perform less well than their urban counterparts, but other studies using the same national data set have reached divergent conclusions.

2.7 Instructional Time and Achievement of pupils

A sense of the value of time-that is, of the best way to divide one's time into one's various activities is an essential preliminary of efficient work. Effective time management is one of the skills necessary for success in school as well as in everyday life and in the world of work. Pupils need time to practice, rehearse, review, apply, and connect new learning and relate it to their

everyday lives. How pupils spend their time in classrooms continue to be a topic of importance for teachers, school administrators and educational researchers. According to Gettinger & Seibert (2002), researchers have concluded that as little as half of each school day may be devoted to instruction in some classrooms depending on teachers' classroom practices, pupils' characteristics and actual time allocated to instruction. Teachers who effectively manage time give their pupils the best opportunity to learn and to develop personal habits that lead to wise use of time. Instructional time according to this study, is the portion of classroom time spent teaching students particular knowledge, concepts, and skills pertaining to school subjects (i.e., excluding routine procedural matters, transitions, and discipline).

Instructional time "tells you something about classroom organization and management." In other words, the time actually available for and spent in teaching is indicative of the teacher's ability to organize instructional activities and expedite non-instructional ones such as transitions and discipline. Instructional time measures also permit inferences about the teacher's organization/management skills. According to Cotton (1989), various other methods for managing time effectively so as to improve student achievement and attitudes are also offered by researchers. Suggestions for teachers include:

- Begin and end lessons on time.
- Reduce transition time between tasks.
- Closely monitor student learning and behaviour, including placing students in desk arrangements that allow teacher and students to see one another well from different points in the classroom.
- Establish and follow simple, consistent rules regarding student behaviour in the classroom.
- Cover content as fully as possible.
- Reduce non-instructional activities whenever possible.

Recommendations for administrators include:

- Encourage in-service activities to help teachers learn to use time more effectively.
- Encourage parents to teach respect for teachers and for schooling as a means to reducing time-consuming disciplinary actions.

- Keep announcements and other interruptions of class time to a minimum

At the school level, the implication of this research for school leaders is that they must minimize the amount of instructional time lost to unnecessary extra-curricular activities. The crucial issue seems to be how the time is used, with quality of instruction being the key.

2.8 Teachers' Content Knowledge and Achievement of pupils in BST

Subject matter knowledge is another variable that one might think could be related to teacher effectiveness. While there is some support for this assumption, the findings are not as strong and consistent as one might suppose. Byrne in Darling-Hammond (2000) summarized the results of thirty studies relating teachers' subject matter knowledge to student achievement. The teacher knowledge measures were either a subject knowledge test (standardized or researcher-constructed) or number of college courses taken within the subject area. The results of these studies were mixed, with 17 showing a positive relationship and 14 showing no relationship. However, many of the "no relationship" studies, Byrne noted, had so little variability in the teacher knowledge measure that insignificant findings were almost inevitable. Ashton and Crocker in Darling-Hammond (2000) found only 5 of 14 studies they reviewed exhibited a positive relationship between measures of subject matter knowledge and teacher performance. Eisenhart, Borko, Underhill, Brown, Jones and Agard (1993) emphasised that lack of content knowledge is an inhibition to effective instruction. In support of this Woolfolk (2001) noted that quality teachers are those who are experienced and have elaborate systems of knowledge of their subjects.

It is intuitively obvious that teachers must possess a professional knowledge base and exhibit knowledge of the subject matter. She/he must demonstrate understanding of central concepts, skills and tools of inquiry in science; apply that knowledge in the context of the pupils' learning; demonstrate understanding of the structure of the content area of science; and demonstrate an understanding of the ways in which science is integrated across the content area. According to Asoko (2000), teachers' lack of subject knowledge in science has been documented and frequently identified as a barrier to the implementation of curriculum reform and to pupils' progress. Teachers who lack knowledge and confidence may naturally attempt to avoid or minimise their difficulties through a variety of strategies, which includes avoidance of topics, heavy reliance on texts, and over-emphasis on practical activities which, over time, may result in an impoverished science education for pupils (Lee, Harlen & Holroyd in NTI, 2009).

Adesoji and Olatunbosun (2008) also observed that one of the fundamental problems facing science teaching today is the question of how current are the professional teachers. The majority of

teachers who have been employed in the past decades have been doing the same thing, the same way all along. They have no knowledge of the current ideas and innovations that have taken place in the educational field in the recent past.

2.9 Teachers' Interaction with Pupils and Achievement of pupils in BST

Many teachers seldom realize that how they teach, how they behave and how they interact with students can be more paramount than what they teach. Teaching is an interaction course that includes classroom conversation in its primary form and takes place between the teacher and student. Darling-Hammond (2008); Gordon, Kane and Staiger (2006) believe that the teacher's relational quality with students has an important role in effectiveness of his teaching and the standard for measuring the effectiveness of the teachers that is creating the learning. On this basis, schools need teachers who will change the school environment so that it can bring hope-inspiring horizons of friendship, equilibrium, support, security, success, honour and prosperity as some gifts (Christie, 2002). A primary school science teacher has to maintain discipline and order in their classroom, while taking the necessary safety measures to protect not only the students but materials, equipment and facilities. According to Thompson and Anderson (2008); Reynolds and Peter (2009) one of the most basic characteristics of the good teachers is the ability to establish the interaction in the classroom and most of the observed stresses in the classrooms come from lack of desired interaction. Focusing on this issue, Brower, Dejonge and Stout (2001) remark that teaching takes place when the teacher interacts with one or more learners.

Apart from different definitions for teaching and different teaching methods, one of the most basic elements of qualitative teaching is the way in which students respond to teaching activities and on the whole, it is the interaction between the teacher and students (Sahlberg, 2007). Babelan and Kia (2010) observed that interaction between students and teachers has significant role in students' achievement. They noted that regression analysis showed that relational components in the classroom were significant predictors for students' achievement. Cohesiveness within the school community, especially between the teacher and the pupils has been theorized to be important in students' pursuits of positive academic outcomes (e.g. Maehr & Midgley, 1996). UNESCO noted that there are differences between male and female teachers' classroom practices, these differences may help to explain the differential performance of their students. More specifically in the developing country context, a UNESCO-sponsored study of four countries (Bangladesh, Nepal, India and Pakistan) on female teachers in rural primary schools found that female teachers were perceived as more effective in classroom practices by the administrators; children also saw them as more open and more comfortable to interact with than male teachers (UNESCO, 2000).

2.10 Teachers' Pedagogical Skills and Achievement of pupils in BST

Pedagogical skills or classroom practices is a measure of what teachers do in their classroom. Some of the challenges of the teachers might be related to what to teach. Eby in Okpala and Ellis (2005) stated that quality teachers use a wide variety of instructional methods, experiences, assignments and materials to ensure that pupils are achieving all sorts of cognitive objectives. Brophy in Okpala and Ellis (2005) concluded that pedagogical skills appear to be a powerful force in changing teachers' instructional practice and by inference learners' achievement. Many primary school teachers have not participated in any in-service training or workshops since completing their initial training. Quality teachers must have mastered the basic skills of teaching and possess the ability to continuously adjust their teaching strategies to meet the diverse needs of their pupils. Successful teacher must have a vast repertoire of instructional strategies and techniques that reflect their knowledge of the subject. Teachers are the key to realizing curriculum aims and the quality of the science and technology education which the pupils receive rest ultimately on them. (Asoko, 2000).

Teachers' mode of presentation of various science concepts affects achievement (NTI, 2009). The question is how best can you put across these concepts to pupils? There are various teaching methods and techniques in basic science and technology teaching, but whereas the methods and techniques are means or ways of impacting scientific knowledge to pupils, the strategies are the skills required for using these methods effectively. Effective teaching of science and technology does not depend on teachers' knowledge of the methods, but his skill to use the appropriate method or combination of methods. No particular method can be labelled good or bad, it all depends on how the teacher uses them. Seweje and Jegede (2005) noted that the ability of a teacher to teach is not derived only from the teacher's academic background but it is based upon outstanding pedagogical skill acquired.

2.11 Teachers' Attitude to BST and Achievement of pupils

Attitude as a concept is concerned with an individual way of thinking, acting and behaving. It has very serious implications for the learner, the teacher, the immediate social group with which the individual learner relates and the entire school system. Attitudes are formed as a result of some kind of learning experiences. They may also be learned simply by following the example or opinion of parent, teacher or friend. The learner draws from his teachers' disposition to form his own attitude, which may likely affect his learning outcomes.

Teachers are role models whose behaviours are easily copied by pupils. What teachers like or dislike, appreciate and how they feel about their learning or studies could have a significant effect on their students. In a nutshell, teachers' attitude directly affect students' attitude. Several research findings have confirmed the hypothesis that teachers' attitude either towards science or towards science teaching affect their students' achievement in and attitudes towards science; found that the effect of teachers' attitude towards assessment practices on students' achievement and their attitude towards Physics was positive. In the same vein it was reported that teachers' attitude towards science is a significant predictor of pupils' science achievement as well as their attitude. Also, the effect of teachers' attitude to mathematics was stronger on the students' mathematical achievement than on their attitude (Okpala, Onocha & Igwe in Yara, 2009).

Gangoli cited in Igwe (2002) stipulates that for teaching and learning of science to be interesting and stimulating, there has to be motivation on the part of both the teacher and the learner so as to ensure the development of positive attitude and subsequently maximum academic achievement. It has been observed that teachers teach science in a way that merely requires the pupils to listen, read and regurgitate. This depicts negative attitude to teaching. Ogunwuyi (2000) found significant causal relationship between the teachers' attitude and students' achievement in Integrated Science. Bajah (1999) was of the opinion that the success of our science programme depends greatly on the classroom teacher as he is the one that translates all our thoughts into action. Adesoji (2002) defined attitude as cognitive, emotional, and action tendency to a particular intent. He ascertained that attitude is an important factor that determined achievement of students in sciences.

It can be argued to some extent that the characteristics of the teachers and their experiences and behaviours in the classrooms, contribute to the learning environment of their students, which in turn will have an effect on student outcomes. Ogunniyi in Yara (2009) found that students' positive attitude towards science could be enhanced by the following teacher-related factors:

- Teachers' enthusiasm,
- Teachers' resourcefulness and helpful behaviour,
- Teachers' thorough knowledge of the subject-matter and their making science quite interesting.

Teachers' attitude towards science is a significant predictor of pupils' science achievement as well as their attitude towards science. Students' positive attitude towards science could be enhanced by teachers' enthusiasms, resourcefulness and helpful behaviour, teachers' thorough knowledge of

the subject matter and their making science quite interesting. The attitude of the teacher can mould the attitude of the students to want to learn or not. Hence the teacher should be psychologically prepared to teach the subject given that every other requirement is met. If pupils are to develop a disposition to do basic science and technology, it is essential that the teacher communicate a positive attitude towards the subject. The first impression most children will receive about a particular academic subject is from their teachers. For this reason, the attitude of the teacher goes a long way toward promoting her students' success in the classroom. Teachers need to establish a supportive classroom learning environment that fosters the confidence of pupils to learn BST.

2.12 Teachers' subject specialisation and Achievement of pupils in BST

Teachers are said to be effective when their teaching can lead to pupils' learning. Nothing has been taught until it has been learnt and this happens when the teacher succeeds in causing a change in behaviour in the learner. It is therefore important that the teacher must see teaching as an attempt on his own part to transfer what he has learnt to his pupils. In a teacher's area of expertise, he/she would feel more comfortable. For great effectiveness, every teacher should be assigned to teach the subject in his/her area of specialization. This is however not the practice in most schools where there is scarcity of science teachers. In Nigeria, there has been an unprecedented increase in the number of pupils enrolled in primary schools. With this increase, it becomes difficult for the schools to be staffed with trained professional science teachers to cope with increasing number of pupils. With this development, it is a common feature to see teachers who major in Biology, Chemistry, Agriculture, Biochemistry, Computer Science, Zoology, Botany, Microbiology, English, Mathematics, Yoruba etc. from the Colleges of Education or University level teaching Basic Science and Technology (BST) in primary schools. In this study effort would be made to examine the performance differentials of these categories of teachers at the primary school level.

Most classroom teachers find that they have a preference for one or more of the subjects that they teach, allowing primary teachers to operate within their specialty areas, either as a content major or minor in schools could help the pupils' achievement. The science specialist would have the primary responsibility for previewing and selecting science curricular materials. The advantages for the pupils of the classroom science specialists-manned classroom include increased teacher content and curricular knowledge, and time dedicated to science instruction. Ingersoll (1999) found out in a study that 63% chemistry, physics, earth and space science instructors do not have certification in the subjects and this result in the poor performance of students. Greenwald, Hedges and Laine (1996) asserted that achievement positively correlated with teacher's qualification. Wayne and Youngs (2003) also found that majoring in the field of teachingwas found to be positively associated

with achievement in science, though not significantly. However, Abuseji (2007) found little or no significant relationship between teacher qualification and achievement.

2.13 Gender of teachers and Achievement of pupils in BST

Women constitute a high preponderance of the teaching force especially at the primary school level in Nigeria (Amusan & Odunuga, 2012). Over time the proportion of female teachers in urban areas has generally been greater than the proportion of female teachers in the rural areas (Mehrotra, 2006). In many states of Nigeria, of which Ogun State is one, there is a preponderance of women in the teaching profession, such that men seem to think that the profession is not for the male gender. This may not necessarily be due to any notion of the inferior abilities of women compared with men. On teacher's gender and achievement, Okoruwa (1999) found that teacher's gender had significant effect on achievement mean scores of pupils in science; male teachers were more effective than their female counterparts. Bilesanmi (1999) reported that the finding on the effect of gender of science teachers on performance of students outside Nigeria was ambivalent. It was shown that in Chile, England, Federal Republic of Germany, Japan and Sweden where there was a greater proportion of male teachers of science in schools, the level of performance was higher. On the other hand, the same trend was found in Australia and Italy where there were more female teachers in schools.

Regardless of student gender, students taught by women perform better than those taught by men (Krieg, 2005). In accordance with Krieg, based on findings from the Southern and Eastern African Consortium for Monitoring Education Quality (SACMEQ), a recent UNESCO Education for All report notes that women teachers have a positive effect on both boys' and girls' achievement (UNESCO, 2005). Similarly, a study from Pakistan (UNESCO, 2000) finds that children in female teachers' classrooms tend to perform better. But a large study in Pakistan presents findings that contradict the studies above. Warwick and Haroona (1994) found that students of male teachers scored significantly higher in mathematics than did students of female teachers. Further complicating this picture, other researchers have found no relationship between teachers' gender and student outcomes. In the Netherlands, for instance, Driessen (2007) found that teacher gender has no effect on student achievement, attitudes, or behaviour, regardless of student gender, ethnic background, or socioeconomic status.

Little conclusive evidence is available on the relationship between teacher gender and students' achievement. The evidence on the relationship between student learning and teacher gender is limited and contradictory. Therefore, the researcher felt the need for this study to look at the relationship that exists between the gender of BST teachers and pupils' outcome.

2.14 Teachers' gender and Attitude to BST teaching

Halladyna and Shanghnessy in Afolabi (2009) concluded that there are a number of factors that contributed to poor performance of students in science subjects, he identified teachers' attitude as a major factor and he concluded that teachers' attitude is significant in determining the achievement of students in sciences. Gender is another factor that has caught researchers' attention in science education. Okpala and Onocha (1988) established significant gender difference in favour of boys while Iroegbu (1998) found out that gender difference do not have effect. Jones and Levin (1994) in their study found that although male and female teachers recognised the usefulness of science for their students but males had a more significant positive attitude towards confidence in teaching science than did the female teachers. Afolabi and Audu (2007) found that teachers' gender has significant effect on the performance of students in sciences. Basu and Chakroborty (1996) reported that student taught by male teacher achieve higher than those taught by female teachers, this was in contrast with Adedipe (1986) that reported a conflicting finding in which students that are taught by female teachers performed significantly better than those taught by their male counterparts.

Cavas, Cavas, Karaoglan and Kisla (2009) opined that science teachers have positive attitudes towards Information Communication Technology, although the teachers' attitude did not differ on account of gender. Okoro and Uwah (2013) however noted that teachers' gender has a significant influence on their attitude and by inference the attitude of pupils to schooling.

The effect of teachers' gender on pupils' academic performance in primary science has not been conclusively arrived at. A preponderance of primary school teachers are women and many consider themselves as not qualified to teach basic science and technology (Amusan, 2010), that is, teachers' gender has a significant effect on attitude to science. Rossiter in Bitner 1992 noted that science is also historically known as a ‘male' profession. Driessen (2007) however, found that teacher gender has no effect on his or her attitudes to the subject and its teaching. Odubunmi and Balogun in Afolabi (2009) have identified teachers' characteristics, which include gender and attitude towards their teaching subjects as factors contributing to poor performance in science subjects. However, Bakr (2011) investigating Egyptian teachers' attitudes towards computers in terms of gender found that there were no significant differences in terms of gender. Effect of gender on learning outcome in sciences is still in debate, different researchers had different findings at different times.

2.15 Teachers' Content Knowledge and knowledge of pedagogical skills

Some of the challenges of teachers might be related to what to teach and how to face the pupils to teach them. Teaching basic science and technology can be a challenge: it requires not only a sound knowledge of the subject per se but more importantly the development of what Shulman (1986) calls 'pedagogical content knowledge' ('PCK'). 'Subject matter content knowledge' refers to 'the amount and organization of knowledge per se in the mind of the teacher' whereas 'pedagogical content knowledge' refers to 'subject matter knowledge for teaching, which includes an understanding of the conceptions and preconceptions that pupils bring with them to the learning environment. The first encounter a pupil has with any subject may have a long-term impact on his/her interest, attitude and understanding of that subject. Hence teachers need to be aware of their students' misconceptions and use teaching strategies that will help their students reorganize their thinking.

The knowledge utilized by teachers has been categorised by Shulman in NTI (2009), as:

- Knowledge of the science curriculum
- The content appropriate to it
- The pedagogy necessary to teach it.

He noted that these three are very essential to the science teacher as a weapon in the classroom. Subject knowledge and pedagogy can develop hand in hand in a mutually inter-dependent manner. Teachers' autonomy provides the considerable freedom to choose their own teaching styles and methods. In addition to being knowledgeable in their subjects, the ability to communicate, inspire trust and confidence, and motivate students, as well as understand their educational and emotional needs, is essential for teachers. Teachers must be able to recognize and respond to individual differences in pupils, and employ different teaching methods that will result in high pupil achievement. They also should be organized, dependable, patient, and creative.

In agreement with Draper (1998) a good teacher requires expertise the subject itself, and experience in learning and teaching it. So the teachers require all of the:

- Knowledge of the subject matter
- Knowledge of teaching methods

- Knowledge of learning and teaching of that particular subject matter (i.e. what learners find hard, get misconceptions of, which alternative prior conceptions they come with)

Cochran (1997) noted that both teachers' pedagogical skills and teachers' subject matter knowledge or content knowledge are very crucial to good science teaching and learners' understanding. Teachers should endeavour to relate their pedagogical skills to their subject content for effective instruction and by inference, improved learners' achievement. Most teachers do not pedagogical skills are important, however, they determine what teachers do minute to minute in the classroom. The key to distinguishing the knowledge base of teaching lies at the intersection of content and pedagogy in the teachers' capacity to transform content knowledge into forms that are pedagogically powerful and yet adaptive to the variety of pupils' abilities and backgrounds (Shulman, 1986).

2.16 Teachers' subject specialisation and school location

Despite considerable efforts by the federal, state and local governments, towards achieving the goal of Education for All (EFA) in Nigeria, multi-grade teaching still takes place more in rural schools, this is becoming a challenge. Multi-grade teaching in Nigeria has been described as the situation in which a teacher teaches more than one class at the same time either in the same classroom or in a different classroom. In Malaysia, Little (2001) noted that multi-grade teaching involves the teaching of children from two or more grade levels in one classroom. The combination is usually of grades close to each other; for example, one and two, five and six. In Pakistan and Australia, however, as many as five or six grades may combine in one class. Multi grade teaching strategies improve access, particularly in the rural areas where there were few teachers to handle all the classes.

Multi-grade Teaching is emerging as a form of schooling which best fits the needs of many countries in the Africa especially Nigeria where teachers are inadequate, as they strive to meet their commitment to provide education for all. The teacher population situation is therefore not so pleasant as to sift teachers on the basis of area of subject specialization. From time immemorial, primary school teachers have been pursuing any subject that exists in the education sector. In primary schools, you could find that a mathematics teacher is still the one who teaches science, Christian religious education, Social studies, the teacher could also teach English and Yoruba. Of course, this could make us the pupils to be confused since it would be very hard for them to shift their minds from one of the teacher's subject to the other. It would be very confusing especially when the same teacher had two consecutive lessons covering two different subjects. The teachers

may also experience some problems since there was always a huge pile of books on their tables. It would most likely be difficult for the teacher too, who had come from an English lesson to immediately switch to start teaching Yoruba.

Specialisation for primary school teachers is defined as strong subject matter background in one discipline. This study sought to find out whether subject specialisation like the one that takes place in secondary schools whereby the teachers select a number of subjects which they are well equipped with the required amount of information for delivering to the learners would not be beneficial in the primary school setting.

2.17 Research Gap

The Nigerian government formulated some policies and initiated some programmes that will enhance the status of science and technology education geared towards the achievement of global standards. The policy in Nigeria presently is for all pupils to transit from middle basic to upper basic class. With the present full transition to the upper basic class in the country, there is a need to establish a good foundation in BST. Improving the foundation might improve students performances in secondary sciences and increase the percentage of learners who take to sciences as careers in tertiary institutions. This would serve to fulfil the Government's desire, which in turn may lead to scientific breakthroughs and bring about technological development in the society.

From previous researches teacher quality has been known to be important in learners' achievement, however, there are conflicting results on what constitutes teacher quality. In view of conflicting reports on the teacher quality variables that enhance academic outcomes in schools, there is the need to carry out a study with a view to determining which of the selected variables will have causal relationship with pupils' achievement in Basic Science and Technology. Also, most available research works on teacher variables were not done with primary school teachers.

2.18 Appraisal of Literature Review

Teachers play a very important role in the learning process. The definition of teacher quality ranged from a focus on what teachers know and do in their classroom, to how knowledge should be acquired. Research studies on teacher quality provide convincing evidence that quality teachers matter, though the evidence on what constitutes a quality teacher are still mixed. The purpose of education in Nigeria includes unparalleled development of science and its application to industry and technology for better living. While adopting education as instrument par excellence, the federal government gave premium on the importance of science and technology and in line with global

perspectives of science for all, made provisions for science and technology education in the national policy on education.

Nothing has been taught until it has been learnt and this happens when the teacher succeeds in causing a change in behaviour in the learner. It is therefore important that the teacher must see teaching as an attempt on his own part to transfer what he has learnt to his students. Teacher quality is seen as extremely difficult to define, and therefore measure. Teachers must be responsible for managing and monitoring student learning and create environments that engage pupils and use time effectively. Therefore, sustained improvements in primary science and technology will depend on improved teacher capability.

Children in rural areas may be considered more difficult to educate. They are likely to have less parental encouragement to go to school, and more alternative demands on their time, such as helping with agricultural tasks. When they attend school, they may find the curriculum less relevant to their lives, and find less support for their learning from the home environment. On the supply side, governments may find it more difficult to supply quality education services in rural areas. In many African countries, of which Nigeria is one, teachers prefer to teach in urban areas. As a result, rural schools may have fewer qualified teachers. Schools located in remote areas also tend to have higher teacher absenteeism; and a relationship between teachers absence and student performance. These factors could combine to weaken the quality of teaching and achievement in rural areas. As little as half of each school day may be devoted to instruction in some classrooms depending on teachers' classroom practices, pupils' characteristics and actual time allocated to instruction. Instructional time according to this study, is the portion of classroom time spent teaching students particular knowledge, concepts, and skills pertaining to school subjects (i.e., excluding routine procedural matters, transitions, and discipline).

At the school level, the implication of this research for school leaders is that they must minimize the amount of instructional time lost to unnecessary extra-curricular activities. The crucial issue seems to be how the time is used, with quality of instruction being the key. One of the fundamental problems facing science teaching today is the question of how current are the professional teachers. The majority of teachers who have been employed in the past decades have been doing the same thing, the same way all along. They have no knowledge of the current ideas and innovations that have taken place in the educational field in the recent past.

Teachers' relational quality with students has an important role in effectiveness of the teachers' teaching and the standard for measuring the effectiveness of the teachers that are creating the learning. One of the most basic characteristics of good teachers is the ability to establish the

interaction in the classroom and most of the observed stresses in the classrooms come from lack of desired interaction, teaching takes place when the teacher interacts with one or more learners. Apart from different definitions for teaching and different teaching methods, one of the most basic elements of qualitative teaching is the way in which students respond to teaching activities and on the whole, it is the interaction between the teacher and students. Interaction between students and teachers should have significant role in students' achievement.

There are various teaching methods and techniques in Basic Science and Technology teaching, but whereas the methods and techniques are means or ways of impacting scientific knowledge to pupils, the strategies are the skills required for using these methods effectively. Effective teaching of science and technology do not depend on teacher's knowledge of the methods, but his skill to use the appropriate method or combination of methods. No particular method can be labelled good or bad, it all depends on how the teacher uses them. The ability of a teacher to teach is not derived only from the teacher's academic background but it is based upon outstanding pedagogical skill acquired. Most classroom teachers find that they have a preference for one or more of the subjects that they teach, therefore, allowing primary teachers to operate within their specialty areas, either as a content major or minor in schools could help the pupils' achievement. The science specialist would have the primary responsibility for previewing and selecting science curricular materials. The advantages for the pupils of the classroom science specialists-manned classroom include increased teacher content and curricular knowledge, and time dedicated to science instruction.

Effect of gender on learning outcome in sciences is still in debate. Little conclusive evidence is available on the relationship between teacher gender and students' achievement. The evidence on the relationship between student learning and teacher gender is limited and contradictory. Therefore, the researcher felt the need for this study to look at the relationship that exists between the gender of BST teachers and pupils' outcome.

Teachers' pedagogical skills and teachers' subject matter knowledge or content knowledge are very crucial to good science teaching and learners' understanding. Teachers need to relate their pedagogical skills to their subject content for effective instruction and by inference,improved learners' achievement. Most teachers do not think pedagogical skills are important, however, these skills determine what teachers do minute to minute in the classroom. Specialisation for primary school teachers is defined as strong subject matter background in one discipline. This study sought to find out whether subject specialisation like the one that takes place in secondary schools whereby the teachers select a number of subjects which they are well equipped with the required amount of information for delivering to the learners would be beneficial in the primary school setting.

Identifying the classroom practices associated with high pupil achievement and targeting these practices in teacher education and professional development provides a pathway to improve the quality of instruction for all pupils. While many studies attest that some teachers contribute more to their pupils' academic growth than other teachers, research results have been contradictory in identifying the specific teacher qualifications, characteristics and classroom practices that are more likely to improve pupils' learning. Unfortunately, this is just the information that educational policy makers need most. In view of conflicting reports on the teacher quality variables that enhance academic outcomes in schools, this study found out the causal effects of some teacher variables (school location, gender, subject specialisation, instructional time, content knowledge, pedagogical skills, attitude and classroom interaction) on pupils' achievement in BST.

CHAPTER THREE

3.0 METHODOLOGY

This chapter reports the methodology that is applied in this study. It describes the research design, population, sampling technique and sample, instrumentation and instruments as well as the data analysis procedures.

3.1 Research Design

The study employed a non-experimental, survey design. It is also an *Ex-postfacto* study becausethe independent variables had occurred much earlier in the population. Therefore, random assignment and manipulation of variables were not carried out by the researcher. Correlations among the variables of study were assessed testing theoretical propositions about cause and effect without manipulating variables. The "causal" in "causal modelling" refers to an assumption of the model that some variables are causally related.

3.2 Variables of the Study

- **Exogenous variables**

1. School location - Rural/Urban
2. Gender - Male / Female
3. Teachers' subject specialisation [Integrated Science, Biology, Mathematics, French, Social Studies, English Language, Yoruba, Physical & Health Education (PHE), etc.]

- **Endogenous variables**

1. Instructional time;
2. Teachers' Basis Science and Technology content knowledge;
3. Teachers' pedagogical skills;
4. Teachers' attitude to BST; and

5. Teachers' interaction with the pupils.

- **Criterion variable**

  Primary six pupils' achievement in Basic Science and Technology

Variables' identification

Z_1 = School location

Z_2 = Teachers' gender

Z_3 = Teachers' subject specialisation

Z_4 = Instructional time

Z_5 = BST teachers' content knowledge

Z_6 = BST teachers' pedagogical skills

Z_7 = BST teachers' attitude to BST

Z_8 = Teacher-pupils classroom interactions

Z_9 = Pupils' achievement

3.3 Population, Sampling Technique and Sample

3.3.1 Population

The population of study comprised all Basic six public primary schools' pupils and teachers in Ogun State, Nigeria. The choice of Basic six pupils was based on the fact that they have passed through the lower basic level and being in the final class of the middle basic level in the primary schools, the pupils would have covered the Basic schools BST curriculum, and therefore, be able to answer the BST achievement test items. Ogun state consists of twenty Local Government Education Authorities (LGEAs) with a total number of 14,751 teachers (5,019 male and 9,732 female) as shown in Table 3.1.

3.3.2 Sampling Techniques and Sample

Multi-stage sampling method was used to get the required respondents for this study. The study covered the twenty Local Government Councils of Ogun State. Using proportionate to size sampling technique, 1% of the 14,751 teachers in the State was sampled. First, the schools in each Local Government Education Authority (LGEA) were stratified into rural and urban schools, the researcher made use of the State Universal Basic Education Board (SUBEB)'s classification. The

teachers were further stratified based on their gender, depending on the ratio of male to female teachers in each Local Government Education Authority (LGEA). Schools in each LGEA were purposively sampled based on location and gender of teachers who teach BST. The unit of measurement for this study is the pupils. A total of 148 BST teachers spread all over the state were participants in the study, while 3, 052 Basic six pupils in intact classes of the teachers were also used for the study. Table 3.1 shows the sampling frame:

TABLE 3.1: Population and Sampling frame of Teachers

S/N	LGEAS	POPULATION		RATIO	TOTAL	SAMPLE	BY GENDER		BY LOCATION		SCHS/LGEA	TOTAL NO OF SCHS
		M	F				M	F	R	U		
1	Abeokuta N	209	748	1:4	957	9	2	7	6	3	3	82
2	Abeokuta S	95	875	1:9	970	10	1	9	-	10	2	49
3	Ado-odo Ota	345	1009	1:3	1354	13	4	9	4	9	5	113
4	Ewekoro	136	326	1:2	462	5	1	4	2	3	2	57
5	Ifo	200	689	1:4	889	9	2	7	5	4	3	95
6	Ijebu-East	210	334	1:2	544	5	2	3	3	2	2	64
7	Ijebu-North	650	301	2:1	951	10	7	3	4	6	5	102
8	Ijebu-North east	119	248	1:2	367	4	1	3	3	1	2	33
9	Ijebu-Ode	189	880	1:5	1069	11	2	9	4	7	4	39
10	Ikenne	91	301	1:3	392	4	1	3	2	2	2	22
11	Imeko-Afon	307	380	1:1	687	7	3	4	5	2	3	57
12	Ipokia	372	385	1:1	757	8	4	4	7	1	3	88
13	Obafemi-Owode	553	569	1:2	922	9	3	6	6	3	5	161
14	Odeda	371	32	12:1	403	4	3	1	2	2	3	106
15	Odogbolu	181	419	1:2	600	6	2	4	3	3	3	53
16	Ogun-Waterside	259	259	1:1	518	5	3	2	3	2	2	61
17	Remo-North	84	179	1:2	263	3	1	2	2	1	2	23
18	Sagamu	139	647	1:5	786	8	1	7	4	4	3	55
19	Yewa-North	429	555	1:1	934	9	4	5	5	4	5	117
20	Yewa-South	280	646	1:2	926	9	3	6	4	5	4	72
	TOTAL	5,019	9,732		14,751	148	49	99	74	74		

Source: Ogun State Universal Basic Education Board (SUBEB), 2012

LGEAS - **Local Government Education Authorities in Ogun State**

POPULATION - **Total number of teachers in each LGEA in Ogun State**

RATIO - **Ratio of male teachers to female teachers**

SAMPLE - **Number of teachers sampled in each LGEA**

SAMPLE BY GENDER - **Gender components of the sampled teachers per LGEA (M - male, F - female)**

SAMPLE BY LOCATION - **Location components of the sampled teachers per LGEA (R - rural, U - urban)**

SCHS/LGEA - **Number of sampled schools in each LGEA**

TOTAL NO OF SCHS - **Total number of schools in each LGEA.**

M - male, F - female, R- rural, U - urban.

TABLE 3.2: Ogun State Basic Science and Technology Teachers' profile

School location	Rural	Urban	Total
	74 (50%)	74 (50%)	148 (100%)
Gender	**Male**	**Female**	
	49 (33.1%)	99 (66.9%)	148 (100%)
Subject specialisation	**Science**	**Non-science**	
	58 (39.2%)	90 (60.8%)	148 (100%)

One hundred and forty-eight teachers responded to the instruments. The BST teachers were sampled from rural and urban schools in equal number (74) each. They also consisted of forty-nine (49) male and ninety-nine (99) female teachers; and 58 of them specialists in science based courses while 90 are in non-science based courses, as shown in Table 3.2. The sampled BST Teachers' profile revealed twenty-seven diverse subject specialisation.

3.4 Instrumentation

The study made use of six (6) validated instruments. These instruments are:

1. BST Teachers' Management of time Observational System (TMOTOS)
2. Pedagogical Skills Observational Schedule (PSOS)
3. Teacher-Pupils' Interaction Observation Instrument (TPIOI)
4. BST Teachers' Attitude to BST Scale (BSTAS)
5. BST Teachers' Content Knowledge Test (CKT)
6. BST Pupils' Achievement Test (BSTPAT)

3.4.1 BST teachers' management of time observational system

Teachers' Management of time observational system (TMOTOS) adapted by the researcher from the Classroom Interaction Scale (CIS) of the Institute of Education, University of Ibadan, Ibadan was used to estimate the proportion of the schools' scheduled time spent on facilitating knowledge in Basic science and technology. (Appendix1). The instrument consists of two sections, A and B. Management of time is a running record observational instrument that documents how the teacher organises or manages pupils' time.

The focus of the observation is the teachers' effective use of the pupils' time. The instrument is a twenty-five minute observation instrument and was used by the researcher and other research assistants trained by the researcher. Section A of the instrument was used in eliciting information such as, school location, gender and subject area specialisation of the teacher, while section B was used to record the time spent in minutes on academic, management and non-academic activities. The content validity and reliability of this instrument were established using Lawshe's method of content validity and Scott pi respectively. The instrument was given to the supervisor and nine other evaluators to check for the suitability or otherwise of each of the items. The Lawshe formula:

$$CVR = \frac{Ne - N/2}{N/2}$$ was used to calculate the content validity

CVR = Content Validity Ratio

N_e = No of panels rating the item good, N = Total number of panels

The average value of these coefficients was found and used as the coefficient of the instrument. Reliability was done using this:

$$R = \frac{N}{N-1}\frac{\delta x2 - \sum pq}{\delta x2}$$

Where δx^2 = variance of testees' scores

P= proportion of testees that answered each item correctly.

Q= proportion of testees that answered each item wrongly.

The coefficients were 0.77 and 0.81 respectively.

3.4.2Pedagogical Skills Observational Schedule

Pedagogical skills observational schedule (PKOS - Appendix 2) was adopted from the practical teaching assessment form of the Federal Training Centre for Teachers of Health Sciences, UCH, Ibadan. The instrument has four sections used to rate teachers' behaviours in the BST classroom, such as, lesson plan, presentation of lessons, class management and control among others. The lesson plan was included to rate the teacher's preparation for the class, since it is what is planned that will be executed in the class,the use and relevance of teaching aids and method to the topic being taught. Some properties of the teaching behaviour rated include subject content knowledge, method of presentation, class control and management. Total obtainable score of the

instrument is 100%. The content validity and reliability of this instrument were established using Lawshe's method of content validity and Scott pi respectively. The coefficients were 0.73 and 0.84 respectively.

3.4.3 Teacher-Pupils' Interaction Observation Instrument (TPIOI)

This instrument was adapted from Flander's Interaction Analysis Categories System (FIACS). Twelve categories were drawn out of the FIACS ten categories and these were coded every 15 seconds unlikethe 3 seconds interval coding in FIACS. It was validated and used to assess the interaction between the BST teachers and their pupils. The observation instrument - Appendix 3 was coded by the researcher and the trained research assistants from the first five minutes of the BST class to the last five minutes. The instrument was used to record every form of interaction between the teacher and the pupils. The content validity and reliability of this instrument were established using Lawshe's method of content validity and Scott pi respectively. The coefficients were 0.81 and 0.82 respectively.

3.4.4 BST Teachers' Attitude to BST Scale (BSTAS)

A validated attitude scale designed by the researcher was used to assess the attitude of the BST teachers to the subject and its teaching. Copies of the attitude scale - Appendix 4, were administered to the BST teachers to assess their attitude to BST as a subject and its teaching. The instrument consisted of 20 items making use of Likert scale rated from 1 (strongly disagree) to 4 (strongly agree) for the positively worded items. For the negatively worded items the reverse was used: 1 (strongly agree) to 4 (strong disagree). The content validity and reliability of this instrument were established using Lawshe's method of content validity and Cronbach Alpha respectively. The coefficients were 0.73 and 0.71 respectively.

3.4.5 BST Teachers' Content knowledge test (CKT)

A forty-item instrument was used to test the teachers' BST content knowledge. The Basic science and technology content knowledge test (CKT) - Appendix 5, consisted of multiple choice test items with four options per item and the teachers were given thirty minutes for the test. The items are from all the topics contained in the table of specifications. The test blueprint based on the first three levels of Bloom's taxonomy of educational objectives was constructed as follows:

Table 3.3 Table of Specifications for BST Teachers' content knowledge test

Content	Knowledge	Comprehension	Application	Total
Air	5 (01) 2.5%	6 (01) 2.5%	7, 8 (02) 5%	10%
Materials(types)	4 (01) 2.5%	1, 3 (02) 5%	2 (01) 2.5%	10%
The human body	9,12(02) 5%	10(01) 2.5%	11 (01) 2.5%	10%
Responsible parenthood	13,16 (02) 5%	14 (01) 2.5%	15 (01) 2.5%	10%
Minerals	40 (01) 2.5%	38(01) 2.5%	37,39 (02) 5%	10%
Machines	33,36 (02) 5%	35 (01) 2.5%	34 (01) 2.5%	10%
Electricity	25(01) 2.5%	27 (01) 2.5%	26, 28 (02) 5%	10%
Heat, energy & temperature	22,23, (02) 5%	21 (01) 2.5%	24 (01) 2.5%	10%
Food	18,19(02) 5%	17 (01) 2.5%	20(01) 2.5%	10%
Our earth & the sky	32(01) 2.5%	30 (01) 2.5%	29, 31 (02) 5%	10%
Total	15(37.5%)	11(27.5%)	14 (35%)	40 (100%)

Table 3.3 guided the researcher in selecting the right number of questions for each topic and for each objective. The difficulty and discriminating indices of the items were found. The items were reduced from sixty to forty, and these were finally used for the study. The items with difficulty indices between 0.35 and 0.64 and with discriminating indices between 0.40 and 0.55 were selected. The instrument was given to ten science education specialists to check for the suitability of each of the items. The content validity of the test was established using Lawshe method. The Lawshe formula:

$$CVR = \frac{Ne - N/2}{N/2}$$ was used to calculate the content validity

CVR = Content Validity Ratio

N_e = No of panels rating the item good, N = Total number of panels

The average value of these coefficients was found and used as the coefficient of the instrument. The content validity coefficient was 0.74. Kuder Richardson 20 (KR-20) was used to establish the reliability coefficient because of the dichotomous scoring.

$$R = \frac{N}{N-1}\frac{\delta x2 - \sum pq}{\delta x2}$$

Where δx^2 = variance of testees' scores

P= proportion of testees that answered each item correctly.

Q= proportion of testees that answered each item wrongly.

The reliability coefficient was 0.96.

3.4.6 BST Pupils' Achievement Test (BSTPAT)

A validated instrument was used to test the sampled schools' Basic six pupils' achievement in BST. The Basic Science and Technology Achievement Test (BSTPAT) consisted of 30 multiple choice test items with four options per item and the pupils were given thirty minutes for the test. The items are drawn from topics contained in the table of specifications. The test blueprint based on the first three levels of Bloom's taxonomy of educational objectives was constructed as follows:

Table 3.4 Table of Specification for BST Pupils Achievement test

Content	Knowledge	Comprehension	Application	Total
Changes around us (erosion)	20, 21(02) 6.7%	22, 23(02) 6.7% %	19 (01) 3.3%	16.6%
Improving crop yield	13,14(02) 6.7%	12, 29(02) 6.7%	30 (01) 3.3%	16.6%
The human body	1(01) 3.3%	4, 5, 6 (03) 10%	3 (01) 3.3%	16.6%
Responsible parenthood	7, 11 (02) 6.7%	8 (01) 3.3% 9	10 (02) 6.7%	16.6%
Air	2 (01) 3.3%	15, 18 (02) 6.7% 16,	17 (02) 6.7%	16.6%
Materials (types)	27(01) 3.3%	24 (01) 3.3%	25, 26, 28 (03) 10%	16.6%
Total	9 (30%)	11(36.7%) 1(	(33.3%)	30(100%)

Table 3.5.8 guided the researcher in selecting the right number of questions for each topic and for each objective. The items were finally reduced from fifty to thirty; these were finally used for the study. Items with difficulty indices between 0.35 and 0.64 and with discriminating indices between 0.40 and 0.55 were selected. The instrument was given to ten raters to check for the suitability of each of the items. The content validity of the test was established using Lawshe method.

The average value of these coefficients was found and used as the coefficient of the instrument. The content validity coefficient was 0.77. Kuder Richardson 20 (KR-20) was used to establish the reliability coefficient because of the dichotomous scoring. The reliability coefficient was 0.92.

3.5 Data Collection Procedure

Twenty research assistants were trained and used for data collection. The contents of the instruments used by each research assistant were explained to him/her and the way and manner

the instruments were to be used for data collection. Those research assistants who used the observational instruments were taken to classrooms outside the study sample for effective practice. The training lasted two weeks. In each school, some of the research assistants distributed copies of the attitude scale, BST content knowledge test and Pupils' achievement test to the respondents and gave instruction on how to fill them. Other research assistants and the researcher filled the observational instruments with one assistant doing audio-video recording of the activities in the BST classes.

The data collection started with the administration of the teachers' attitude scale (BSTAS). After this, the researcher and assistants used the Pedagogical skills observational schedule, the Teacher-pupils interaction observation instrument and BST Teachers' Management of time observational system to assess the teachers' classroom practices, interaction with pupils and use of time during BST lessons in the different classes/schools. All the three observation instruments were used by the researcher and two other research assistants on each of the BST teachers in one BST lesson. The audio-video recording of the lesson also went on at the same time. Finally, the BST Teachers' Content knowledge test and BST Pupils' Achievement Test were administered to the teachers and pupils respectively. The data collection took a total of eight weeks. After the administration of the instruments, the researcher and the assistants collected and collated the instruments for analysis.

3.6 The Hypothesised Path Model

Path analysis provides the researcher the method for explicitly formulating a theory and exploring the tenability of causal linkages among the exogenous and endogenous variables of the hypothesized (theoretical) causal model. The model was developed based on extensive literature review and logical assumption that helped the researcher in tracing the implications of a set of causal assumptions. Causal modelling is a technique for selecting those variables that are perceived to be determinants of the effects made by each cause or predictor variable through the application of path analysis technique (Blalock, 1964). This is subject to three assumptions of the recursive system (Kerlinger & Pedhazzur, 1973):

i. There is no reciprocal causation between variables,

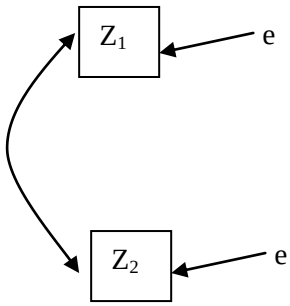
ii. The residuals are uncorrelated with variables preceding them in the model, and among themselves; and

iii. Each of the endogenous or dependent variables is directly related to all the variables preceding it in the hypothesized causal sequence.

3.6.1 Building the Hypothesised Recursive Path Model

The decision as to most meaningful diagram is made in consideration of temporal order, research findings, theory, logic, expert opinions and personal observations and experiences.

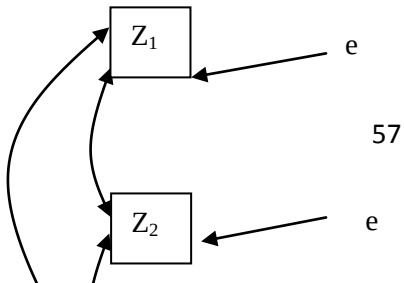
Based on personal observations and experiences, most female teachers apart from enjoying the sympathy of management, lobby to be posted and retained in urban schools. School management usually opine that male teachers can cope better in tough situations like rural school location. The linkages among variables Z_1 (school location), Z_2 (gender) as shown in fig. 3.1,



Z_1 = School location ; Z_2 = Teachers' gender

Figure 3.1 - Hypothesised Causal Linkages of Variables Z_1 and Z_2

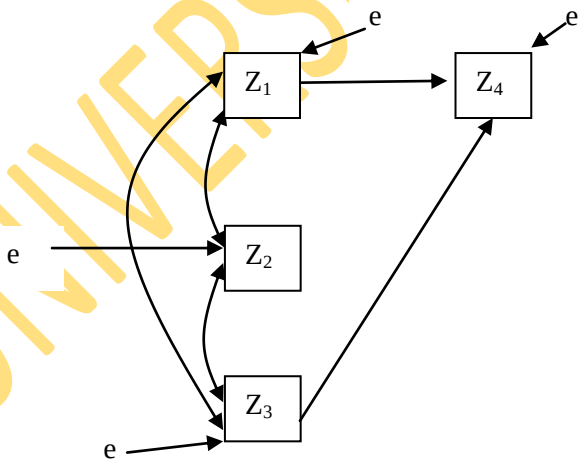
Research opined that the female gender are discouraged from taking science and technology based courses since it is generally thought they are too difficult and therefore inappropriate for the female gender. Such socio-cultural barriers are seen as being responsible for male applicants far out-numbering female applicants in the science and technology courses in Universities' Matriculation Examinations (Amusan, 2011). There is likely to be a linkage between Z_2 and Z_3 (gender and subject specialisation) as shown in figure 3.2. Considering the linkage between Z_1 (school location) and Z_3 (subject specialisation), most schools in the rural area make use of multi-grade teaching because of smaller teacher population in comparison to urban schools, therefore, there would be likelihood of the schools rurally located not having enough teachers qualified to teach BST. Based on literature and logic therefore, there would be a causal linkage between school location and teachers' subject specialisation (Yusuf, Jekayinfa, et al. 2011). The linkage between Z_2 (gender) and Z_3 (subject specialisation) is as shown in figure 3.2;



Z_1 = School location; Z_2 = Teachers' gender; Z_3 = Subject specialisation.

Figure 3.2 - Hypothesised Causal Linkages of Variables Z_1, Z_2 and Z_3

Based on research findings school location Z_1 can predict effective use of instructional time Z_4. Mulken (2005) noted that, teachers in rural schools may teach less than their counterparts in urban areas. Researches in the United State also showed that in rural areas, pupils have less instructional time (Abadzi, 2007). From logic, teachers whose subject specialisations are not science related may not be able to effectively utilize the pupils' BST instructional time, therefore, Z_3 (subject specialisation) would have a bearing on Z_4 (instructional time). The linkages among variables Z_1, Z_2, Z_3 and Z_4, as shown in fig. 3.3



Z_1 = School location; Z_2 = Teachers gender, Z_3 = Subject specialisation; Z_4 = Instructional time

Figure 3.3 - Hypothesised Causal Linkages of Variables Z_1, Z_2, Z_3 and Z_4

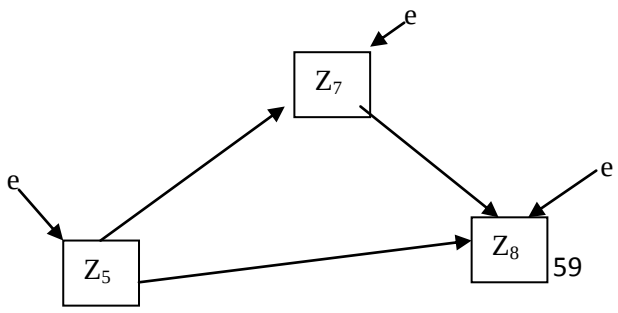
Based on temporal order, teachers' subject specialisation Z_3 existed before teachers' BST content knowledge Z_5 and their pedagogical skills Z_6. In essence, teachers' subject specialisation will affect both the teachers' content knowledge and pedagogical skills. Also, research reveals that

teachers with various subject backgrounds are often required to teach the subject they are not trained for. These teachers use various kinds of coping strategies in order to teach science meaningfully and effectively whilst filling the gaps of content knowledge and pedagogical content knowledge in the subject that they are required to teach (Subahan, Lilia, Khalijah & Ruhizan, 2001) in Osman, Halim and Meerah (2006). The linkages among variables $Z_{3,}$ $Z_{5,}$ and Z_6 are as shown in fig. 3.4

Figure 3.4 - The Hypothesised Causal Linkages of Variables Z_5 Z_5 and Z_6

Z_1 = School location; Z_2 = Teachers gender, Z_3 = Subject specialisation; Z_4 = Instructional time Z_5= Content knowledge Z_6= Pedagogical skills

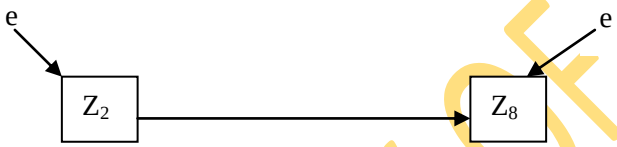
From experiential knowledge, BST teachers' content knowledge Z_5 could affect teachers' attitude to BST as a subject and its teaching Z_7. Teachers with poor background knowledge of BST would likely have poor attitude to it as a subject and its teaching. It is reasoned that such teachers with poor subject content knowledge would also not be able to have confidence to interact with the pupils well in BST lessons. Therefore BST teachers' content knowledge would likely affect the attitude and classroom interaction of the teachers. The teachers' attitude to BST as a subject and its teaching could also influence the teacher-pupils' interaction in BST class. The linkages among the variables $Z_{5,}$ Z_7 and Z_8 as shown in fig. 3.5



Z_5 = Teachers' BST content knowledge, Z_7 = Teachers' attitude to BST, Z_8 = Teachers' classroom interaction

Figure 3.5 - The Hypothesised Causal Linkages of Variables Z_5, Z_7 and Z_8

From research findings, there is a relationship between the gender of teachers and interpersonal relationship with learners in the classroom. Female teachers are perceived to be more uncertain and admonishing in the classrooms than their male counterparts (Amusan & Odunuga 2012).



Z2 = Teachers' gender ; Z8 = Classroom interaction

Figure 3.6 - The Hypothesised Causal Linkages of Variables Z_2 and Z_8

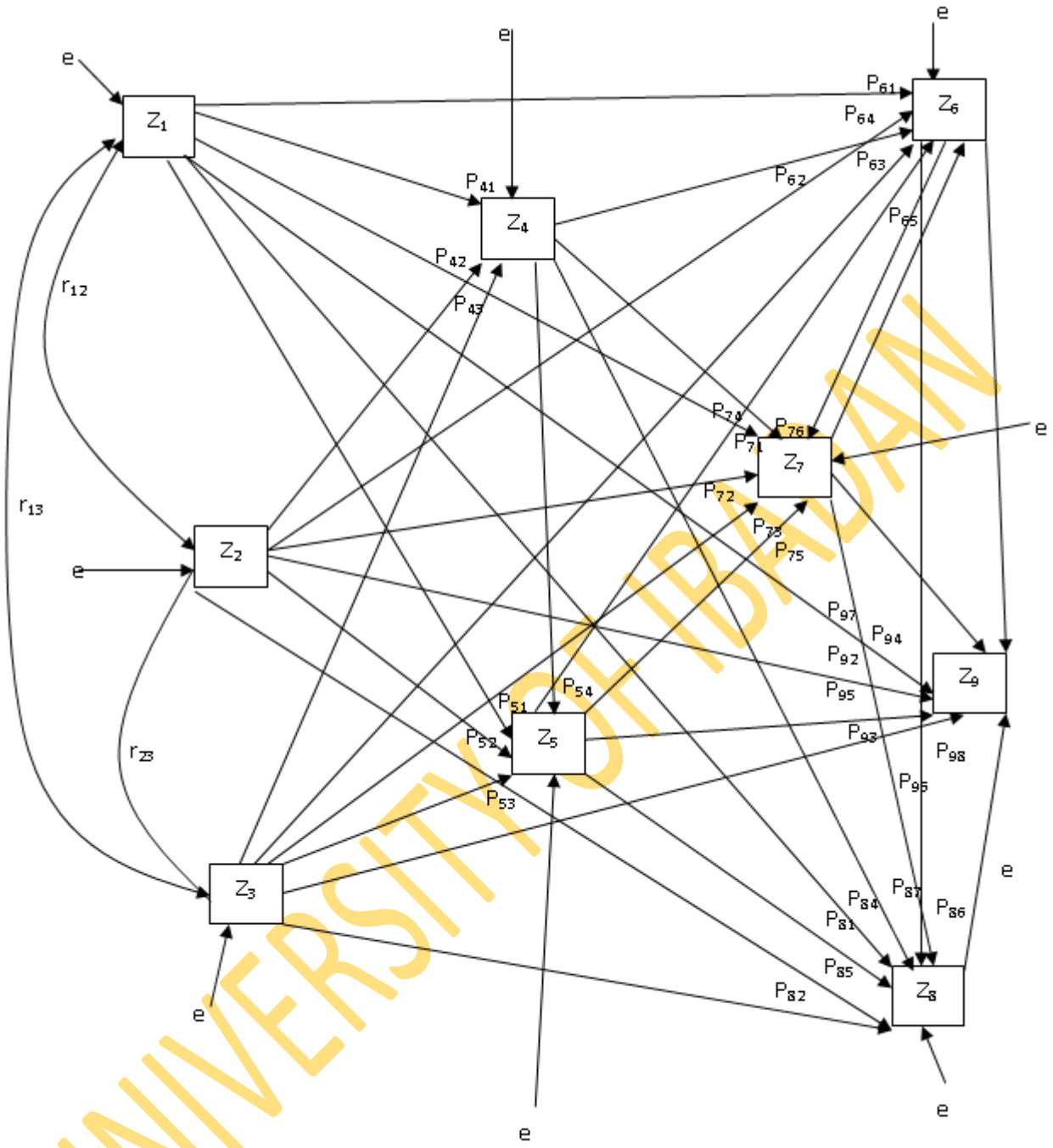


Figure 3.7 Hypothesised Recursive Path Model of the 9- Variable System.

Key: Z_1 = School location Z_2 = Gender of teacher Z_3= Teachers' subject specialisation

Z_4 = Instructional time Z_5 = Teachers' BST content knowledge Z_6 = Teachers' pedagogical skills

Z_7 = Teacher's attitude to BST Z_8 = Teachers' interaction with pupils Z_9 = Pupils' Achievement in BST

The hypothesised model in Figure 3.7 shows the links among the nine variables.

Structural equations of the hypothesised model

$Z_1 = e_1$ ……..Eqn. 3.1

$Z_2 = e_2$ ……..Eqn. 3.2

$Z_3 = e_3$……..Eqn. 3.3

$Z_4 = P_{41}Z_1 + P_{42}Z_2 + P_{43}Z_3 + e_4$ ……..Eqn. 3.4

$Z_5 = P_{51}Z_1 + P_{52}Z_2 + P_{53}Z_3 + P_{54}Z_4 + e_5$ ……,,,,,.Eqn. 3.5

$Z_6 = P_{61}Z_1 + P_{62}Z_2 + P_{63}Z_3 + P_{64}Z_4 + P_{65}Z_5 + e_6$ ……Eqn. 3.6

$Z_7 = P_{71}Z_1 + P_{72}Z_2 + P_{73}Z_3 + P_{74}Z_4 + P_{75}Z_5 + P_{76}Z6 + e_7$ ……Eqn. 3.7

$Z_8 = P_{81}Z_1 + P_{82}Z_2 + P_{83}Z_3 + P_{84}Z_4 + P_{85}Z_5 + P_{86}Z_6 + P_{87}Z_7 + e_8$ ……Eqn. 3.8

$Z_9 = P_{91}Z_1 + P_{92}Z_2 + P_{93}Z_3 + P_{94}Z_4 + P_{95}Z_5 + P_{96}Z_6 + P_{97}Z_7 + P_{98}Z_8 + e_9$ ……Eqn.3.9

3.8 Statistical Analysis

Research questions 1, 2, 3 and 4 were answered using multiple regression and path analysis.

3.9 Methodological Challenges

The challenges faced in the execution of this study were as follows:

1. Challenges from Sampling Techniques

Female teachers were found to be more in the teaching service across all the local government education authorities in Ogun state. Therefore, to get the respondents that would represent the population the researcher used 1:2, male to female ratio. Even at this, to get schools with male teachers sometimes constituted a great challenge.

2. Challenges Relating to Data Collection Procedure

Anxiety on the part of the teacher tended to interfere with the drawing of valid inferences about what normally occurs in the classroom, especially when they know that their teaching would

be recorded. To solve this, efforts were put in place to carry out the exercise in a relaxed, non-threatening manner to enable the teachers teach as they normally do.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSIONS

The results of the statistical analysis of data obtained from the administration of research instruments are presented and discussed in this chapter.

Results

The Ogun State BST teachers profile revealed twenty-seven diverse teachers' subject specialisations. The state basic educational system makes use of the teachers as subject generalists, that is, teaching all subjects to the pupils in their assigned class. Only 39.8% of the BST teachers in the Ogun State have their subject specialisations in science and technology based courses. The study found that the pupils had a mean score of 8.64 out of the total score of 30 in the BST achievement test with a pass mark of 12. That is the majority of the pupils scored below the pass mark.

4.1 Research Question 1:

What is the pattern of relationships (correlations) in the model consisting of school location, teachers' gender, subject specialisation, instructional time, content knowledge of Basic Science and Technology, pedagogical skills, attitude to BST as a subject and its teaching, Classroom interaction with their pupils and pupils' achievement in Basic Science and Technology in Ogun State Primary Schools?

TABLE 4.1: The Original and Reproduced Correlation Matrix for the Nine Variables

Variables	Z_1	Z_2	Z_3	Z_4	Z_5	Z_6	Z_7	Z_8	Z_9
Z1	1.000	.043	.080	.126	.046	.159	.019	.092	.115
Z2	.043	1.000	-.069	-.026	-.220	-.051	.055	.000	-.016
Z3	.080	-.069	1.000	.048	-.052	.222	.070	.188	.073
Z4	.134	-.025	.048	1.000	.197	.735	-.030	.680	.181
Z5	.034	-.220	-.030	.197	1.000	.259	-.172	.135	.049
Z6	.065	-.051	.222	.734	.259	1.000	-.041	.757	.234
Z7	.038	-.018	.083	.013	-.157	.018	1.000	-.022	-.174
Z8	-.052	.000	.187	.680	.135	.757	-.022	1.000	.250
Z9	.141	-.016	.073	.181	.049	.235	-.174	.250	1.000

Key: Z_1 = School location Z_2 = Gender of teacher Z_3 = Teachers' subject specialization Z_4 = Instructional time Z_5 = Teachers' BST content knowledge Z_6 = Teachers' pedagogical skills Z_7 = Teachers' attitude to BST Z_8 = Teachers' interaction with pupils Z_9 = Pupils' Achievement in BST

Table 4.1 reveals high significant relationships among the variables ($p < .05$). However, there is norelationship between Gender and Classroom interaction. It is also notable that the highestcorrelation ($r = 0.757$) is between Pedagogical skills and Classroom interaction.

4.2 Research Question 2:

Is the model describing the causal effects among the variables (school location, teachers' gender, subject specialisation, instructional time, content knowledge of Basic Science and Technology, pedagogical skills, attitude to BST as a subject and its teaching, Classroom interaction with their pupils and pupils' achievement in Basic Science and Technology in Ogun State Primary Schools) consistent with the observed correlations among these variables?

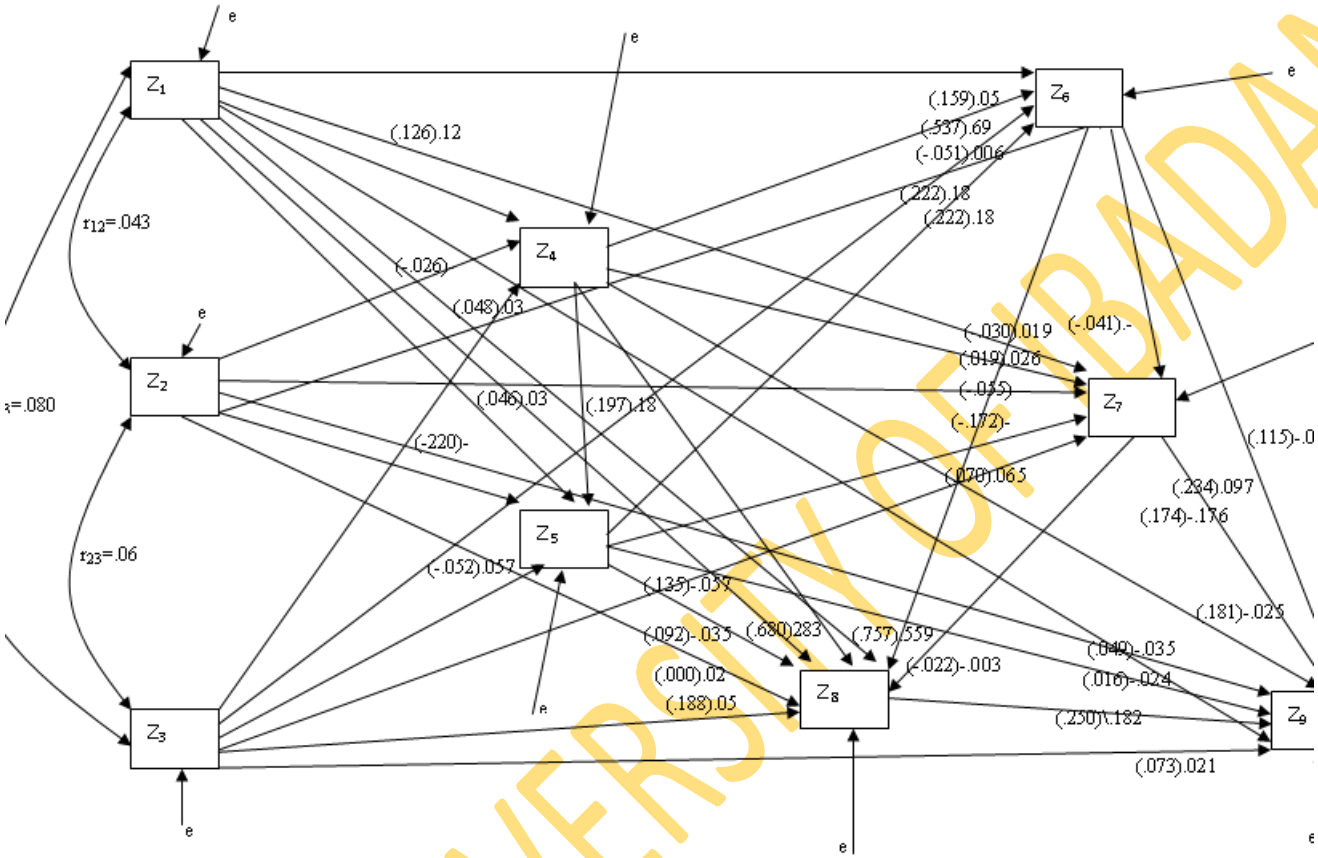


Figure 4:1 Hypothesized Recursive Path Model of the 9- Variable System.

Key: Z_1 = School location Z_2 = Gender of teacher Z_3 = Teachers' subject specialisation Z_4 = Instructional time Z_5 = Teachers' BST content knowledge

Z_6 = Teachers' pedagogical skills Z_7 = Teachers' attitude to BST Z_8 = Teachers' interaction with pupils Z_9 = Pupils' Achievement in BST

To obtain the pattern of relationships (correlations), there was need to determine the zero-order correlations among the nine variables. Table 4.2 presents the relationships (Pearson's correlation coefficient) among the variables. Both the obtained correlation coefficients and path coefficients were written on each pathway of the model with the correlation coefficients in parentheses (See Figure 4.1).

Some obtained correlation coefficients in Table 4.1 show high significant relationships among the variables ($p > .05$). However, there is no relationship between Gender and Classroom interaction. It is also notable that the highest correlation ($r = 0.757$) is between Pedagogical skills and Classroom interaction. The Table also reveals positive and statistically significant relationship ($p > .05$) between Basic Science and Technology achievement and School location; Subject specialisation; Effective use of instructional time; Pedagogical skills; Attitude to BST as a subject and it's teaching; and Classroom interaction. This shows the importance of these variables in predicting pupils' achievement in BST.

To determine the values of path coefficients of the hypothesised model, six multiple regression analyses were conducted, thus:

One: Z_4 was regressed on Z_1, Z_2 and Z_3

Two: Z_5 was regressed on Z_1, Z_2, Z_3 and Z_4

Three: Z_6 was regressed on Z_1, Z_2, Z_3, Z_4 and Z_5

Four: Z_7 was regressed on Z_1, Z_2, Z_3, Z_4, Z_5 and Z_6

Five: Z_8 was regressed on Z_1, Z_2, Z_3, Z_4, Z_5, Z_6 and Z_7

Six: Z_9 was regressed on Z_1, Z_2, Z_3, Z_4, Z_5, Z_6, Z_7 and Z_8

The values on the path coefficient i.e., beta coefficients β of the independent variables obtained from each of the six-regression analysis are shown in Table 4.2.

TABLE 4.2: Path Coefficients of the Obtained Hypothesised Model.

Path	Path Coefficients	Correlation coefficients	Significance	Decision
P_{41}	.125	.126	Significant	Retain
P_{42}	-.028	-.026	Not Significant	Delete
P_{43}	.036	.048	Not Significant	Delete
P_{51}	.036	.046	Not Significant	Delete
P_{52}	-.221	-.220	Significant	Retain
P_{53}	-.057	-.052	Significant	Retain
P_{54}	.189	.197	Significant	Retain
P_{61}	.050	.159	Significant	Retain
P_{62}	.006	-.051	Not Significant	Delete
P_{63}	.189	.222	Significant	Retain
P_{64}	.694	.735	Significant	Retain
P_{65}	.127	.259	Significant	Retain
P_{71}	.026	.019	Not Significant	Delete
P_{72}	-.052	-.055	Significant	Retain
P_{73}	.065	.070	Significant	Retain
P_{74}	.019	-.030	Not Significant	Delete
P_{75}	-.179	-.172	Significant	Retain
P_{76}	-.029	-.041	Not Significant	Delete
P_{81}	-.035	.092	Not Significant	Delete
P_{82}	.028	.000	Not Significant	Delete
P_{83}	.053	.188	Significant	Retain
P_{84}	.283	.680	Significant	Retain
P_{85}	-.057	.135	Significant	Retain
P_{86}	.559	.757	Significant	Retain
P_{87}	-.003	-.022	Not Significant	Delete
P_{91}	.090	.115	Significant	Retain
P_{92}	-.024	.016	Not Significant	Delete
P_{93}	.021	.073	Not Significant	Delete
P_{94}	-.025	.181	Not Significant	Delete
P_{95}	-.035	.049	Not Significant	Delete
P_{96}	.097	.234	Significant	Retain
P_{97}	-.176	.174	Significant	Retain
P_{98}	.182	.250	Significant	Retain

The decision to retain or delete the paths shown above was based on the fact that a path is said to be significant when absolute beta coefficient values β and correlation coefficient values r of the independent variables are significant at .05.

Table 4.3 shows decisions to trim/delete paths, beta coefficients β values >0.05, which are statistically significant were taken. This is in line with Adegoke (2012); Kerlinger and Pedhazur (1981) recommendations that paths whose coefficients (beta weight) are lower than 0.05 should be deleted. Therefore, of the total of thirty-three paths, fourteen paths P_{42}, P_{43}, P_{51} $P_{62,}$ P_{71}, P_{74}, P_{76}, P_{81}, P_{82}, P_{87}, P_{92}, P_{93}, P_{94} and P_{95} were deleted, while nineteen paths P_{41}, P_{52}, $P_{53,}$ $P_{54,}$ $P_{61,}$ $P_{63,}$ $P_{64,}$ $P_{65,}$ P_{72}, P_{73}, P_{75}, P_{83}, P_{84}, P_{85}, P_{86}, P_{91}, P_{96}, P_{97} and P_{98}were retained.

TABLE 4.3: Differences between the original and reproduced correlations

	Original correlation	**Reproduced correlation**	**Difference**
r_{14}	.126	.134	-.008
r_{15}	.046	.034	.012
r_{16}	.159	.065	.094*
r_{17}	.019	.038	-.019
r_{18}	.092	-.052	.144*
r_{19}	.115	.141	-.026
r_{24}	-.026	-.025	-.001
r_{25}	-.220	-.220	.000
r_{26}	-.051	-.051	.000
r_{27}	-.055	-.018	-.037
r_{28}	.000	.000	.000
r_{29}	-.016	-.016	.000
r_{34}	.048	.048	.000
r_{35}	-.052	-.030	-.022
r_{36}	.222	.222	.000
r_{37}	.070	.083	-.013
r_{38}	.188	.187	.001
r_{39}	.073	.073	.000
r_{45}	.197	.197	.000
r_{46}	.735	.734	.001
r_{47}	-.030	.013	-.043
r_{48}	.680	.680	.000
r_{49}	.181	.181	.000
r_{56}	.259	.259	.000
r_{57}	-.172	-.157	-.015
r_{58}	.135	.135	.000
r_{59}	.049	.049	.000
r_{67}	-.041	.018	-.059*
r_{68}	.757	.757	.000
r_{69}	.234	.235	-.001
r_{78}	-.022	-.022	.000
r_{79}	-.174	-.174	.000
r_{89}	.250	.250	.000

Structural Equations of the Re-specified Model

$Z_1 = e_1$ ……4.1

$Z_2 = e_2$ ……4.2

$Z_3 = e_3$ ……4.3

$Z_4 = P_{41}Z_1 + e_4$ ……4.4

$Z_5 = P_{52}Z_2 + P_{53}Z_3 + P_{54}Z_4 + e_5$ ……4.5

$Z_6 = P_{61}Z_1 + P_{63}Z_3 + P_{64}Z_4 + P_{65}Z_5 + e_6$ ……4.6

$Z_7 = P_{72}Z_2 + P_{73}Z_3 + P_{75}Z_5 + e_7$ ……4.7

$Z8 = P_{83}Z_3 + P_{84}Z_4 + P_{85}Z_5 + P_{86}Z_6 + e_8$ ……4.8

$Z9 = P_{91}Z_1 + P_{96}Z_6 + P_{97}Z_7 + P_{98}Z_8 + e_9$ ……4.9

Having deleted these paths, the re-specified model is shown in Figure 4.2.

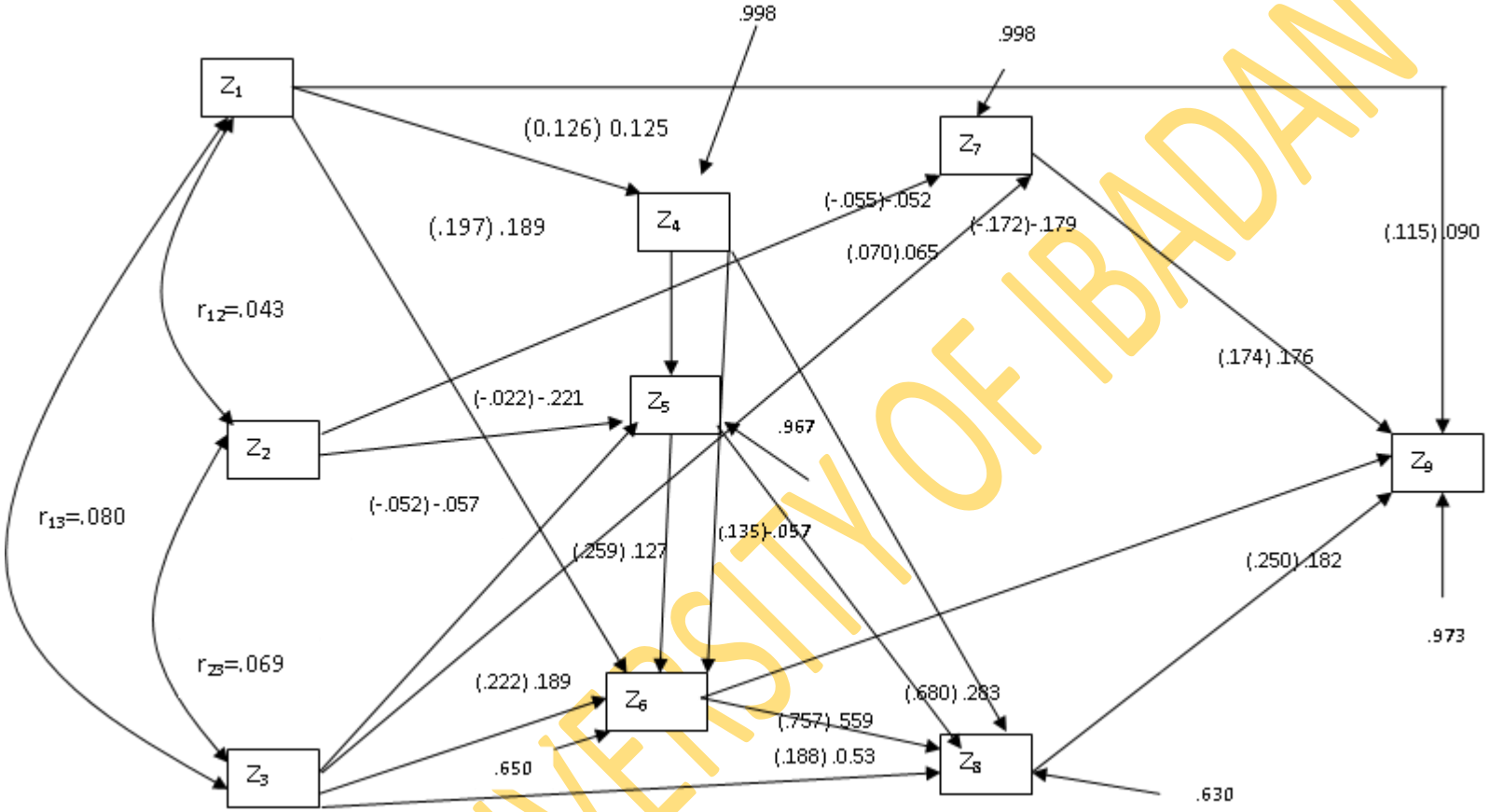


Figure 4.2

Key: Z_1 = School location Z_2 = Gender of teacher Z_3 = Teacher's subject area specialization Z_4 = Instructional time Z_5 = Teacher's BST content knowledge Z_6 = Teacher's pedagogical skills Z_7 = Teacher's attitude to BST Z_8 = Teacher's interaction with pupils Z_9 = Pupils' Achievement in BST

The differences between the original and the reproduced correlations are stated in table 4.3. To verify the efficacy of the re-specified model (Fig. 4.2), the obtained and reproduced correlations were compared. It was observed that in only three (3) of the thirty-three (3) cases did the difference exceed the .05 criterion. This difference accounted for 9.1%, below the 40% criterion level according to Kerlinger and Lee (2000). This implies that the hypothesised model fits the empirical data. Therefore, the obtained model is consistent with the observed correlations.

4.3 Research Question 3

If the model is consistent, what are the estimated direct, indirect and total causal effects among the variables?

TABLE 4.4: The direct and indirect paths of the predictor variables to the criterion variable

Outcome	Determinants	Effects	
		Direct	**Indirect**
Z_4	Z_1	P_{41}	-
Z_5	Z_1	-	$P_{41}P_{54}$
	Z_2	P_{52}	-
	Z_3	P_{53}	-
	Z_4	P_{54}	-
Z_6	Z_1	P_{61}	$P_{41}P_{64} + P_{41}P_{54}P_{65}$
	Z_3	P_{63}	$P_{53}P_{65}$
	Z_4	P_{64}	$P_{54}P_{65}$
	Z_5	P_{65}	-
Z_7	Z_1	-	$P_{41}P_{54}P_{75}$
	Z_2	P_{72}	$P_{52}P_{75}$
	Z_3	P_{73}	$P_{53}P_{75}$
	Z_4	-	$P_{54}P_{75}$
	Z_5	P_{75}	-
Z_8	Z_1	-	$P_{41}P_{84} + P_{41}P_{54}P_{85} + P_{41}P_{64}P_{86}$
	Z_2	-	$P_{52}P_{85} + P_{52}P_{65}P_{86}$
	Z_3	P_{83}	$P_{53}P_{85} + P_{63}P_{86} + P_{53}P_{65}P_{86}$
	Z_4	P_{84}	$P_{54}P_{84} + P_{64}P_{86} + P_{54}P_{65}P_{86}$
	Z_5	P_{85}	$P_{56}P_{86}$
	Z_6	P_{86}	-

Outcome	Determinants	Effects	
		Direct	**Indirect**
Z_9	Z_1	P_{91}	$P_{41}P_{54}P_{85}P_{98} + P_{41}P_{64}P_{86}P_{98} + P_{41}P_{64}P_{96} + P_{41}P_{54}P_{65}P_{96} + P_{41}P_{84}P_{98} + P_{61}P_{96} + P_{61}P_{86}P_{98}$
	Z_2	-	$P_{52}P_{85}P_{98} + P_{52}P_{65}P_{96} + P_{52}P_{75}P_{97} + P_{52}P_{65}P_{86}P_{98}$
	Z_3	-	$P_{53}P_{65}P_{96} + P_{53}P_{65}P_{86}P_{98} + P_{53}P_{75}P_{97} + P_{53}P_{85}P_{98} + P_{63}P_{86}P_{98} + P_{63}P_{96} + P_{73}P_{97} + P_{83}P_{98}$
	Z_4	-	$P_{54}P_{65}P_{86}P_{98} + P_{54}P_{65}P_{96} + P_{54}P_{75}P_{97} + P_{54}P_{85}P_{98} + P_{64}P_{86}P_{98} + P_{64}P_{96} + P_{84}P_{98}$
	Z_5	-	$P_{65}P_{86}P_{98} + P_{65}P_{96} + P_{75}P_{97} + P_{85}P_{98}$
	Z_6	P_{96}	$P_{86}P_{98}$
	Z_7	P_{97}	-
	Z_8	P_{98}	-

All the predictor variables had causal influence on the criterion variable. Four of the eight predictor variables (school location, pedagogical skills, BST teachers' attitude to the subject and its teaching and teacher-pupils classroom interaction) had direct effects on the criterion variable (pupils' achievement in BST); while six of the eight (school location, gender, teachers subject specialisation, effective use of instructional time, BST content knowledge and pedagogical skills) had indirect effects on the criterion variable.

The values of the direct and indirect effects of the predictor variables to the criterion variable are stated in Table 4.5. The table shows the direct, indirect, and total effects of the six endogenous variables.

TABLE 4.5: Summary of Causal Effect for Re - specified Model (BST Achievement)

Outcome	Determinants	Effects		Total
		Direct	Indirect	
Instructional time (Z_4)	School location (Z_1)	.125	-	.125
Adj R^2 = .002				
Content knowledge (Z_5)	School location (Z_1)	-	.024	.024
	Gender (Z_2)	-.221	-	-.221
	Subject Specialisation (Z_3)	-.057	-	-.057
Adj R^2 = .064	Instructional time (Z_4)	.189	-	.189
Pedagogical Skills (Z_6)	School location (Z_1)	.050	.090	.140
	Subject Specialisation (Z_3)	.189	-.007	.182
	Instructional time (Z_4)	.694	.024	.718
Adj R^2 = .578	Content knowledge (Z_5)	.127	-	.127
Attitude (Z_7)	School location (Z_1)	-	-.004	-.004
	Gender (Z_2)	-.052	.040	.012
	Subject Specialisation (Z_3)	.065	.010	.075
	Instructional time (Z_4)	-	-.034	-.034
Adj R^2 = .004	Content knowledge (Z_5)	-.179	-	-.179
Interaction (Z_8)	School location (Z_1)	-	.084	.084
	Gender (Z_2)	-	.003	.003
	Subject Specialisation (Z_3)	.053	.023	.076
	Instructional time (Z_4)	.283	.454	.737
	Content knowledge (Z_5)	-.057	.071	.014
Adj R^2 = .595	Pedagogical Skills (Z_6)	.559	-	.559
BST Achievement (Z_9)	School location (Z_1)	.090	.032	.122
	Gender (Z_2)	-	-.005	-.005
	Subject Specialisation (Z_3)	-	.034	.034
	Instructional time (Z_4)	-	.199	.199
	Content knowledge (Z_5)	-	.050	.050
	Pedagogical Skills (Z_6)	.097	.102	.199
	Attitude (Z_7)	-.176	-	-.176
Adj R^2 = .053	Interaction (Z_8)	.182	-	.182

Direct Effects

Basic Science and Technology Achievement

From the study, the criterion variable is BST achievement. Out of the eight hypothesised direct predictors of BST achievement, only four had statistically significant direct effect on it. These are school location, pedagogical skills, attitude and classroom interaction.

Instructional Time

School location predicted the effective use of instructional time and it had a statistically significant effect.

Content Knowledge

Of the four hypothesised direct predictors of Content Knowledge, school location, gender, subject specialisation; three had statistically direct effect on it. These are gender, subject specialisation and effective use of instructional time.

Pedagogical Skills

The four determinants of pedagogical skills, school location, subject specialisation, instructional time and content knowledge had statistically significant direct effect on pedagogical skills .

Attitude

Of the five hypothesised predictors of teachers' attitude to BST as a subject and it's teaching, school location, gender, subject specialisation, instructional time and content knowledge; three had statistically significant direct effect on it. These are gender, areas of subject specialisation and content knowledge.

Classroom Interaction

Out of the six hypothesised predictors of classroom interaction, school location, gender, subject specialisation, instructional time, content knowledge and pedagogical skills; four had statistically significant direct effect on it. The predictor variables subject specialisation, instructional time, content knowledge and pedagogical skills.

Indirect Effects

Table 4.5 reveals that some of the predictor variables exert statistically significant indirect effects on the other, and on the criterion variable.

Basic Science and Technology Achievement

Out of the eight hypothesised direct predictors of BST achievement, school location, gender, subject specialisation, instructional time, content knowledge, pedagogical skills and classroom interaction; only three had statistically significant indirect effect on it. These are instructional time, content knowledge and pedagogical skills.

Instructional Time

The predictor variable, school location did not have any indirect effect on instructional time.

Content Knowledge

None of the predictor variables, school location, gender, subject specialisation and instructional time had a statistically significant indirect effect on content knowledge.

Pedagogical Skills

Of the four determinants of pedagogical skills, school location, subject specialisation, instructional time and content knowledge; only one variable had a statistically significant indirect effect on it. It is school location.

Attitude

Of the five hypothesised predictors of teachers' attitude to BST as a subject and it's teaching, school location, gender, subject specialisation, instructional time and content knowledge; none had statistically significant indirect effect on it.

Classroom Interaction

Out of the six hypothesised predictors of classroom interaction, school location, gender, subject specialisation, instructional time, content knowledge and pedagogical skills; three had statistically significant indirect effect on it. These predictor variables are school location, instructional time and content knowledge.

Interpretation of Direct, Indirect and Total Effects

Direct Effects

Table 4.5 reveals the following:

The direct effect of school location on instructional time is .125. This implies that instructional time increased by .125 for every one standard deviation increase in school location, controlling for other predictors. The direct effect of gender on content knowledge is -.221, implying that, content knowledge decreased by .221 for every one unit increase in gender, controlling for other predictors. The direct effect of subject specialisation on content knowledge is -.057. This implies that, content knowledge decreased by .057 for every one unit increase in subject specialisation, controlling for other predictors.

Direct effect of instructional time on content knowledge is .189, implying that, content knowledge increased by .189 for every one unit increase in instructional time, controlling for other predictors. The direct effect of school location on pedagogical skills is .050, implying that pedagogical skills increase by .050 for every one unit increase in school location, controlling for other predictors. The direct effect of subject specialisation on pedagogical skills is .189. This implies that pedagogical skills increase by .189 for every one unit increase in subject specialisation, controlling for other predictors. Direct effect of instructional time on pedagogical skills is .694, implying that pedagogical skills increase by .694 for every one unit increase in instructional time, controlling for other predictors.

The direct effect of content knowledge on pedagogical skills is .127. This implies that pedagogical skills increase by .127 for every one unit increase in content knowledge, controlling for other predictors. The direct effect of gender on attitude to BST and its teaching is -.052. This means that attitude to BST decreased by .052 for every one unit increase in gender, controlling for other predictors. Direct effect of subject specialisation on attitude to BST is .065, implying that attitude to BST increased by .065 for every one unit increase in subject specialisation, controlling for other predictors.

The direct effect of content knowledge on attitude to BST is -.179. This implies that attitude to BST decreased by .179 for every one unit increase in content knowledge, controlling for other predictors. The direct effect of subject specialisation on classroom interaction is .053, implying that classroom interaction increased by .053 for every one unit increase in subject specialization, controlling for other predictors. The direct effect of instructional time on classroom interaction is

.283. This implied that classroom interaction increased by .283 for every one unit increase in instructional time, controlling for other predictors.

The direct effect of content knowledge on classroom interaction is -.057. This implies that classroom interaction decreased by .057 for every one unit increase in content knowledge, controlling for other predictors. Direct effect of pedagogical skills on classroom interaction is .559, implying that classroom interaction increased by .559 for every one unit increase in pedagogical skills, controlling for other predictors. The direct effect of school location on pupils' achievement in BST is .090, implying that pupils' achievement increased by .090 for every one unit increase in school location, controlling for other predictors.

Direct effect of pedagogical skills on achievement is .097. This implies that achievement increased by .097 for every one unit increase in pedagogical skills, controlling for other predictors. The direct effect of attitude on achievement is -.176, implying that achievement decreased by .176 for every one unit increase in attitude, controlling for other predictors. The direct effect of classroom interaction on achievement in BST is .182, that is, achievement increased by .182 for every one unit increase in classroom interaction, controlling for other predictors.

Indirect Effects

From Table 4.5:

The indirect effect was estimated statistically as the products of standardized coefficient for the paths that comprise them. The standardized indirect effect of school location on content knowledge was estimated as the product of standardized coefficient for the paths: from School location to Instructional time X from Instructional time to Content knowledgeor (.125) (.189).This gives .024.That is, the indirect effect of school location on content knowledge was .024.This means that content knowledge increased by .024 standard deviation for every increase in the school location effect of one full standard deviation via its' prior effect on instructional time. The indirect effect of school location on content knowledge is insignificant.

The indirect effect of school location on pedagogical skills was estimated as the product of standardized coefficients for the paths: from School location to Instructional time X from Instructional time to Pedagogical skills or (.125) (.694) + School location to Instructional time X Instructional time to Content knowledge X Content knowledge to Pedagogical skills or (.125) (.189) (.127) = .087 + .003 = .090. That is, the indirect effect of school location on pedagogical skills was .090. This can be interpreted that pedagogical skills increased by .090 standard deviation for every

increase in the school location effect of one standard deviation via its prior effects on instructional time and content knowledge. The study revealed that school location has a positive, significant indirect effect on teachers' pedagogical skills.

The indirect effect of Subject specialisation on Pedagogical skills was estimated as the product of standard coefficients for the paths: from Subject specialisation to Content knowledge X Content knowledge to Pedagogical skills or (-.057) (.127) = -.007. The indirect effect of subject specialisation on pedagogical skills was -.007. This can be interpreted that pedagogical skills decreased by .007 standard deviation for every increase in the subject specialisation effect of one standard deviation via its prior effect on content knowledge. The study found that, the indirect effect of subject specialisation on pedagogical skills is negative and insignificant.

The indirect effect of Instructional time on Pedagogical skills was estimated as the product of standard coefficients for the paths: Instructional time to Content knowledge X Content knowledge to Pedagogical skills or (.189) (.127) = .024. The indirect effect of instructional time on pedagogical skills was .024. This can be interpreted that pedagogical skills increased by .024 standard deviation for every increase in the instructional time effect of one standard deviation via its prior effect on content knowledge. The indirect effect of teacher's effective use of instructional time on pedagogical skills is not significant.

The indirect effect of School location on Attitude was estimated as the product of standard coefficients for the paths: from School location to Instructional time X Instructional time to Content knowledge X Content knowledge to Attitude or (.125) (.189) (-.179) = -.004. The indirect effect of school location on attitude was -.004. This is interpreted that attitude decreased by .004 standard deviation for every increase in the school location effect of one standard deviation via its prior effects on instructional time and content knowledge. The study found out that the indirect effect of school location on teachers' attitude to BST as a subject and its teaching is negative and insignificant.

The indirect effect of Gender on Attitude was estimated as the product of standard coefficients for the paths: from Gender to Content knowledge X Content knowledge to Attitude or (-.221) (-.179) = .040. The indirect effect of gender on attitude was .040. This can be interpreted that attitude increased by .040 standard deviation for every increase in the gender effect of one standard deviation via its prior effect on content knowledge. The indirect effect of teachers gender on attitude to BST as a subject and its teaching is not significant.

The indirect effect of Subject specialisation on Attitude was estimated as the product of standard coefficients for the paths: from Subject specialisation to Content knowledge X Content knowledge to Attitude or (-.057) (-.179) = .010. The indirect effect of subject specialisation on attitude was .010. This means that attitude increased by .010 standard deviation for every increase in the specialisation effect of one standard deviation via its prior effect on content knowledge. The indirect effect of teachers' subject specialisation on attitude to BST as a subject and its teaching is not significant.

The indirect effect of Instructional time on Attitude was estimated as the product of standard coefficients for the paths: from Instructional time to Content knowledge X Content knowledge to Attitude or (.189) (-.179) = -.034. The indirect effect of instructional time on attitude was -.034. This can be interpreted that attitude decreased by .034 standard deviation for every increase in the instructional time effect of one standard deviation via its prior effect on content knowledge. The indirect effect of teacher's effective use of instructional time on his attitude to BST as a subject and its teaching is negative and not significant.

The indirect effect of School location on Classroom interaction was estimated as the product of standard coefficients for the paths: from School location to Instructional time X Instructional time to Classroom interaction or (.125) (.283) + School location to Instructional time X Instructional time to Content knowledge X Content knowledge to Classroom interaction or (.125) (.189) (-.057) + School location to Instructional time X Instructional time to Pedagogical skills X Pedagogical skills to Classroom interaction or (.125) (.694) (.559). This gives:(.125) (.283) + (.125) (.189) (-.057) + (.125) (.694) (.559) = .084. The indirect effect of school location on classroom interaction was .084. This can be interpreted that classroom interaction increases by .084 standard deviation for every increase in the school location effect of one standard deviation via its prior effects on instructional time, content knowledge and pedagogical skills. The study revealed that, the indirect effect of school location on teacher-pupils classroom interaction is positive and significant.

The indirect effect of Gender on Classroom interaction was estimated as the product of standard coefficients for the paths: from Gender to Content knowledge X Content knowledge to Classroom interaction or (-.221) (-.057) + Gender to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Classroom interaction (-.221) (.127) (.559). This gives: (-.221) (-.057) + (-.221) (.127) (.559) = -.003. The indirect effect of gender on classroom interaction was -.003. This can be interpreted that classroom interaction decreases by .003 standard deviation for every increase in the gender effect of one standard deviation via its prior effects on content

knowledge and pedagogical skills. The study revealed that, the indirect effect of teachers gender on his interaction with pupils is negative and insignificant.

The indirect effect of Subject specialisation on Classroom interaction was estimated as the product of standard coefficients for the paths: from Subject specialization to Content knowledge X Content knowledge to Classroom interaction or (-.057) (-.057) + Subject specialisation to `Pedagogical skills X Pedagogical skills to Classroom interaction (.189) (.559) + Subject specialization to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Classroom interaction (-.057) (.127) (.559). This gives: (-.057) (-.057) + (.189) (.559) + (-.057) (.127) (.559) = .023. The indirect effect of subject specialisation on classroom interaction was .023. This can be interpreted that classroom interaction increases by .023 standard deviation for every increase in the subject specialisation effect of one standard deviation via its prior effects on content knowledge and pedagogical skills. The study shows that, the indirect effect of teachers' subject specialisation on teacher-pupils classroom interaction is insignificant.

The indirect effect of Instructional time on Classroom interaction was estimated as the product of standard coefficients for the paths: from Instructional time to Content knowledge X Instructional time to Classroom interaction or (.189) (.283) + Instructional time to Pedagogical skills X Pedagogical skills to Classroom interaction or (.694) (.559) + Instructional time to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Classroom interaction or (.189) (.127) (.559). This gives: (.189) (.283) + (.694) (.559) + (.189) (.127) (.559) = .454. The indirect effect of instructional time on classroom interaction was .454. This can be interpreted that classroom interaction increases by .454 standard deviation for every increase in the instructional time effect of one standard deviation via its prior effects on content knowledge and pedagogical skills. This study revealed that, the indirect effect of teacher's effective use of instructional time on teacher-pupils classroom interaction is positive and highly significant.

The indirect effect of Content knowledge on Classroom interaction was estimated as the product of standard coefficients for the paths: from Content knowledge to Pedagogical skills X Pedagogical skills to Classroom interaction or (.127) (.559). The indirect effect of content knowledge on classroom interaction was .071. This can be interpreted that classroom interaction increases by .071 standard deviation for every increase in the content knowledge effect of one standard deviation via its prior effect on pedagogical skills. The study found that, the indirect effect of teacher's BST content knowledge on his classroom interaction with pupils is significant.

The indirect effect of School location on Pupils' achievement was estimated as the product of standard coefficients for the paths: from School location to Instructional time X Instructional time to Content knowledge X Content knowledge to Classroom interaction X Classroom interaction to Pupils' achievement or (.125) (.189) (-.057) (.182) + School location to Instructional time X Instructional time to Pedagogical skills X Pedagogical skills to Classroom interaction X Classroom interaction to Pupils' achievement or (.125) (.694) (.559) (.182) + School location to Instructional time X Instructional time to Pedagogical skills X Pedagogical skills to Pupils' achievement or (.125) (.694) (.097) + School location to Instructional time X Instructional time to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Pupils' achievement or (.125) (.189) (.127) (.097) + School location to Instructional time X Instructional time to Classroom interaction X Classroom interaction to Pupils' achievement (.125) (.283) (.182) + School location to Pedagogical skills X Pedagogical skills to Pupils' achievement (.050) (.097) + School location to Pedagogical skills X Pedagogical skills to Classroom interaction X Classroom interaction to Pupils' achievement or (.050) (.559) (.182).

This gives: (.125) (.189) (-.057) (.182) + (.125) (.694) (.559) (.182) + (.125) (.694) (.097) + (.125) (.189) (.127) (.097) + (.125) (.283) (.182) + (.050) (.097) + (.050) (.559) (.182) = .032. The indirect effect of school location on pupils' achievement was .032. This can be interpreted that pupils' achievement in BST increases by .032 standard deviation for every increase in the school location effect of one standard deviation via its prior effects on instructional time, pedagogical skills, classroom interaction and content knowledge. The study found that, the indirect effect of school location on pupils' achievement is not significant.

The indirect effect of Gender on Pupils' achievement was estimated as the product of standard coefficients for the paths: from Gender to Content knowledge X Content knowledge to Classroom interaction X Pupils' achievement or (-.221) (-.057) (.182) + Gender to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Pupils' achievement (-.221) (.127) (.097) + Gender to Content knowledge X Content knowledge to Attitude X Attitude to Pupils' achievement or (-.221) (-.179) (-.176) + Gender to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Classroom interaction X Classroom interaction to Pupils' achievement or (-.221) (.127) (.559) (.182). This gives: (-.221) (-.057) (.182) + (-.221) (.127) (.097) + (-.221) (-.179) (-.176) + (-.221) (.127) (.559) (.182) = -.005. The indirect effect of gender on pupils' achievement was -.005. This can be interpreted that pupils' achievement in BST decreases by .005 standard deviation for every increase in the gender effect of one standard deviation via its prior effects on content knowledge, classroom interaction, attitude and pedagogical

skills. The study found that, the indirect effect of teachers gender on pupils' achievement is negative and not significant.

The indirect effect of Subject specialisation on Pupils' achievement was estimated as the product of standard coefficients for the paths: Subject specialisation to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Pupils' achievement or (-.057) (.127) (.097) + Subject specialisation to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Classroom interaction X Classroom interaction to Pupils' achievement or (-.057) (.127) (.559) (.182) + Subject specialisation to Content knowledge X Content knowledge to Attitude X Attitude to Pupils' achievement or (-.057) (-.179) (-.176) + Subject specialisation to Content knowledge X Content knowledge to Classroom interaction X Classroom interaction to Pupils' achievement or (-.057) (-.057) (.182) + Subject specialisation to Pedagogical skills X Pedagogical skills to Classroom interaction X Classroom interaction to Pupils' achievement or (.189) (.559) (.182) + Subject specialisation to Pedagogical skills X Pedagogical skills to Pupils' achievement or (.189) (.097) + Subject specialisation to Attitude X Attitude to Pupils' achievement or (.065) (-.176) + Subject specialisation to Classroom interaction X Classroom interaction to Pupils' achievement or (.053) (.182).

This gives: (-.057) (.127) (.097) + (-.057) (.127) (.559) (.182) + (-.057) (-.179) (-.176) +

(-.057) (-.057) (.182) + (.189) (.559) (.182) + (.189) (.097) + (.065) (-.176) + (.053) (.182) = .034

The indirect effect of subject specialisation on pupils' achievement was .034. This can be interpreted that pupils' achievement in BST increases by .034 standard deviation for every increase in the subject specialisation effect of one standard deviation via its prior effects on content knowledge, pedagogical skills, classroom interaction and attitude. The indirect effect of teacher's area of subject specialisation on pupils' achievement is not significant.

The indirect effect of Instructional time on Pupils' achievement was estimated as the product of standard coefficients for the paths: Instructional time to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Classroom interaction X Classroom interaction to Pupils' achievement or (.189) (.127) (.559) (.182) + Instructional time to Content knowledge X Content knowledge to Pedagogical skills X Pedagogical skills to Pupils' achievement or (.189) (.127) (.097) + Instructional time to Content knowledge X Content knowledge to Attitude X Attitude to Pupils' achievement or (.189) (-.179) (-.176) + Instructional time to Content knowledge X Content

knowledge to Classroom interaction X Classroom interaction to Pupils' achievement or (.189) (-.057) (.182) + Instructional time to Pedagogical skills X Pedagogical skills to Classroom interaction X Classroom interaction to Pupils' achievement or (.694) (.559) (.182) + Instructional time to Pedagogical skills X Pedagogical skills to Pupils' achievement or (.694) (.097) + Instructional time to Classroom interaction X Classroom interaction to Pupils' achievement or (.283) (.182). This gives: (.189) (.127) (.559) (.182) + (.189) (.127) (.097) + (.189) (-.179) (-.176) + (.189) (-.057) (.182) + (.694) (.559) (.182) + (.694) (.097) + (.283) (.182) = .199

The indirect effect of instructional time on pupils' achievement was .199. This can be interpreted that pupils' achievement in BST increases by .199 standard deviation for every increase in the instructional time effect of one standard deviation via its prior effects on content knowledge, pedagogical skills, classroom interaction and attitude. The study discovered that the indirect effect of teacher's effective use of instructional time on pupils' achievement is positive and highly significant.

The indirect effect of Content knowledge on Pupils' achievement was estimated as the product of standard coefficients for the paths: Content knowledge to Pedagogical skills X Pedagogical skills to Classroom interaction X Classroom interaction to Pupils' achievement or (.127) (.559) (.182) + Content knowledge to Pedagogical skills X Pedagogical skills to Pupils' achievement or (.127) (.097) + Content knowledge to Attitude X Attitude to Pupils' achievement or (-.179) (-.176) + Content knowledge to Classroom interaction X Classroom interaction to Pupils' achievement or (-.057) (.182). This gives: (.127) (.559) (.182) + (.127) (.097) + (-.179) (-.176) + (-.057) (.182) = .050

The indirect effect of content knowledge on pupils' achievement was .050. This can be interpreted that pupils' achievement in BST increases by .050 standard deviation for every increase in the content knowledge effect of one standard deviation via its prior effects on content knowledge, pedagogical skills, classroom interaction and attitude. The indirect effect of teacher's content knowledge on pupils' achievement is positive and significant.

Finally, the indirect effect of Pedagogical skills on Pupils' achievement was estimated as the product of standard coefficients for the paths: Pedagogical skills to Classroom interaction X Classroom interaction to Pupils' achievement or (.559) (.182). The indirect effect of pedagogical skills on pupils' achievement was .102. This can be interpreted that pupils' achievement in BST increases by .102 standard deviation for every increase in the pedagogical skills effect of one standard deviation via its prior effect on classroom interaction. The indirect effect of teacher's pedagogical skills on pupils' achievement is positive and highly significant. Note that when the path

coefficients are negative, the term decrease is used. But, when the path coefficients are positive, the term increase is used.

Total Effects

Total effects are the sum of all direct and indirect effects of one variable on the other. For instance, (Table 4.5) the standardized total effects of school location on content knowledge were .024. For the interpretation, it means that increasing school location by one standard deviation increases content knowledge by .024 standard deviations via all presumed direct and indirect causal links between them. The total effects of school location on teachers' BST content knowledge were therefore not found to be significant.

The standardized total effects of school location on pedagogical skills were .140. To interpret this, it implies that increasing school location by one standard deviation increases pedagogical skills by .140 standard deviations via all presumed direct and indirect causal links between them. Therefore, the study found that, the total effects of school location on teachers' pedagogical skills were positively significant.

Similarly, the standardized total effects of subject specialisation on pedagogical skills were .199. For the interpretation, it means that increasing subject specialisation by one standard deviation increases pedagogical skills by .189 standard deviation via all presumed direct and indirect causal links between them. The study therefore concludes that, the total effects of teachers' subject specialisation on his pedagogical skills were positively significant.

Also, the standardized effect of instructional time on pedagogical skills were .718. To interpret this, it means that increasing instructional time by one standard deviation increases pedagogical skills by .718 standard deviation via all presumed direct and indirect causal links between them. The total effects of teachers' effective use of pupils' instructional time on his pedagogical skills were positively significant.

The standardized total effects of school location on teachers' attitude to BST were -.004. This implies that decreasing school location by one standard deviation increases attitude by .004 standard deviations via all presumed direct and indirect causal links between them. The total effects of school location on teachers' attitude to BST as a subject and its teaching were not significant.

Similarly, the standardized total effects of gender on attitude were .012, implying that increasing gender by one standard deviation increases attitude by .012 standard deviations via all

presumed direct and indirect causal links between them. The total effects of the teachers gender on his attitude to BST as a subject and its teaching were not significant.

The standardized total effects of subject specialisation on attitude were .075. This implies that increasing subject specialisation by one standard deviation increases attitude by .075 standard deviations via all presumed direct and indirect causal links between them. The total effects of teachers' subject specialisation on teachers' attitude to BST as a subject and its teaching were positively significant.

Also, the standardized total effects of instructional time on attitude were -.034. This implies that decreasing instructional time by one standard deviation increases attitude by .034 standard deviations via all presumed direct and indirect causal links between them. The study therefore found out that the total effects of teachers' effective use of pupils' instructional time on his attitude to BST as a subject and its teaching were negative and not significant.

The standardized total effects of school location on classroom interaction were .084. This implies that increasing school location by one standard deviation increases classroom interaction by .084 standard deviations via all presumed direct and indirect causal links between them. The total effects of school location on teacher-pupils classroom interaction were positively significant.

The standardized total effects of gender on classroom interaction were .003. This implies that increasing gender by one standard deviation increases classroom interaction by .003 standard deviations via all presumed direct and indirect causal links between them. The total effects of teachers gender on teacher-pupils classroom interaction were not significant.

Also, the standardized total effects of subject specialization on classroom interaction were .076. This implies that increasing subject specialisation by one standard deviation increases classroom interaction by .076 standard deviations via all presumed direct and indirect causal links between them. From the study, total effects of teachers' subject specialisation on classroom interaction with pupils were positively significant.

Similarly, the standardized total effects of instructional time on classroom interaction were .737. This implies that increasing instructional time by one standard deviation increases classroom interaction by .737 standard deviations via all presumed direct and indirect causal links between them. The total effects teachers' effective uses of pupils' instructional time on classroom interaction with pupils were positive and highly significant.

The standardized total effects of content knowledge on classroom interaction were .014. This implies that increasing content knowledge by one standard deviation increases classroom interaction by .014 standard deviations via all presumed direct and indirect causal links between them. The study discovered that, the total effects of teacher's BST content knowledge on his classroom interaction with the pupils were not significant.

The standardized total effects of school location on pupils' achievement were .122. This implies that increasing school location by one standard deviation increases pupils' achievement by .122 standard deviations via all presumed direct and indirect causal links between them. The total effects of school location on pupils' achievement in BST were positively significant.

The standardized total effects of gender on pupils' achievement were -.005. This implies that decreasing gender by one standard deviation increases pupils' achievement by .005 standard deviations via all presumed direct and indirect causal links between them. The total effects of teachers gender on pupils' achievement in BST were not significant.

Also, the standardized total effects of subject specialisation on pupils' achievement were .034. This implies that increasing subject specialization by one standard deviation increases pupils' achievement by .034 standard deviations via all presumed direct and indirect causal links between them. The total effects of teachers' subject specialisation on pupils' achievement in BST were not significant.

Similarly, the standardized total effects of instructional time on pupils' achievement were .199. This implies that increasing instructional time by one standard deviation increases pupils' achievement by .199 standard deviations via all presumed direct and indirect causal links between them. The study found that, the total effects of teacher's effective use of the pupils' instructional time on pupils' achievement in BST were positively significant.

The standardized total effects of content knowledge on pupils' achievement were .050. This implies that increasing content knowledge by one standard deviation increases pupils' achievement by .050 standard deviations via all presumed direct and indirect causal links between them. The total effects of teacher's BST content knowledge on pupils' achievement in BST is slightly significant.

Finally, the standardized total effects of pedagogical skills on pupils' achievement were .199. This implies that increasing pedagogical skills by one standard deviation increases pupils' achievement by .199 standard deviations via all presumed direct and indirect causal links between

them. Here, the study discovered that, the total effects of teachers' pedagogical skills on pupils' achievement were positively significant.

From Table 4.5, the outcome of primary interest was BST achievement of which its major determinants were school location, gender, subject specialization, instructional time, content knowledge, pedagogical skills, attitude and classroom interaction, with adjusted R^2 = .053 (see first column of Table 4.5). This means that this model explained approximately 5.3% of the variances in BST achievement.For instructional time, the primary determinant was school location, with adjusted R^2 = .002; this model explained approximately .02% of the variance in instructional time. The primary determinants of content knowledge were school location, gender, subject specialisation and instructional time, with adjusted R^2 = .064; this model explained approximately 6.4% of the variances in content knowledge.For pedagogical skills, the primary determinants were school location, subject specialisation, instructional time and content knowledge, with adjusted R^2 = .578. This model explained approximately 57.8% of the variances in pedagogical skills.The primary determinants of attitude-as can still be seen in Table 4.5, were school location, gender, subject specialisation, instructional time and content knowledge, with adjusted R^2 = .004; this model explained approximately 0.4% of the variances in attitude. Finally, the primary determinants of classroom interaction were school location, gender, subject specialisation, instructional time content knowledge and pedagogical skills, with adjusted R = .595; this model explained approximately 59.5% of the variances in classroom interaction.

4.4. Research Question 4

What is the relative importance of each exogenous and endogenous variable on the pupils' achievement in Basic science and technology?

The direct effect, indirect effect and total effect of each independent variable on the criterion variable Basic science and technology achievement are shown in Table 4.5. From the Table, instructional time and pedagogical skills had the highest total effect (0.199) each; followed by classroom interaction (0.182); then attitude to BST as a subject and its teaching (-.176); followed by school location (0.122); BST teachers' content knowledge (0.050); teachers' subject specialisation (.034) and teachers gender (0.005) the least. It follows therefore that in the model in which Basic science and technology achievement was the criterion variable, instructional time and pedagogical skills were the most important, followed by teacher-pupils classroom interaction; attitude to BST as a subject and its teaching; school location; teachers' content knowledge; teachers' subject specialisation and teachers gender the least.

4.5 Discussion of Findings

The Ogun State BST teachers profile revealed twenty-seven diverse teachers' subject specialisations, with only 39.2% of the teachers having their subject specialisation in the sciences (Table 3.2). The state basic educational system makes use of the teachers as subject generalists, that is, teaching all subjects to the pupils in their assigned class. The study found that the pupils had a mean score of 8.64 out of the total score of 30 in the BST achievement test with a pass mark of 12. That is, the majority of the pupils scored below the pass mark. The fact that only 39.8% of the BST teachers in the Ogun State have their subject specialisations in science and science- based courses could be responsible for pupils poor performance in BST. This is agreement with Schwatz and Newsome (2008) that not employing the services of teachers, who have their subject specialisation in the sciences, to teach BST, may not be profitable for the pupils' achievement gain in BST.

The findings of the study shows that out of the thirty three (33) causal path in the hypothesised recursive model (Fig. 4.1) only nineteen (19) were significant for producing the re-specified causal model. The nineteen causal paths were derived from the six (6) new structural equations. The paths deleted were in existent in terms of variable linkage but not strong enough for consideration in the hypothesised model. The efficacy of the re-specified model was verified comparing the obtained and reproduced correlation coefficients. In the comparison, it was established that significant differences < .05 were observed in three instances of relationship accounting for 9.1% of the variances in pupils' BST achievement. Thus, the re-specified model is retained and sustained for providing explanations about variances in BST achievement. Findings from the re-specified parsimonious model show that there were moderately significant relationships between school location, instructional time, pedagogical skills, attitude, classroom interaction and the criterion variable BST achievement.

4.5.1. Discussion of findings - Direct effects

School location had significant direct effect on BST achievement of the pupils. This agrees with Owoeye (2000), who opined that school location has a significant effect on the academic performance of the pupils. Also, Adepoju (2001) found that learners in urban schools manifest more brilliant performance than their rural counterparts. Ogunleye (2002), Ndukwu (2002) and Odinko (2002) reported a significant difference in the achievement of students in urban and peri-urban areas. In the course of data collection on field, the researcher observed that teachers in rurally located schools were not too committed to the profession. Many teachers were not on ground in different schools when the research team got there, they had to be sent for in many instances. This would

likely affect pupils' achievement in BST. The result of this study however contradicts some findings which noted that, school location has no significant effect on academic performance of pupils (Onah & Ugwu 2010; Yussuf & Adigun 2010).

Pedagogical skills had significant direct effect on the criterion variable, BST achievement. In the course of this study, it was observed that many BST teachers came to class not well-prepared for the lessons in terms of relevant learning aids and pedagogy. Few of them made use of field trips, experimentation and demonstrations; majority lectured. The findings of this study are consistent with the findings ofOkpala and Ellis (2005) who concluded that pedagogical skills appear to be a powerful force in changing teachers' instructional practice and by inference learners' achievement.

Attitude of BST teachers to the subject and its teaching had significant direct effect on the criterion variable (Pupils' achievement in BST). This agrees with Ogunwuyi (2000) who found significant causal relationship between teachers' attitude and students' achievement in Integrated Science. Falaye and Okwilagwe (2008) also found that teachers' attitude had significant effect on the academic achievement of learners. It was observed that primary school teachers generally have poor attitude to BST and this could be reflected in the pupils' achievement.

Teacher-pupils classroom interaction in BST classes had a direct significant effect on the BST achievement of the pupils. This agrees with Darling-Hammond (2008) and Gordon, Kane and Staiger (2006) who believe that the teacher's relational quality with students has an important role in effectiveness of his teaching and the learning of the pupils. Babelan and Kia (2010) also observed that interaction between students and teachers has significant role in students' achievement. Classroom interaction between teacher and pupils in BST classes had the strongest relationship with the criterion variable (pupils' achievement) of all the variables correlated in this study. This is in consonance with the research work of Bennett (2001) who noted that the analysis of variance revealed a significant positive correlation between the climate of the classroom and that of achievement. This study posits that if BST teachers strive to create an interactive, relaxed and conducive classroom atmosphere, pupils will have learn better.

This study found a significant direct effect of school location on effective use of instructional time. This finding is in agreement with the opinion of Howley, Howley and Shamblen(2001) that compared to their colleagues in urban located schools, their rides to and fro their schools tended to be more arduous, traversing poor roads, hilly or mountainous terrain. Even where the teachers reside in these rural locations, they, many at times have to shuttle to and fro their work stations and family residences. In the course of the data collection, many teachers were not on ground, some had to be

sent for and came in very late for their classes. Their long rides and variety of household activities tend to reduce teachers' academic attentiveness.

The study discovered a high significant effect of teachers' gender on BST content knowledge. Primary school teachers are majorly females who see them as incapable of teaching BST effectively according to Amusan (2011). It is reasoned that because of this negative attitude many of the teachers would not readily accept the challenge of updating their knowledge before coming to class. Generally, teachers at this level have the views that their pupils do not have enough knowledge to challenge their inadequacies on the subject matter.

The state basic education system makes use of the teachers as subject generalists, with the teacher taking all the subjects in a contained classroom irrespective of their subject specialisation. The findings of this study points to the fact that the teachers' subject specialisation had just a slight significant effect on teachers' BST content knowledge. This is not in consonance with the findings of Wayne and Youngs (2003); Schwartz and Gess-Newsome (2008) who opined that science specialists typically have greater science content background, perhaps even holding a degree in a science area and specializing in science teaching. The study's findings however agrees with those of Abuseji, (2007) who found little or no significant relationship between teacher qualification and pupils' achievement. This study discovered that primary teachers' subject specialisation had low effect on their BST content knowledge as evidenced in their test scores. BST Teachers who had their subject specialisations in the sciences did not necessarily perform better than those with their subject specialisations in other courses of study.

The study revealed that teachers' effective use of instructional time had influence on his BST content knowledge. This is in agreement with Okpala and Ellis (2005), who emphasized that lack of content knowledge, is an inhibition to effective instruction. The primary teachers made poor use of the instructional time because their BST content knowledge is low.

The study found significant direct effect of school location on pedagogical skills. Moulton (2001) also noted that while in many school locations, furniture can be locally supplied, instructional materials are not available. These include not only textbooks but also the visual materials that decorate classrooms and stimulate learning, as well as simple scientific laboratory equipment and other audio-visual equipment that have become a valuable part of many classrooms. It was observed that learning aids were absent in many schools, however, improvisation was done in some urban schools, probably because they are closer to the inspectorates.

There is also a significant effect of BST teachers' subject specialisation on teachers' pedagogical skills. Science specialists are more likely to know and apply different science-related pedagogical skills in the teaching of BST. This agrees with Schwartz and Gess-Newsome (2008) who noted that those schools with specialists seem to have a more consistent use of the science curriculum and a better understanding of what inquiry-based science looks like, their students are therefore exposed to a greater amount of effective pedagogical skills. Teachers who had their specialities in the science and technology based courses displayed better topic-related pedagogical skills. Teachers who are trained in science education are supposed to have training in science pedagogy, therefore it is reasoned that teachers who have their subject specialisation in the sciences are likely to have good pedagogical skills in BST class. This was found to be so by the researcher while collecting data.

Effective use of instructional time had high predictive effect on teachers' pedagogical skills. The primary school teachers who made use of pedagogical skills appropriate for the BST lesson would likely effectively use the allocated time, thereby have effective use of instructional time. Teachers who had proper plans for their BST were found to make effective use of the class instructional time.

The study also reveals that there is a significant relationship between teachers' content knowledge and pedagogical skills. Even though good pedagogical skills are required to transform communication to the learners' advantage, in agreement with Solis (2009), to teach learners effectively, teachers indeed need to understand subject matter deeply and flexibly so they can help students map their own ideas, relate one idea to another, and re-direct their thinking to create powerful learning. Teachers also need to see how ideas connect across fields and to everyday life. This research work found out that the teacher's BST content knowledge has effect on his application of good pedagogical skills in the classroom. This agrees with Shulman in NTI (2009) who said the knowledge utilized by teachers has been categorised as: knowledge of the science curriculum, the content appropriate to it and the pedagogy necessary to teach it. Draper (1998) also noted that a good teacher not only requires knowledge of the subject matter but also knowledge of teaching methods. Appleton and Harrison (2001) also opined that teachers' limited subject content knowledge do manifests itself as limited pedagogical skills. At the heart of effective content teaching are the teachers' pedagogical skills. If we are to improve the quality of teaching and learning in critical core content areas, we need to resist some old traditions in professional learning. . it was revealed that teachers who had poor BST content knowledge did actually have poor pedagogical skills. The low content

knowledge of the BST teachers manifested itself in the poor pedagogical skills of the teachers, quite a few of them even taught wrong content.

This study reveals a slight significant relationship between gender and attitude to BST as a subject and its teaching. This finding is in agreement with the finding of Morrell and Lederman (1998) who found that gender differences were not very related to classroom science attitude but disagrees with Amusan (2012), who found a highly significant positive relationship between gender of BST teachers and their attitude. The majority of the primary school teachers in Nigeria are females, it was observed that only few male teachers in the system seemed not to share in the negative attitude of their female colleagues to BST teaching.

Subject specialisation of the teacher does have effect on the attitude to BST as a subject and its teaching. It is probable that a teacher whose area of subject specialisation is non-science based would have poor attitude to BST as a subject and its teaching. This agrees with the Schwartz and Gess-Newsome (2008) survey which showed that more than two-thirds of their sampled teachers reported that they did not feel well prepared to teach science. In this study too, only 39.8% of the BST teachers had their fields of study in the science and technology related areas, this may explain the negative attitude displayed towards BST as a subject and its teaching.

The study discovered that teachers' content knowledge had influence on his attitude to BST as a subject and its teaching. This agrees with Schwartz and Gess-Newsome (2008), who noted that teachers' perceptions of their own preparedness reflected their minimal science background. They went further, that, lack of content knowledge has been linked to teachers' lack of self-confidence in teaching science and, in turn, lack of science emphasis in their elementary classroom. It was observed in this study that many of the teachers come to BST classes unprepared, especially content-wise. This gives a reflection of their attitude to the subject and its teaching.

The study found that teachers' subject specialisation had a slight significant effect on his/her classroom interaction with pupils. Having discovered that subject specialisation of teachers has a significant effect on content knowledge; it implies that subject specialisation would have bearing on classroom interaction of teacher with the pupils. Also, teachers' content knowledge had a slight significant effect on teacher-pupils classroom interaction. Teachers' mastery or non-mastery of subject content knowledge would affect positively or otherwise interaction with the pupils. In this study also, instructional time had a significant effect on teacher-pupils interaction in BST classes, according to Gettinger and Seibert (2002), researchers have opined that as little as half of each school day may be devoted to instruction in some classrooms depending on teachers' classroom

practices, such as classroom interaction. This study also found out that ineffective use of instructional time had effect on teacher-pupils interaction, there were poor interactions in the BST classes.

4.5.1. Discussion of findings - Indirect effects

Instructional time had a significant indirect effect on the criterion variable (BST achievement). This is because instructional time has direct effects on school location, pedagogical skills and classroom interaction; whereas these three have significant direct effects on the pupils' achievement in BST. This is in consonance with the works of Mulken (2005) who noted that, teachers in rural schools may teach for lesser time than their counterparts in urban areas. Lomotey and Swanson in Freeman and Anderman (2005) stated that disciplinary problems and large class size especially, have implication for effective use of instructional time. Also, Abadzi, (2007) in his work in Morocco concluded that there is a consistency with an earlier research in United State which showed that in rural areas pupils have less instructional time. This study found out that teachers who make use of good pedagogical skills are more likely to use effectively, the pupils' instructional time. The teacher who effectively uses his/her instructional time also had good interaction with the pupils. According to Gettinger and Seibert (2002), researchers have concluded that as little as half of each school day may be devoted to instruction in some classrooms depending on teachers' classroom practices, pupils' characteristics and actual time allocated to instruction. The majority of the teachers actually devoted less than fifty percent of the thirty-five minutes allocated for BST lessons on instruction.

Pedagogical skills had significant indirect effect on the criterion variable, BST achievement. The findings of this study are consistent with the findings ofOkpala and Ellis (2005) who concluded that pedagogical skills appear to be a powerful force in changing teachers' instructional practice and by inference learners' achievement. In the course of this study, it was observed that many BST teachers came to class not well-prepared for the lessons in terms of relevant learning aids and pedagogy. Few of them made use of field trips, experimentation and demonstrations; majority either lectured or wrote on chalk boards.

The study found significant indirect effect of school location on pedagogical skills. Moulton (2001) also noted that while in many school locations, furniture can be locally supplied, instructional materials are not available. These include not only textbooks but also the visual materials that decorate classrooms and stimulate learning, as well as simple scientific laboratory equipment and other audio-visual equipment that have become a valuable part of many classrooms. Many of these

primary schools lacked relevant learning aids, however, BST teachers in the urban located schools did some improvisations. This could be because of their proximity to schools' inspectors.

Subject specialisation had significant indirect effect on teachers' attitude to BST in this study. The researcher is of the opinion that teachers whose area of subject specialisation is out of the science and technology would likely be prone to not having positive attitude to BST teaching.Also in this study, school location had a significant indirect effect on teacher-pupils classroom interaction. Teachers in schools located in rural locations mostly travel early to and late from their schools. Such long rides reduced the number and variety of household activities and reduced teachers' sleep time, recreational time, academic attentiveness, and extracurricular participation (Spence, 2000). Even where the teachers reside in these rural locations, they, many a times have to shuttle to and fro their work station and family residences. The overall effect of this would be tiredness in class, leading to poor teacher-pupils classroom interaction.

Effective use of instructional time had a very significant indirect effect on teacher-pupils classroom interaction. It is reasoned that if adequate use is made of the time available to teach BST, it could result in good interaction of teacher and pupils.Teachers' BST content knowledge had a significant indirect effect on teacher-pupils classroom interaction. Teachers' mastery or non-mastery of subject content knowledge could affect positively or otherwise interaction with the pupils.

CHAPTER FIVE

SUMMARY AND CONCLUSIONS

5.1 Introduction

This chapter presents the summary and recommendations, the limitations of the study and suggestions for further research were also given attention.

5.2 Summary

The prevailing low enrolment in science and science-related courses in tertiary edcation institutions over time formed the premise upon which this study was conducted. The factors presumed to be responsible were looked into. In order to establish the links between them and achievement a model of presumed causal interrelationship among the variables of study was hypothesised and tested. The variables (school location, gender, subject specialisation, instructional time, content knowledge, pedagogical skills, attitude to BST, classroom interaction and achievement in Basic science and technology) were observed through the use of correlation data. A sample size of 148 BST teachers was used. This sample size was obtained from the twenty local government education areas in Ogun State of Nigeria. Six instruments were used to collect data.

The findings of this study are summarised as follows:

1. Among the eight variables assumed to be predictors of basic Science and Technology achievement, instructional time and pedagogical skills had the most significant effect, followed by classroom interaction; attitude; school location; content knowledge; subject specialisation and gender the least.

2. The discrepancy between the original and reproduced correlation was minimal. The new model is therefore tenable in explaining the causal interaction among the variables - instructional time, teacher quality, subject specialisation and BST achievement.

3. School location had only direct effect on instructional time.

4. Of the four variables linked with BST teachers content knowledge, only three (gender, subject specialisation and instructional time) had direct effect while school location had indirect effect on content knowledge.

5. Out of the four variables linked with teacher pedagogical skills, school location, subject specialisation and instructional time had both direct and indirect effects while content knowledge had only direct effect on pedagogical skills.

6. Gender and subject specialisation had both direct and indirect effects; content knowledge had direct effect while school location and instructional time had only indirect effects on teachers' attitude to BST as a subject and its teaching.

7. Out of the six variables linked with classroom interaction, subject specialisation, instructional time and content knowledge had both direct and indirect effects; school location and gender had indirect effect and pedagogical skills had only direct effect on classroom interaction.

8. Out of the eight variables linked with pupils' achievement in BST, only school location and pedagogical skills had both direct and indirect effects. Attitude to BST and classroom interaction had only direct effects while instructional time had an indirect effect on pupils' achievement.

School location accounts for 0.2% variance in explaining instructional time (Adj. R^2 = .002). School location, gender, subject specialization and instructional time account for about 6.4% variance in explaining content knowledge (Adj. R^2 = .064). School location, subject specialization, instructional time and content knowledge account for about 57.8% variance in explaining pedagogical skills (Adj. R^2 = .578). School location, gender, subject specialisation, instructional time and content knowledge account for 0.4% of variance in explaining attitude (Adj. R^2 = .004). School location, gender, subject specialisation, instructional time content knowledge and pedagogical skills account for 59.5% of variance in explaining classroom interaction (Adj. R^2 = .595). School location, gender, subject specialisation, instructional time content knowledge, pedagogical skills and classroom interaction account for 5.3% of variance in explaining classroom interaction (Adj. R^2 = .053).

5.3 Conclusion

The inferences drawn from the findings of this study are that generally, teacher factors do affect the manner in which pupils learn. The period of this study served to sensitise the system on the importance of BST as a subject. Teachers and pupils became slightly more interested in the teaching and learning of Basic Science and Technology. The findings reveal that school location, instructional time, pedagogical skills, and teachers' attitude to BST as a subject and it's teaching; and classroom interaction have significant and predictive influence on pupils' achievement in Basic Science and

Technology. However, teacher-pupils classroom interaction and instructional time were the most potent of the variables which can effect pupils' achievement in BST. Conclusively, the findings established significant relationships between instructional time and school location; between gender, subject specialisation, instructional time and Content knowledge; between school location, subject specialisation, instructional time, content knowledge and pedagogical skills; between gender, subject specialisation, content knowledge and attitude to BST; and finally between subject specialisation, instructional time, content knowledge, pedagogical skills and classroom interactions.

5.3 Recommendations

From the research findings, the following recommendations are made:

a. This research established that teacher-pupils classroom interaction is a potent variable; therefore, teachers should strive to create friendly, pupil -centred environment to achieve effectively in BST classes.

b. Teachers should use the classroom instruction time effectively for academic work, instructional time being another potent variable in this study

c. Good pedagogical skills were also found to relate positively with pupils' achievement. This means all teachers would need to develop and exhibit varied teaching skills in BST classes so that pupils can learn BST effectively. Educational policy makers and stakeholders should endeavour to train in and expose teachers to the use of different and relevant teaching methods in science; while providing for science equipment.

d. It is also advocated that teachers should adopt the right attitude that could encourage and allow pupils' to exhibit interest in BST and be better achievers in science and technological based courses at higher levels.

e. Since school location is a factor which this study has found to influence pupils achievement in BST, policy makers should endeavour to provide enabling school environment that could allow for near uniformity in the performance of teachers across rural and urban locations.

f. Teachers should be encouraged to come to BST classes better prepared to teach. This would redirect the classes from the present teacher-oriented classroom to pupil-oriented ones. Presently, majority of the teachers are lecturing their pupils.

g. More studies should be carried out in primary schools on BST teaching and learning to create more interest in its teaching and learning.

5.4 Limitation of the Study

Caution should be taken to limit the generalisations of study within the population of study and geographical location.

5.5 Areas for Further Research

i. The study could be replicated with focus on other states in Nigeria

ii. Apart from the six predictor variables considered in this research work, there still remain some other teacher variables which interested researchers could explore to further explain pupils' achievement in Basic science and technology.

iii. Other predictor variables can be derived from other educational-stakeholders aside teachers, (e.g. parents, pupils, school proprietors and government) which could be envisaged to affect achievement in BST and these can be suggested for inclusion while modelling the said criterion variable.

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APPENDIX 1

UNIVERSITY OF IBADAN

INSTITUTE OF EDUCATION

INTERNATIONAL CENTRE FOR EDUCATIONAL EVALUATION

BASIC SCIENCE & TECHNOLOGY TEACHER MANAGEMENT OF TIME OBSERVATION SYSTEM (TMOTOS)

Section A: Background Information

Gender: Male ☐ Female ☐

School location: Rural ☐ Urban ☐

Teacher's Area of subject specialization:.....

Teacher Code : ..... Observer Code: ..... Date:.....

Section B:

Time (mins)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Academic activities																				
Teacher explains																				
Teacher explains with aid																				
Teacher demonstrates																				
Teacher demonstrates with aid																				
Teacher gives examples																				
Teacher gives directives																				
Teacher asks questions																				
Pupil(s) respond																				
Tr acknowledges positive answer																				
Teacher motivates																				
Tr acknowledges wrong answer																				
Teacher punishes pupil(s)																				
Teacher redirects question																				
Teacher probes																				
Teacher prompts																				
Pupil(s) gives answer																				
Pupils write on the board																				
Teacher writes on the board																				
Pupils read BST texts																				

Teacher reads BST texts																				
Pupils count																				
Teacher counts																				
Pupil(s) recite																				
Pupil(s) identify objects																				
Mgt. & Non academic activities																				
Teacher disciplining pupils																				
Teacher marking pupils' notes																				
Teacher writing lesson notes																				
Teacher socializing with others																				
Teacher in inaudible discussion																				
Teacher's out-of-class activity																				

APPENDIX 2

UNIVERSITY OF IBADAN
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INTERNATIONAL CENTRE FOR EDUCATIONAL EVALUATION

PEDAGOGICAL SKILLS OBSERVATION SCHEDULE (PKOS)

Name of school: .....

Topic: .....

Teacher Code: .....Observer Code:.....Date: .....

Observable Behaviours **Ratings**

A. Lesson plan (15%)

a. Statement of objectives 5, 4, 3, 2, 1, 0

b. Orderliness and logicality 5, 4, 3, 2, 1, 0

c. Language of presentation 5, 4, 3, 2, 1, 0

B. Teaching Aid or Laboratory Experience/Field Trip

Demonstration Experiment (20%)

(a)Relevance of aid to the topic 5, 4, 3, 2, 1, 0

(b) How visible the demonstration is to all 3, 2, 1, 0

(c) Effective use (adequate emphasis on relevant feature) 5, 4, 3, 2, 1, 0

(d) How correctly handled 2, 1, 0

(e) Field Trip (reinforces classroom experience, bridges gap) 5, 4, 3, 2, 1, 0

C. Presentation (55%)

(a) Introduction (relevant, interesting, imaginative, purposeful) 3, 2, 1, 0

(b) Knowledge of subject matter (adequate mastery of subject matter, no wrong facts. 12, 10, 8, 6, 4, 2, 0

(c) Method of presentation (suitable, logical, systematic) 5, 4, 3, 2, 1, 0 (d)

Command of language – simple, clear, fluent, accurate speech. No vague description of objects. 5, 4, 3, 2, 1, 0

(e) Questioning techniques (good quality, varied, well distributed) 8, 7, 6, 5, 4, 3, 2, 1, 0

(f) Pupil participation (opportunity for pupils' questions,

allowed discussions, assignment given)	10, 8, 6, 4, 2, 0
(g) Use of the chalkboard (bold, neat, legible, orderly)	6, 5, 4, 3, 2, 1, 0
(h) Teacher's movement around the class, supervising	3, 2, 1, 0
(i) Conclusion (brisk recapitulatory questions)	3, 2, 1, 0

D. **Class Management and Control 10%**

(a) Teacher-pupil relationship (alert to incipient problems, class routines handled properly, maintains control even under informal conditions, recognition of safety precautions)	3, 2, 1, 0
(b) Pupils' reaction (attentive involvement, majority participation, evidence of comprehension, question from pupils)	4, 3, 2, 1, 0
(c) Assessment of pupils' progress (evidence of having checked home assignments and class work)	3, 2, 1, 0
TOTAL OBTAINABLE SCORE	100

APPENDIX 3

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OBSERVATION INSTRUMENT FOR TEACHER-PUPIL INTERACTION

Teacher Code:……Observer Code : .....Date:……

	min	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
code																										
1																										
2																										
3																										
4																										
5																										
6																										
7																										
8																										
9																										
10																										
11																										
12																										

- Question asked naming a target pupil (coded as 1).
- Question asked a volunteer pupil (coded as 2).
- Unsolicited response (coded as 3).
- Statement (coded as 4).
- Exchange (coded as 5).
- Non-verbal (coded as 6).
- Teacher praises or encourages (coded as 7).
- Teacher accepts or uses ideas (coded as 8).
- Teacher lectures (coded as 9).
- Teacher writes on the board (coded as 10).
- Teacher criticizes or disciplines (coded as 11).

- Silence or Confusion (coded as 12).

APPENDIX 4

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BASIC SCIENCE & TECHNOLOGY TEACHER ATTITUDINAL SCALE (BSTAS)

INSTRUCTION: Please tick SA if you strongly agree, A if you agree, D if you disagree and SD if you strongly disagree with each of the statements below

Gender: Male ☐ Female ☐ Teacher Code:.....

1.	Teaching of BST makes many teachers nervous.	A			D
2.	Teachers have less trouble teaching BST than other subjects.				
3.	Most teachers have capabilities to solve science problems.				
4.	The teaching of BST is usually enjoyable in primary schools.				
5.	Most teachers are happier in a BST class than in any other classes.				
6.	Many teachers are willing to teach Basic Science and Technology.				
7.	Teachers study as much Science as they can in their spare time.				
8.	Pupils find BST more difficult to learn than other subjects.				
9.	Teachers find many aspects of BST uninteresting and challenging.				
10.	Teachers avoid teaching many aspects of BST				
11.	BST class is a waste of time to most pupils				
12.	BST is the best subject for most pupils				
13.	BST classes put many teachers under stress.				
14.	Problems in BST are solved without much difficulty.				
15.	Many pupils do not have scientific minds.				
16.	Most primary school teachers are not science-oriented persons.				
17.	BST is one of the most important subjects in schools.				
18.	BST would be very helpful to the pupils now and in future				
19.	BST is dull and boring.				
20.	Most pupils would avoid studying Science courses at tertiary level				

APPENDIX 5

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BST TEACHERS' CONTENT KNOWLEDGE TEST (CKT)

INSTRUCTION: Please circle the correct option for each question. Time: 30 mins

Teacher Code: .....

1. The soil which has the highest water retaining capacity is .....

   A. clay B. loamy C. sandy D. igneous

2. The major difference between rubber and plastic is that rubber is .....

   A. difficult to obtain B. tougher C. harder D. more elastic

3. Metals that contain iron are called .....

   A. ferrous metals B. coloured metals C. non-ferrous metals D. alloys

4. Which of the following is a non-metal? .....

   A. iron B. aluminium C. gold D. plastic

5. The instrument for reading air pressure is called .....

   A. anemometer B. barometer C. hygrometer D. wind vane

6. Which of the following is NOT true of air? It .....,.....

   A. can be compressed B. has weight C. is a compound D. is a mixture

7. An instrument which helps a pilot to jump out of a plane to land safely on the ground is known as ..... A. balloon B. girder C. kite D. parachute

8. The force which makes the balloon move in the forward direction is known as .....

   A. inertia B. thrust C. gravity D. velocity

9. The scapula is a bone found in the .....

   A. arm B. shoulder C. thigh D. knee

10. .....protects the body against diseases

    A. red blood cells B. white blood cells C. platelets D. plasma

11 .....carry blood from the heart to other parts of the body.

   A. arteries B. veins C. capillaries D. kidneys

12. Organs of the .....system remove waste products from the human body. A. excretory B. respiratory C. reproductive D. skeletal

13. Early exposure to sexual intercourse by teenagers and adolescents is known as ...

    A. sexual intercourse B. sexual abuse C. sexual deficiency D. marital sex

14. Irresponsible sexual behaviour can result into .....

    A. malariaB. typhoid C. HIV D. over weight

15. HIV cannot be spread through .... A. Sexual intercourse

B. sharing toothbrush C. blood transfusion D. sharing toilet

16. .....is the best way to avoid contracting HIV A. Abstinence

B. sleeping early C. early sex D. running from men

17.A good source of vitamin C is .....

A. beans B. rice C. meat D. lemon

18. Which of the following is carbohydrate?

A. garden egg B. melon C. lettuce D. maize

19. Which of these is a good source of protein?

A. egg B. guinea corn C. maize D. rice

20. Which of the following is NOT a function of food A. body building

B. disease resisting C. energy giving D. skin coloration

21. Which of the following is a good conductor of heat?

A. bone B. glass C. iron D. paper

22. The temperature of boiling water is .....

A. 32^0C B. 100^0C C. 120^0C D. 180^0C

23. The instrument used for measuring temperature is called .....

A. an ammeter B. an anemometer C. a thermostat D. a thermometer

24. Which of the following material is a source of solar energy?

A. coal B. kerosene C. sun D. water

25. Objects which allow electricity to pass through them are called .....

A. insulators B. conductors C. cables D. metals

26. When an electrical circuit is not complete, it is said to be .....

A. open B. close C. complete D. incomplete

27. Which of the following will cut off the source of electricity when there is electrical fault in the house? A. switch B. filament C. battery D. fuse

28. The instrument that controls the flow of electricity in fridge and electric iron is called .....A. thermometer B. fuse C. thermostat D. barometer

29. The earth revolves round the sun in about .....days.

A. 60 B. 360 C. 365 D. 90

30. The earth is .....in shape A. spherical B. flat C. angular D. cylindrical

31. An eclipse of the moon occurs when .....comes in between the sun and the moon. A. moon |B. sun C. rainbow D. earth

32. Rainbow is made up of .....colours A. 5 B. 7 C. 9 D. 10

33. A device which makes work easier and faster is called .....

A. motor B. lever C. inclined plane D. machine

34. Which one of the following is NOT true of friction? A. causes wear and tear of surfaces B. helps us to fall easily on roads C. produces heat D. stops bodies when they move over each other

35. The force that acts on a mango fruit as it falls to the ground is called .....force

A. electrical B. frictional C. gravitational D. magnetic

36. .....is an example of inclined plane

A. staircase B. bottle opener C. scissors D. wheel barrow

37. Which of these minerals is used in production of steel

A. iron B. lead C. marble D. tin

38. The crude form in which minerals are obtained is called .....

A. coal B. oil C. ore D. petrol

39. Which of these cannot be obtained from petroleum?

A. alum B. diesel C. engine oil D. kerosene

40. .....is used for making cement

A. crude oil B. coal C. limestone D. copper

APPENDIX 6

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INTERNATIONAL CENTRE FOR EDUCATIONAL EVALUATION

BASIC SCIENCE & TECHNOLOGY PUPILS' ACHIEVEMENT TEST (BSTPAT)

INSTRUCTION: Please circle the correct option for each question. Time: 30 mins

1. .....system is the group of organs which remove waste products from the human body. A. excretory B. respiratory C. reproductive D. skeletal
2. The air we breathe in is called .....
   A. carbon (IV) oxide B. oxygen C. carbon (II) oxide D. nitrogen
3. .....protects the body against diseases
   A. red blood cells B. white blood cells C. platelets D. plasma
4. .....carry blood from the heart to other parts of the body.
   A. arteries B. veins C. capillaries D. kidneys
5. The scapula is a bone found in the .....
   A. arm B. shoulder C. thigh D. knee
6. .....carry blood from all the parts of the body to the heart.
   A. arteries B. veins C. capillaries D. kidneys
7. Early exposure to sexual intercourse by teenagers and adolescents is known as ...
   A. sexual intercourse B. sexual abuse C. sexual deficiency D. marital sex
8. Irresponsible sexual behaviour can result into .....
   A. malariaB. typhoid C. HIV D. over weight
9. HIV cannot be spread through A. sexual intercourse B. sharing toothbrush C. blood transfusion D. sharing toilet
10. For safe child bearing reproductive age for girls should not be earlier than.....
    A. 13 yrs B. 18 yrs C. 30 yrs D. 40 yrs
11. The full meaning of AIDS is .....A. abstinence immune deficiency syndrome B. acquired immune deficiency syndrome C. acquired immune deficiency sex D. abstinence immune disease syndrome
12. The application of either manure, animal droppings or fertilizer .....
    A. causes weeds to replace crops B. increases yield and soil fertility
    C. lessens the farmer's labour D. reduces overcrowding of crops
13. The following are good for plant growth EXCEPT
    A. fertile soil B. light C. water D. heat
14. .....is a method of improving crop yield A. crop rotation B. allowing pests C. farming a plot continuously D. planting overcrowded crops
15. A pressing of air upon an object is known as .....
    A. air effort B. air load C. air pressure D. air power
16. When air is heated, ... A. it goes out B. it expands C. it cools down D. it becomes hot

17. A device used when people have to jump out of planes when it wants to crash is known as .....A. safety cloth B. glider C. protector D. parachute
18. Which of the following statements is NOT true of air? A. it has weight B. it can be seen C. it is present everywhere D. it fills spaces
19. Which of these is NOT a way of controlling erosion A. contour ridging B. felling of trees C. mulching of ridges D. planting cover crops
20. The washing away of the top soil and rocks from the earth's surface is called ..... A. conservation B. drainage C. erosion D. Irrigation
21. One of the ways by which man destroys his environment is by ..... A. bush burning B. conservation of the forest C. improving the fertility of the soil D. planting of the crops
22. All of these cause erosion EXCEPT..... A. deforestation B. poor waste disposal C. overgrazing by animals D. pollination
23. The following are the effects of erosion EXCEPT ..... A. loss of nutrients B. loss of properties C. poor harvest D. good roads
24. Which of the following cannot be picked with magnet A. safety pins B. coins C. cork D. needles
25. Which of the following will cut off the source of electricity when there is electrical fault in the house? A. Switch B. filament C. battery D. fuse
26. The major difference between rubber and plastic is that rubber is ..... A. difficult to obtain B. tougher C. harder D. more elastic
27. Which of the following is a non-metal? A. Iron B. aluminium C. gold D. plastic
28. The instrument that controls the flow of electricity in fridge and electric iron is called .....A. Thermometer B. fuse C. thermostat D. barometer
29. The following are good for plant growth EXCEPT A. fertile soil B. light C. water D. heat
30. Which of the following CANNOT improve soil fertility? A. animal waste B. artificial fertilizer C. tree planting D. compost manure