EFFECT OFSOCRATIC QUESTIONING TECHNIQUE ON ACADEMIC PERFORMANCE OF UPPER BASIC SCIENCE STUDENTS OF DIFFERENTCOGNITIVE STYLES, ZARIA EDUCATION-ZONE, KADUNA STATE, NIGERIA

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MARCH, 2021

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Bsc.Ed Integrated Science (A.B.U., 2016)

P17EDSC8092

A DISSERTATION SUBMITTED TO THE SCHOOL OF POSTGRADUATE STUDIES AHMADU BELLO UNIVERSITY INPARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF THE MASTERS DEGREE IN SCIENCE EDUCATION

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MARCH, 2021

DECLARATION

I declare that the Contents in this dissertation entitled "**Effect of Socratic Questioning Technique on Academic Performance of Upper Basic Science students of different Cognitive Styles, Zaria Education-Zone, Kaduna State, Nigeria."** has been written by me in the Department of Science Education, Faculty of Education, Ahmadu Bello University, Zaria, under the supervision of Prof. I.A. Usman and Dr. M.S. Tudun Kaya. No part of this dissertation was previously presented for another Degree or Diploma at any University elsewhere.The informationderived from the literature has been duly acknowledged in the text and the list ofreferences provided.

_____ _____

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CERTIFICATION

This dissertation **"Effect of Socratic Questioning Technique on Academic Performance of Upper Basic Science Students of different Cognitive Styles, Zaria Education-Zone, Kaduna State, Nigeria."** meets the requirements governing the award of Master's Degree in ScienceEducation of Ahmadu Bello University, Zaria and it is approved for itscontribution to knowledge and literary presentation.

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DEDICATION

This Study is dedicated tomy Late Father in Person of AlhAdamuIsah and Prof. I.A. Usman.

AKNOWLEGMENTS

All praises and thanks be to Almighty Allah, the Creator and the Dominion (S.W.T). I thank Him for giving me the opportunity to be where I am today in my Educational carrier and comes to the completion of my Master's Degree (Msc.Ed.) in this prestigious University. There is no way to express my gratitude than to say thanks and glory be to You alone(Alhamdulillah).

I wish first and foremost to appreciate the efforts of my majorsupervisor Prof I.A. Usman, for the thoroughness and dedication to which heshowed in going through mywork. Sir, I don't have the vocabulary to thanks you, May Almighty Allah grant you success, prosperity, soon and speedy recovery from your sickness. I shall forever remain grateful.

I sincerely appreciate the efforts of my second supervisor Dr. S.M TudunKaya for his imminence contributions to the success of this study. May Almighty Allah rewards you abundantlySir.

My sincerely appreciation also goes to my Mentor Prof. J.O. Olajide for being there with me from the beginning of this study to the end. Mummy, please accept my apologies because I don't have the vocabulary to thanks you. May God bless you.

My absolute appreciation also goes to my H.O.D, my Daddy Prof. S.S. Bichi for your supports and advices. Thanks a lot for being there with me. My sincerely appreciation also goes to my P.G coordinator in person of Dr. M.O. Ibrahim, your maximum and undeniable support will never be forgotten sir. May Allah reward you abundantly.

I must also appreciate the efforts of all staffs in Science Education for their contributions for the fulfillment of this program. I am honored to be your student Prof. A.A.M Shaibu, Prof. J.S. Mari, Prof. M. Musa, Prof. F.K. Lawal, Prof. BintaAbdulkareem, Prof. S.S. Obeka, Prof. T.E. Lawal, Prof. M.A. Lakpini, Prof. M.M. Atadoga, Dr. S.B Olorukooba, Dr. M.K. Falalu, Dr. I.H. Usman,

Dr. Ginga, Dr. M. Bawa, Dr. A.A. Dada and finally Miss. Ramatu. And to all others who have taught me in one way or the other, for grooming me rightthrough my undergraduate and post graduate studies. To all of you, I say thank you.

My profoundgratitude goes to Zaria Education Zonal Director, principals of GSS Dakace, GSS k/KuyanBana, GSS Yakassai and GSS Tudun/ Jukun for making this study possible.

My special gratitude goes to Mr.Ojo for his support and guidance. I will never forget your efforts Sir.

Myeternal appreciation also goes to my family for without their support I would never have completed this study; my mother my everything Hajiya. Fatima Umar, my siblings: Maryam Adam, Shamsuddeen Adam, Aisha Adam, Hadiza Adam and Ahmad Adam. My children; Abdallah A Adam,Adam S Adam, Aisha S Adam, Fatima S Adam, NafeesatAbdullahi, Musaddiq Hussain and Aisha Umar.My absolute gratitude also goes to my lovely and adorable wife RahamaMuhammad. May God bless you all and keep us all together (Ameen).

Finally, I acknowledge greatly with much gratitudethe support of my friends and well-wishers who encouraged me even when I was at a level of breakdown. Your individual understanding pushed me towards the successful completion of this work. To all, I say a big thank you.

List of Abbreviations

ANOVA	-	Analysis of Variance
ANCOVA	-	Analysis of Covariance
AUT	-	Alternative Uses Test
ACP	-	Academic Performance
BSPT	-	Basic Science Performance Test
CLT	-	Central Limit Theorem
DI	-	Discrimination Index
F1	-	Facility Index
FD	-	Field Dependent
FI	-	Field Independent
MAN	-	Mathematics Association of Nigeria
SQT	-	Socratic Questioning Technique

OPERATIONAL DEFINITION OF TERMS

Socratic Questioning Technique: Teaching by questioning where by answers and discussions are used to elicit the expected learning.

Academic Performance: This is the expected learning outcome from the students by the teacher after given a set of instruction.

Cognitive Style: This is an information processing habit representing the learner's typical way of perceiving and organizing information.

Convergent: Individuals concerned with focusing on the best or most appropriate solution to a problem.

Divergent: these are individuals concerned with focusing on searching of varieties of ideas or solution to a given problem.

Rural: Geographical areas that are villages with little population density.

Urban: Geographical areas with high population density and infrastructure.

Environmental Hazards: Environmental hazard are occurrences arising from Interactions between Natural, Social and Technological systems of the Environment which are harmful to people and their possessions.

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ABSTRACT

This study titled Effect of Socratic Questioning Technique on Academic Performance of Upper Basic Science students of Different Cognitive Styles in Environmental Hazard Concept in Zaria Education Zone, Kaduna State, Nigeria. The Design of the study was Quasi-Experimental design. The population comprised all the 18,508JSS2 Basic Science Students from 37 public secondary schools in Zaria Education Zone. Sample of 297 students from four randomly selected coeducational schools were used for the study. The Experimental Group was taught the concept of Environmental Hazard using Socratic Questioning Technique while the Control Group was taught the same concept using Lecture Method. A validated Instrument called Basic Science Performance Test (BSPT) and Alternative Uses Test (AUT)with a reliability coefficient of 0.79 and 0.81 was used for the data collection. Five research questions and five null hypotheses were formulated to guide the study. ANOVA, ANCOVA, and Independent t-test statistics were used to test the null hypotheses at $P \leq 0.05$ level of significance. Findings among others revealed that there is statistical significance difference between the Experimental and Control group in favor of the experimental group, the findings also revealed that there is statistically significant difference between the convergent and divergent students in the experimental group. The researcher thus concluded that Socratic Questioning Technique was found to be helpful in changing students' performance. It was therefore recommended among others that Junior Secondary school Basic Science Teachers should endeavor to use the Socratic Questioning Technique while teaching to improve students' Performance in Upper Basic Science.

CHAPTER ONE

THE PROBLEM

1.1 Introduction

The importance of science and technology to national development in the life of any country cannot be over emphasized. This is because knowledge and skills in science and technology are very vital in the development of any society. Mulemwa (2005) points out that, the fast changing applications of science and technology and the global reliance on its processes and products in all areas of human endeavor have made them invaluable that any society or country without them risks being alienated from the global village. This means that for an individual to be well-grounded in science, and competent enough to face the challenges of life in his society, he or she must have gone through a science programme that is well planned, assessed and implemented. Shaibu (2008) expresses the opinion that Nigerian citizens should pursue Science, Technology and Mathematics Education (STME) to prevent Nigeria from being perpetual slave to the developed world. Science is a great enterprise which nation depends on in order to advance technologically Nwagbo and Chukelu (2011). Scientists work with great care, using their hands and brains, as well as complex equipment to carry out research in order to make discoveries and inventions. To do these effectively, they use materials safely and efficiently (Obeka, 2011). Science education as described by Pember and Humbe (2009) as a process of teaching or training especially, in school to improve one's knowledge about one's environment and to develop one's of systematic enquiry as well as rational attitudinal characteristics. Scientific knowledge endows humanity with power which them to exert their will over nature to create resources, conquer and uplift the quality of life.

A history of science teaching has its root in primary schools when Nature study, Hygiene, Agric and domestic science featured promptly. General science emerged in the late 30s was

referred up to the primary school certificate and the first two years in the secondary. Science teaching took up from there and undergoes several modifications until 1982 when it became Integrated Science taught in the secondary school. In 2009 the nomenclature of integrated science was changed to basic science and broken into Lower, Middle, and Upper Basic Science covering primary 1-3, 4-6 and JSS 1-3 respectively. The change to basic science of 9years, 3years senior secondary and 4years tertiary is a policy and not a system. The country still maintains the system of 6-3-3-4 (9-3-4). Basic Science is one of the subjects taught in Nigerian Junior Secondary Schools. It is a subject meant to provide a solid foundation for the Senior Secondary Science subjects like Biology, Chemistry and Physics (Gadzama, 2012). It is a subject rooted from integrated science which is developed by the Science Teachers Association of Nigeria (STAN) in the 1970's with the aim of providing an integrated approach to the teaching of science, stressing the fundamental unity of its branch disciplines. However, observations from the Basic science classrooms reveal that most teachers do not adopt instructional techniques and strategies that could stimulate students' creativity and performance (Olorukooba & Lawal, 2010). Basic Science pedagogy like in any other science subject revolves around the practical, but the theoretical teaching and rhetoric learning within the contemporary Nigerian classrooms have become obstacles in the bid to transform the knowledge of Basic Science into achievements (Banfe, 2013).

Basic science was introduced into the Nigerian Secondary School as a core subject at the junior secondary school level in 2006 (Eggari, Kukwui, Mahmuda, &Sambo, 2014). The aim of that basic science curriculum was to introduce students to the world of science and to prepare them for higher education in science and technology. Basic science is taught in all junior secondary schools in Nigeria as a course of study which is devised and presented in such a way as to enable the students gains concept of the fundamental unity of science, the commonality of approach to problem of scientific nature and help student to gain an

understanding of the roles and function of science in everyday life and the world in which they live (Sambo, 2012). Basic science incorporates the study of elementary biology, anatomy, ecology, genetics, chemistry and physics into one integrated science subject and taught in the junior secondary schools in Nigeria (Omiko, 2016). It is the bedrock of advance studies in the field of science, technology and Engineering. Therefore, Basic Science become fundamental to every science subject and to this effect, suitable technique and approach should be given to prepare learners to study science at higher level. It's from this tenet that this study seeks to find the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles, Zaria Education-Zone, Kaduna State, Nigeria.

This thesis is an effort to connect philosophy to education. It focuses on the Socratic Questioning Technique, a teaching and learning approach extrapolated from Socrates conversations with his interlocutors in Plato's works. By explaining and relating the method to studies in cognitive science, developmental psychology, and education.

The Socratic Technique is teaching by questioning whereby answers and discussions are used to elicit the expected learning. Here the teacher leads and guides the students to express their opinions and ideas with the view to find answers to problems collectively. Eisner (2002) explained that the discussion method works on the principle that the knowledge and ideas of several people are more likely to find solutions or answers to specified problems or topics. This is in line with the saying that, two good heads are better than one. Discussion teaching engages both the teachers and students in thinking. It also develops in student's social skills of talking and listening. The Socratic teaching Technique encourages active participation. It requires the students to critically evaluate their own beliefs. It requires them to articulate reasoned concepts behind their beliefs. Socrates believed that teachers should not lecture. They should tap into the knowledge that lies deep within everyone.

Some of the advantages of the method is that it allows for sharing of ideas by students, development of social skills of talking and listening, clarification of ideas and promotion of team work. Teaching method are patterns of teacher behavior that occur either simultaneously or in sequence in a verified way. Choosing specific teaching methods that best achieves course objectives is one of the most important decisions a teacher faces. Knowing what methods are available and what objectives each method is best suited for, help teachers make this decision more easily. It is against this background that this study seeks to Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles, Zaria Education-Zone, Kaduna State, Nigeria.

Academic Performance as observed by Shaibu (2017) is the exhibition of knowledge attained or skills developed by a student in a subject designed by test scores assigned by teachers. It is influenced by a number of factors such as teaching method, class size, qualification and experience of science teachers, and instructional materials available among others (Salisu, 2016). According to Achino (2002), academic performances is the level of individual's growth in a test when compared with the scores of others of the same level. Several instructional strategies such as problem-solving, cooperative learning, concept- mapping and inquiry methods among others have been devised over the years with the hope of improving students' performance. It is best on this premise that this study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles, Zaria Education-Zone, Kaduna State, Nigeria.

The concepts of cognitive stylesarise from the fact that individual differences exist as a result of differences in the psychological functioning of person, including the selection and recall of information from memory (Daniel, 2002) Study of cognitive styles has become a broad stream in cognitive psychology and mathematics education. Individuals display their own personal cognitive styles which is a major attribute in what makes an individual to respond to

various situations (Anastasi, 1996: Musya 2015). Cognitive style is a term used to describe the way individuals perceive, think and remember information (Lusweti, Kwena & Mondo, 2018). Douglass (2003) found that as many as nineteen (19) different ways of describing cognitive styles have been identified over the years, all of which consist of bipolar distinctions of thinking and thought processing styles. Some of these distinctions are:

i. The Converger - Diverger construct by Guilford (1956)
ii. The Reflective – Impulsive cognitive style by Kagan, Rosman, Day, Albert, and Philips (1964)
iii. The Holist – Serialist theory by Pask (1976)
iv. The Adaption – Innovation theory by Kirton (1976)
v. The Ornstein's (1973) Hemispherical Lateralization Concept
vi. The Field Dependence–Field Independence model by Witkin, Oltman, Raskin, and Karp (1971)
vii. The Wholist- Analytic and Verbal –Imagery model by Riding and Cheema (1991).

Cognitive styles are the psychological differences between how people obtain information. They are defined as the indicators of how students perceive, interact with, and respond to different learning environments (Sankar & Raju, 2011). By understanding which cognitive styles an individual ascribes to, he or she can better prepare studying and learning methods to help them obtain the greatest amount of information. While each cognitive style is different, no one is better than any other (Sternberg& Li-fang, 2005). People all learn differently and understanding how each individual learns best will give that individual the best chance of success. Hence this study focuses Convergent - Divergent cognitive dimension.

A convergent learner is one who tends to look for unique methods and unique solutions. Such thinkers are noted for creativity or lateral thinking. A divergent learner is characterized by lateral thinking, creativity and capacity to see new combinations of ideas and to examine

the possibilities of more than one way of doing things, leading to several outcomes (Guilford, 1959 in Adamu, 2018). Convergent thinking is the finding of a single best solution to a problem that we are trying to solve (Williams, 2013). Many tests that are used in schools, such as multiple-choice tests, spelling tests, math quizzes, and standardized tests, are measures of convergent thinking. Divergent thinking is the process to create several unique solutions intending to solve a problem. The processof divergentthinking is spontaneous and free-flowing, unlike convergent thinking, which is systematic and logical. When using convergent thinking, we use logical steps in order to choose the single best solution. By using divergent thinking, instead of only choosing among appointed options, we search for new options. Convergent thinking stands firmly on logic and less on creativity, while divergent thinking is mostly based on creativity. We use divergent thinking mostly in open-ended problems that creativity isa fundamental part (Williams, 2013). Divergent perceive concretely and think reflectively and imaginatively. Divergent thinking is related to fluency (i.e., the ability to produce multiple ideas in response to a task rapidly), flexibility (i.e., the capacity to consider multiple approaches to a problem), originality (i.e. The tendency to produce novel ideas in response to a task), and elaboration (i.e., the ability to consider the implications and consequences of ideas). Divergent thinkers tend to choose the liberal arts and humanities. According to Akbari (2011) convergent and divergent students can be identified easily by their areas of interest. That convergent student relies heavily reading and experiment to process information. Kolb (2008) stated the convergent and divergent students are very different in their learning style but they can both benefit greatly from working with one another.

It was suggested by Muhammad (2010) that convergent pupils tended to specialize in the sciences and classics, but divergent pupils may be good in arts, history and modern language. Cognitive Styles regardless of their types, are different from ability which some believe to be

a characteristic of intelligence. Whereas ability refers more to the content of cognition, cognitive styles help one predict how information is processed by each individual (Witkin & Goodenough, 1981: Adamu, 2018). A large body of researches suggest that students with different cognitive styles approach processing of Information and problem solving in different ways. McNally (1987; Adamu, 2018) asserts that learners are differentially prepared to learn. From an information processing point of view, the relative preparedness of a learner for learning about a given situation is determined by the amount of input that must occur before output reliability occurs. Some styles increase preparedness in one situation and others increase preparedness in other situations. For example, impulsivity/reflectivity is thought of as a style dimension. For studying books, the reflective student who takes information in and thinks about it is likely to do well in book learning. On the other hand, the impulsive student who is always seeking new stimulation, probably due to being low in arousal, is much better than the reflective in the jungle. It's from this tenet that this study seeks tofind out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Rural and Urban Zaria Education-Zone, Kaduna State, Nigeria.

School location is used to describe the geographical 'position of a school. Many towns are usually demarcated by the socio-economic status of the residents and by the quantity of social amenities and infrastructure. Therefore, some schools are located in the urban areas while some are situated in the rural areas. Rural areas are geographic areas that are located outside towns and cities. Rural life is uniform, homogenous and less complex than that of urban centers, with cultural diversity, typical rural areas have a low population density and small settlements. Urban areas are human settlements with high population density and infrastructure of a built environment. Ogunleye (2002) found out in a study thatschool location had a significant effect on achievement. Studies by Okereke (2011) showed that there was a higher and significant difference in achievement of students from urban and rural

schools in chemistry. This was attributed to the disparity in resources between urban schools and rural ones. Anwar (2012), concluded that rural area students in Pakistan have lesser facilities and socioeconomic situations but have higher attitudes towards science than the students of urban areas with much more facilities and high socio-economic status. Most of these researches were based on the assessment of students‟ performances in the traditional classroom instructionalprocess that is mainly lecture oriented(Uju,2006). This study therefore seeks to Analyses Socratic Questioning Technique on Academic Performance of Basic Science Student of different Cognitive Styles on Environmental Hazard concept in Zaria Education-Zone, Kaduna State, Nigeria.

Environmental hazards are events or occurrences arising from interactions between natural, social and technological systems of the environment which are harmful to people and their possessions(Cutter, 2001). They are elements of the physical environment which are threats to man and are caused by forces extraneous to him (Oluwole & Oluwafemi, 2016). Environmental hazards are generally classified into natural and man-made (Ragheb, 2014). Natural hazards result from natural conditions and sometimes products of negative consequences of interactions between man and nature. Man-made hazards are caused by physical, chemical, biological and technological operations of man. They are the usual consequences of high urbanization and industrialization (McMichael, 2000; Kotter, 2003). Examples of these hazards include earthquakes, hurricanes, tornadoes, tsunamis, land degradation, pollution, desertification, deforestation, wild-land fires, and loss of biodiversity (Al-Amin, 2013) among others. Environmental hazards and related risks occur in any sphere of human environment and at any locations where human activities take place (Hilary, 1999 in Oluwafemi, 216). The occurrences have been widely documented in both developed anddeveloping countries of theworld (Lenon, 2013). The effects of environmental hazards at any of these locations are devastating considering thedisaster cases experienced in the world.

It was long estimated that between 1975 and 1998, environmental hazards caused an annual death tolls of 9000 lives and over $300 billion in property and crop damages (Mitchell and Thomas, 2001). In recent times, the death tolls resulting from environmental hazards from 2003 to 2012 have an annual average estimation of 106, 654 lives and 96.5 million people were victims of such occurrences worldwide (Lenon, 2013). The developed world in particular is considered to be vulnerable to typical natural disaster occurrences (Levy and Gopalkrishnan, 2010). Prominent disaster occurrencesin the regionscomprise the Hurricane Katrina in America and Heat Wave in Europe, among others (Farber, 2011). The situation likewise applies to the developing countries. For instance, disaster occurrences in Asia are more of geophysical and Oceania factors with recent events comprising the earthquake, cyclone Phailin and cyclone Utor/Labuyo in Thailand, India and China respectively (Lenon, 2013). In Africa, natural environmental hazards such as Global Warming, Flooding, Drought and Desertification are resultant effects of natural environmental variables such as elements of weather and climates (Amokaye, 2005). Nevertheless, there is also the prevalence of man-made environmental hazards, especially those that are products of living conditions and behavior of inhabitants (Afon, 2011). They are observed to have direct link with activities in urban residences. In Nigeria, environmental hazards and risks resulting from poor living conditions in the residential environments include presence of open site dumps, unkempt waste disposal facilities, overgrown lawns, electric generating plants, open drainages, location and conditions of sanitary facility, and indoor cooking, among others (Afon, 2011). It's based on this premise that the study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Zaria Education-Zone Kaduna State, Nigeria.

One major goal for reform in science education is to evolve a science oriented program for every child to participate actively and learn maximally irrespective of gender, socio-economic

background and ability levels (Gadzama, 2012). There have been a number of studies on gender and academic performance in science. Researches on gender and academic performance such as those of Ibrahim (2012) and Olorukooba, Lawal and Jiya (2012) observed that boys achieved better than girls, but studies by Bunkure (2012) and Dahiru (2013) pointed out that girls achieved better than boys. However, some others such as Ifamuyiwa (2003), Abdulganiyi (2017) and Yahaya (2017) revealed that male and female students do not differ significantly in their academic performance. It is against this background that this study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles, Zaria Education-Zone, Kaduna State, Nigeria.

1.1.1 Theoretical Framework

This study is hinged on philosophical thought of Socrates (470-399 BC) and Guilford theory of convergent and divergent thinker (1956).

Socrates (470-399 BC) proposed that participants seek and gain deeper understanding of concepts in the text through thoughtful dialogue rather than memorizing information that has been provided for them. He believed that students should be actively involved in their own learning; their morals and understanding of certain concepts should be challenged in order to make them think critically. He believed that disciplined practice of thoughtful questioning enabled the student to examine ideas logically and to determine the validity of those ideas. According to him, knowledge is possible but the first step to knowledge is recognition of one's ignorance. He sought to get to the foundations of his students' and colleagues' views by asking continual questions until a contradiction was exposed, thus proving the fallacy of the initial assumption. He beliefs that all new knowledge is connected to prior knowledge, that all thinking comes from asking questions, and that asking one question should lead to asking further questions. When students make these connections, they are learning new material and

relating it to what they already know (Dewey, 1916). Many educators today believed that the constructivist theory is a relatively new theory in education but the tenets of constructivism can be traced back to Socrates. Socrates was well known for asking his students question's that would stretch their minds and force them to think on higher level (Tredennick & Tarrant, 1993: Adamu, 2018).

Guilford (1956) was an early proponent of the idea that intelligence is not a unitary concept. Based on his interest in individual differences, he explored the multidimensional aspects of the human mind, describing the structure of the human intellect based on a number of different abilities. He proposed the concept of convergent and divergent thinking, when he noticed that creative people tend to exhibit this type of thinking more than others. He sees divergent learner characterized by lateral thinking, creativity and capacity to see new combinations of ideas and to examine the possibilities of more than one way of doing things, leading to several outcomes. He thus associated divergent thinking with creativity, appointing it several characteristics. Guilford believed that standard intelligence tests do not favor divergent thinking, working better for convergent thinkers. it's from this tenet that this study seeks to Analyses Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles, Zaria Education-Zone, Kaduna State, Nigeria.

1.2 Statement of the Problem

Basic Science is a solid foundation of science subjects but facing a lot of challenges especially in the performances of students in the subject recently. The objectives of teaching Basic Science in Junior Secondary Schools are to facilitate the acquisition of basic knowledge in science as well as the development of scientific attitudes in students (Gadzama, 2012). A lot has been done to improve the teaching of Basic Science in secondary schools in Nigeria. In spite of that students continue to perform poorly in the subject. However, a number of factors have been identified as contributing to the consistent poor performance of Junior

Secondary School students in Upper Basic Science at Junior School Certificate Examinations (JSCE). Such factors include gross inadequacy or lack of instructional materials, poor utilization of instructional materials in classroom instruction and the teachers' method of teaching among others (Olorukooba & Lawal, 2010; Gadzama, 2012). According to Nurudeen (2011), the statistics of grades obtained by candidate in the Junior Secondary School Examination Council (JSSCE) especially in Basic Science Examination in recent years is a course of concern. It was also reported by the Junior Secondary School Examination Council (JSSCE) Zonal Coordinator that 57% of Students that sat for the Examination in previous years failed Basic Science. Therefore, the statistics of Basic Science Students Performances in Junior Secondary School Certificate Examination in Zaria Educational Zone and Kaduna State as a whole indicate rates of over 70%failure as shown in table 1.1.

Table 1:1 Students Performance Trends in (JSCE) results of Basic Science 2007-2017.

Year	No. of students sat for JSSCE	No. of students that passed (A1-C6)	No. of students that fail	% ofstudent that passed (A1-C6)	% of student that failed (D7-F9)
2007	326541	98215	228326	30	60
2008	758849	295951	462898	39	61
2009	22853	80354	148559	35	65
2010	25009	85150	163949	34	66
2011	367562	120560	247002	33	67
2012	659132	204330	454802	31	69
2013	791227	245280	545947	31	69
2014	866616	251319	615297	29	71
2015	289520	84520	205000	29	71
2016	182759	39225	143534	21	79
2017	428034	80233	347801	19	81

Source: Kaduna North Education Zonal Office (2018)

The poor performance in science has endured in spite of the various reforms and interventions by the government and the situation has remained a source of concern to science educators

and educational experts. Presumably, the various strategies available may have failed to improve the performance. Studies has been done by Ibitoye (2001) and Adamu (2014) on the use of more effective teaching methods such as problem-solving, discovery learning, and hands-on activity among others. Therefore, it will be worthwhile to Analyses Socratic Questioning Technique on students' performance in Upper Basic Science.

In the same vein, Cognitive styles has been used by researchers to investigate how individuals process information and make choices in learning science. Nwachuku and Nwosu (2009) opined that lack of attention by teachers in handling students of varying learning styles have been implicated as some key factors accounting for student's poor performance in biology in spite of the large enrolment. Study by Igwe (2002) suggest that learners with certain cognitive style are either facilitated or hampered by the particular teaching methods to which they are exposed. Muhammad (2001) pointed that students with field-independent cognitive style has higher academic performance than students with field-dependent cognitive style. Therefore, a number of instructional strategies such as demonstration method, inquiry method and problem solving among others have been employed by science teachers but there still the needs to t direct these strategies towards meeting the learning needs of Convergent and Divergent learners at the Junior Secondary School two (JSS II) Basic Science students to achieve better performance.

Consequently, from the foregoing, if students are left unchecked and the same poor result continues to refuse, the Nigeria's dream of technological buoyancy and subsequent development would be a mirage. It's in the light of the above situational problems that this study attempts to Analyses Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Zaria Education-Zone, Kaduna State, Nigeria.

1.3 Objective of the study

The study has the following objectives to:

i. Find out the effect of Socratic Questioning Technique on Academic Performance of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concept.

ii. Examine the effect of Socratic Questioning Technique on Academic Performance of Male and Female Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concept.

iii. Find out the effect of Socratic Questioning Technique on Academic Performance of Rural and Urban Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concept.

iv. Examine the effect of Socratic Questioning Technique on Academic Performance of Rural and Urban Convergent and Divergent Male and Female Upper Basic Science Students taught Environmental Hazard Concept.

v. Find out the effect of Socratic Questioning Technique on Academic Performance of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concept within the Experimental Group.

1.4 Research Questions

The following questions were formulated to guide the study:

i. What is the difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

ii. What is the difference between the mean Academic Performance scores of Male and Female Convergent and Divergent Upper Basic Science Students taught Environmental

Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

iii. What is the difference between the mean Academic Performance scores of Rural and Urban Convergent and Divergent Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

iv. What is the difference between the mean Academic performance scores of Rural and Urban Convergent and Divergent Male and Female Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

v. What is the difference between the mean Academic performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique?

1.5 Null Hypotheses

The following null hypotheses are set to be tested at $P \leq 0.05$ level of significance:

HO1: There is no significant difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method.

HO2: There is no significant difference between the mean Academic Performance scores of Male and Female Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method.

H03: There is no significant difference between the mean Academic Performance scores of Rural and Urban Convergent and Divergent Upper Basic Science Students taught

Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method.

HO4: There is no significant difference between the mean Academic Performance scores of Rural and Urban Convergent and Divergent Upper Basic Science Male and Female Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same concept using traditional lecture method.

HO5: There is no significant difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique within the Experimental group.

1.6 Significance of the Study

The findings from this research work will tremendous help in the following ways:

Basic Science Teachers: The Teachers will benefit since the study will help them to understand the appropriate methods of teaching to be employed in carrying out their duties.

Basic Science Students: The Students will be able to identify the effective technique influence, thereby making them cooperative for better performance in Environmental hazard concept.

Curriculum Planners: Curriculum Planners will take cognizance of the impact of Socratic Questioning Technique effectiveness hence enacting ways which will ensure that the lesson has been effective.

Administrators: Administrators will be able to see the extent to which the effectiveness of Socratic Questioning Technique can influence the student's confidence and their performance there by encouraging them to put in more effort.

Professional bodies: Professional bodies such as STAN and MAN among others can be able to see the level at which Socratic Technique improved the Performance of upper basic science student. There by supporting the use of the technique in basic science classes.

Researcher: researcher formulates new knowledge to existing literature in Basic Science.

1.7 Scope of the Study

This study focused on the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive style Zaria -Education Zone, Kaduna State, Nigeria.

The study will be carry out on JSSII Rural and Urban Upper Basic Science Students in Public schools in Zaria Education Zone and the schools are: GSS K/Kuyan Bana, GSS T/Jukun, and JSS Dakace and GSS Yakassai. The reason for the selection of JSSII students is that they are midway through the program to write their JSCE examination and the student are finding it difficult when encountered during the Examination. The following topics will be drawn from the Basic Science concept (Environmental Hazard):

i. Soil erosion
ii. Bush burning
iii. Desertification
iv. Flooding
v. Deforestation
vi. Depletion of ozone layer

The topics are used because of the dwindling performance of Upper Basic Science Students as only few Students had passed credit level (A, B or C), (D & E) with the majority having the lowest grades of fail (F) as indicated by Kaduna North Zonal Education office (2018).

Therefore, the statistics of Basic Science Students Performances in Junior Secondary School Certificate Examination in Zaria Educational Zone and Kaduna State as a whole indicate rates of over 70% failure as shown in Table 1.1.

The cognitive styles to be used in this research will be delimited to:

i. Convergent; and

ii. Divergent.

The Socratic Questioning Technique to cover are:

i. What?

ii. How?

iii. Why? And When? Among Others.

1.8 Basic Assumptions

The research is based on the assumptions that:

- Junior secondary students will be familiar with Socratic Teaching Technique and can be able to apply it on convergent and divergent students in Upper Basic Science.
- Socratic questioning technique may be an effective teaching strategy at Junior Secondary School Upper Basic Science.
- The schools to be used for the study will be Junior Secondary School representatives in Zaria Educational Zone.
- It will also assume that the Socratic questioning technique is appropriate for teaching the topic selected.
- The selected topic is appropriate for the class (JSS II) used in this study.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 Introduction

This research work attempt to Analyses of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles, Zaria Education-Zone, Kaduna State, Nigeria. This chapter revealed the work done by others as it relates to this work under the following sub headings:

2.2 Teaching Basic Science at Junior Secondary Schools.

2.3 Science Teaching Strategies.

2.4 Socratic Questioning Technique.

2.4.1 Socratic Questioning Technique and Knowledge Organization.

2.5 Academic Performance in Basic Science.

2.5.1 Academic Performance and Socratic Questioning Technique

2.6 Cognitive Style.

2.6.1 Cognitive Style and Academic Performance in Science

2.7 Cognitive Style and Socratic Questioning Technique

2.8 Overview of Similar Studies.

2.9 Implication of Literature Reviewed for the Present Study

2.2 Teaching Basic Science at Junior Secondary Schools.

A history of science teaching has its root in primary schools when Nature study, Hygiene, Agriculture and domestic science featured promptly. General science emerged in the late 30s was referred up to the Primary School Certificate and the first two years in the secondary. Science teaching took off from there and underwent several modifications from 2yrs course in the 1970s to 3yrs in 1982. By 1982 it became Integrated Science taught in the secondary

school. In 2009 the nomenclature of integrated science was changed to basic science and broken into lower (primary 1-3), middle (4-6), and Upper Basic (JSS 1-3) science covering. Basic Science is one of the subjects taught in Nigerian Junior Secondary Schools. It is a subject meant to provide a solid foundation for the Senior Secondary Science subjects like Biology, Chemistry and Physics (Gadzama, 2012). It is a subject rooted from integrated science which is developed by the Science Teachers Association of Nigeria (STAN) in the 1970's with the aim of providing an integrated approach to the teaching of science, stressing the fundamental unity of its branch disciplines. However, observations from the Basic science classrooms reveal that most teachers do not adopt instructional techniques and strategies that could stimulate students' creativity and performance (Olorukooba & Lawal, 2010). Basic Science pedagogy like in any other science subject revolves around the practical, but the theoretical teaching and rhetoric learning within the contemporary Nigerian classrooms have become obstacles in the bid to transform the knowledge of Basic Science into achievements (Banfe, 2013).

Basic science was introduced into the Nigerian Secondary School as a core subject at the junior secondary school level in 2006 (Eggari, Kukwui, Mahmuda, & Sambo, 2014). The aim of that basic science curriculum was to introduce students to the world of science and to prepare them for higher education in science and technology. Basic science is taught in all junior secondary schools in Nigeria as a course of study which is devised and presented in such a way as to enable the students gains concept of the fundamental unity of science, the commonality of approach to problem of scientific nature and help student to gain an understanding of the roles and function of science in everyday life and the world in which they live (Sambo, 2012). Basic science incorporates the study of elementary biology, anatomy, ecology, genetics, chemistry and physics into one integrated science subject and taught in the junior secondary schools in Nigeria (Omiko, 2016). It is the bedrock of advance

studies in the field of science, technology and Engineering. Therefore, Basic Science become fundamental to every science subject and to this effect, suitable technique and approach should be given to prepare learners to study science at higher level.

Basic Science has the following Characteristics:

- It's an approach to science teaching.
- It's the fundamental unity of science.
- It eliminates repetitiveness of subject boundary.
- It explains what science is and how scientist work.
- The course should be relevant to the child experience.
- It should stress the fundamental unity of science.
- Lay adequate foundation for subsequent studies.
- It should add a cultural dimension to science education.

Objectives of Teaching Basic Science at Junior Secondary School

The objectives of Basic Science aimed at enabling the child exposed to it to acquire the following skills;

- Observing thoroughly and carefully.
- Reporting completely and accurately of what he observed.
- Organizing Information acquired.
- Generalizing on the basis of acquired information.
- Predicting as a result of generalization.
- Designing experiments including control where necessary to test the hypothesis formulated.
- Continuing the process of inquiry when new data do not conform to prediction.

To this effect, the study seeks to Analyses Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education zone, Kaduna State, Nigeria.

2.3 Basic Science Teaching Methods.

Teaching is the process of impacting or transferring knowledge by the teacher to the students or vice-versa. Omosewo (2004) considers teaching method as the way of creating learning situations and making individuals think through the provision of books, equipment, materials and questions to be answered. Also, Obi (2005) express that teaching techniques are strategies employed by the teacher to improve teaching. Ajoma (2009) concluded that teaching method is the professional technique teachers adopt in their instructional exercises to enable them impart relevant knowledge and skills to their students. According to Barry (2010), teaching method comprises the principles and methods used for instruction. Teaching method, therefore, refers to the techniques or strategies employed by the teacher in order to achieve the set objective of a lesson. Method, techniques and strategies in the educational practice refer to activities that teachers engage inside of the classroom. Specifically, they are procedures and techniques that are undertaken and primarily planned by the teacher to transfer knowledge. From the definitions given, it could be concluded that the responsibility of the selection and adoption of teaching method to be used in the teaching of a subject or a particular topic rest on the shoulder of the teacher.

In selecting the method of teaching. The following should be put into consideration;

- Students age, their previous knowledge and general ability.
- The method should be suitable to the topic to be taught.
- Basic science teacher should select the method he/she can handle effectively.
- The time of the day the lesson will take place should be considered for selecting appropriate teaching method.

- The size of the class in relation to student's population should be highly considered.
- Availability of the resources at the teacher's disposal is important guide in selecting appropriate teaching method.

Commonly used teaching methods may include class participation, hands-on activities, Guided discovery method, demonstration, problem-solving, fieldtrip, lecture, hands-on activities, discussion method, play way method and cooperative strategy among others.

i. **Hands-on activity based Method;** this instructional method is meant to facilitate learner's active participation in the learning process. It facilitates the learning of new skills, knowledge acquisition and gaining of experience through active participation of learners in the process of knowledge acquisition. Hands-on activity is meant to facilitate learner's active participation in the learning process. Many research findings have shown that this type of activity-based instructional strategy is very effective for teaching (Epstein, 2007).

ii. **Guided Discovery Method;** this is a method of enquiry in which the teacher provides explanatory materials for students and guide them to study on their own. It helps students to acquire skills that are exceptionally their own because it originates from their own (Omwirhireh, 2002). According to Akinbobola (2008), guided-discovery method is child-centered strategy in which teachers are facilitators of learning.

iii. **Demonstration Method:** this method of teaching simply refers to a situation where the teacher exhibit/present or display emotion to impact or transfer knowledge and students watch over him/her. Demonstration teaching method is a useful teaching strategy because it improves students' understanding and retention McKee, Williamson and Ruebush (2007). However, the time available to perform this demonstration is very limited in a classroom setting. Therefore, a demonstration often designed to allow students to make observations rather than through hands-on

laboratory (McKee, Williamson, and Ruebush, 2007). It is also referred to as teacher-centred method of teaching. Aliyu (2000) considered Teacher-demonstration method as a method of teaching whereby all new subject matter is presented and explained by the teacher before it is studies from the textbook by the class. It's of different types; *Teachers Demonstration*; where the teacher participated most in the work. *Students Demonstration;* where the students participated most in the work. And *Teacher-Students Demonstration;* where both the teacher and the students participated in the work collectively.

iv. **Project Method:** This method is a teacher-facilitated collaborative approach in which students acquire and apply knowledge and skills to define and solve realistic problems (Howell, 2003). According to Ajoma (2009) project method is a student-centre-method of teaching and learning in which learners are allowed a great deal of involvement right from the beginning to the end of the project. The use of the project method of teaching can help students to be innovative, thoughtful and creative, since they are fully engaged in the learning process. Howell and Mordini (2003) claimed that the project method of teaching serves the interest of the students best by utilizing problem - solving to encourage critical thinking, progressing through the steps of investigation, planning, testing, evaluating, and improving during their project work.

v. **Lecture Method:** Lecture method is often used to deliver a large amount of information to the students in a short period (Berry, 2008). This method is known to be effective in dealing with a large class. However, it could also be used for a small class. Research indicates that this method dominates most of the tertiary institutions (Deslauriers, Schelew and Wieman, 2011). Lecture method of instruction is the usual classroom "chalk-talk" method where a teacher does most of the talking while the learners are passive listeners (Ezumezuh, 2017). According to Shaibu (2017), lecture

method is teacher-cantered with little or no participation of students in the instructional process. The lecture method deprives the learner the opportunity to participate fully on the learning process.

According to Aggarwal (2005), method of teaching should aim at the following objectives:

i. They should aim at developing interest for the work.
ii. They should develop the capacity for clear thinking, they should aim at inculcating the desire to do work with the highest maximum of efficiency which one is capable of.
iii. They should provide adequate opportunities for participation in freely accepted projects and activities in which cooperation and discipline are constantly in demand.
iv. They should expand the student‘s interest. This can be achieved by providing in the time table, at least one free period every day in which students pursue their favorite hobbies and creative activities individually or in groups, preferably under the guidance of some interested teachers.
v. They should aim at providing opportunities to pupils to apply practically the knowledge and skill acquired by them.
vi. They should aim at the quickening of interest and training in efficient techniques of learning and study.

However, the teacher needs to have a good understanding of the several methods of teaching available in presenting his lessons to students, according to Mohammed (2002) the following should be taken into consideration:

- nature of subject matter to be taught and the objective to be attained,
- Availability of Time,
- Population of the student’s,
- Availability of the instructional material,
- interest and abilities of the teacher, and

- Effectiveness of methods.

Based on the above premise, the study aimed to investigate into Socratic Technique as determinant of Academic Performance and Cognitive Style among Upper Basic Science students, Zaria Educational Zone, Kaduna State Nigeria.

2.3 Socratic Questioning Technique.

Socratic Questioning Technique, named after the classical Greek philosopher Socrates, is a form of inquiry and discussion between individuals, by asking and answering questions to stimulate critical thinking and to illustrate ideas. It is a logical method, often involving a discussion in which the defense of one point of view is questioned; one participant may lead another to contradict himself in some way, thus strengthening the inquirer's own point (Gose, 2009). In the Socratic Technique, according to Reich (2003), there are no lectures and no need of rote memorization. But neither, as you might in the Socratic Technique, the classroom experience is a shared conversation (dialogue) between teacher and students in which both are responsible for pushing the dialogue forward through questioning. The teacher of the dialogue, asks probing questions in an effort to expose the values and beliefs which frame and support the thoughts and statements of the participants in the inquiry. The students ask questions as well. Socrates believed that there were different kinds of knowledge, important and trivial or unimportant such as cognitive, affective among others. He acknowledges that most of us know many "trivial" things. He states that the expert possesses important knowledge, the practice of his craft, but this is important only to himself, the craftsman. But this is not the important knowledge that Socrates is referring to. The most important of all knowledge is "how best to live." He posits that this is not easily answered, and most people live in shameful ignorance regarding matters of ethics and morals. (Brickhouse, 2000).

Through his method of powerfully questioning his students, he seeks to guide them to discover the subject matter rather than simply telling them what they need to know. The goals of education are to know what you can; and, even more importantly, to know what you do not know. The Socratic Teaching Technique involves open ended, higher level questions designed to extract from (elicit) discussion, debate and analysis. The Socratic teaching Technique works well in discussing values and ideas. The Socratic Technique is teaching by questions. It helps the student through the following;

- Develop powers of understanding and communication.
- It promotes better self-images.
- It motivates students to learn.
- Its high expectations help students to grow through the knowledge that somebody believes in them.

The Socratic Questioning Technique encourages active participation. It requires the students to critically evaluate their own beliefs. It requires them to articulate reasoned concepts behind their beliefs. Socrates believed that teachers should not lecture. They should tap into the knowledge that lies deep within everyone. It tries to help students discover answers for themselves and promote or facilitate discussion rather than provide answers. Socrates makes the claim there are two very different sort of knowledge. One is ordinary knowledge; this is of very specific (and ordinary) information (Brickhouse, 2000). They claim that to have such knowledge does not give the possessor of said knowledge and expertise or wisdom worth mentioning. The higher could possibly be described as definitional knowledge; Socrates is extremely interested in defining words and concepts. He accepts the pursuit of definitional knowledge as a priority to philosophical discussion. (Brickhouse, 2000) dedicate much of their thought to this concept of belief. Definitional knowledge is also divided into two levels; Higher-level questions and Lower level questions.

Higher Level Question: this ask how would you do this? What is the relationship between behaviorism and what you will be teaching in a classroom? Ask, "Why"? Higher-level questions seek deeper thought. They require the students to listen carefully, analyses, and to think critically. Higher-level questions seek the big ideas and the big picture. Higher-level questions ask the student to demonstrate what they know and how much they understand. Students are required to articulate ideas. Socratic questions require the teacher to focus in on the big ideas, which are worth teaching. (Selma & Wasserman in Adamu, 2018) in the other hand, Lower level questions seek details.

The Importance of Knowledge Organization

Learning is a process with multiple steps. Students first need to overcome obstacles posed by their preconceptions (thinking ahead or prejudice) in order to fully absorb new information. After they absorb the new information, there comes another task the students need to perform in order to integrate the new information into their existing knowledge (knowledge organization). In some cases, especially when the students have major conceptual misconceptions or misunderstanding, they have to make ever greater modification and reorganization of their knowledge system to integrate the new information. Because of the impact on students' learning efficiency and capacity, having a well-organized knowledge structure is crucial to learners and is the route from novice to expertise.

There are other reasons why having a well-organized body of knowledge is important. A very good analogy has been offered by Frederick Reif (2008) where he compares a body of knowledge to a cabinet with folders: if you have an unorganized cabinet with multiple folders, the information in your folder will be *available*; however, they will not be easily *accessible*. This is arguably the most important reason for having a good knowledge organization, in Reif's own words, "poorly organized knowledge cannot readily be remembered or used". Additionally, as the amount of information one needs to handle

increases and one's body of knowledge expands, knowledge organization will have great impact in the selective knowledge retrieval the process or recalling a specific piece of information. Finally, for scientists, knowledge organization is pivotal or fundamental because "the central goal of science is to predict or explain a large number of observable phenomena".

Process Concept of Socratic Questioning Technique

The Socratic Technique is a powerful tool to inspire students to take a deep interest in their own enthusiastically (excitedly) willful education and succeed in life. This helps students become more attentive and thoughtful as a matter of their natural character. A high quality and persistence of attentiveness is the most fundamental difference between merely existing and expressing the art of living (Benson, 2000). The Socratic Technique, within its influence on the structure of communication and participation, inspires people to attentively embrace and express their own original thinking and creative doing as they enthusiastically participate in the art of living an examined life. Character traits such as deep curiosity, fearless inquiry, and the unending passion to embrace a lifelong quest or search for understanding and self-improvement are a natural result of the successful use of the Socratic Method (Scott, 2000). The habits of Socratic communication are the habits of good citizenship in creative dialogue. These character traits are developed as student's experience regular exposure to teachers, classmates, parents or guardians who are able to engage a Socratic style of conversation (Brick, 2000).

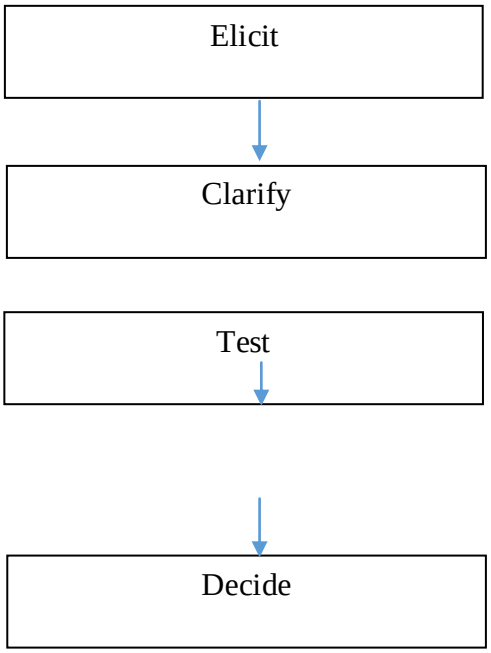
Steps in the Socratic Questioning Technique

To apply the Socratic Questioning Technique, the learners will either first begin on an inquiry or is confronted by a proposition (plan) contradictory to their preconceptions. Given that learners bring in their preconceptions as they interpret new information, questions are asked to elicit (extra) their preconceptions. As the learners become aware of their preconceptions, clarifying questions can be asked so as to reveal to learners what their preconceptions entail/

demand. After fully eliciting and clarifying learners' preconceptions, learners will construct hypotheses or propositions based on their preconceptions. These hypotheses or propositions will then be tested by further fact check, critical questions, counter-arguments, counter-examples, or check for contradiction, etc. Based on critical evaluation of the hypotheses, learners will then re-assess their opinions and decide whether to accept or reject their hypotheses, propositions, as well as preconceptions. Each step in the Socratic Teaching Technique can be characterized by different types of questions. Setting out to elicit students' preconceptions, the teacher will typically ask a question like "what do you already think at this point?" This type of questions helps to draw out students' initial opinion, which is mostly likely a product of their preconceptions. Then the teacher can clarify students' preconceptions by asking what they mean by the proposition they have offered. The teacher may ask questions such as "What do you mean by *x*? Do you really mean for *x* to apply in this or other cases?" This step aims to have students attend to their preconceptions by letting them expressing and articulating their thoughts. Next, the teacher can test students' preconceptions by asking them how the proposition or hypothesis that they have generated using their preconceptions would account for counter-arguments, counter-examples, or any new information that conflict with what they already believe. Questions that characterize this step usually start with "how" or "why": "How does *x* account for *y*? How do you know? Why should I believe that? Can that really be true given *z*?" At this point, not only the students can consciously attend to their preconceptions but also notice any incommensurability between their preconceptions and the new information. In the last step, the students will decide whether or how to modify their preconceptions given the new information. The teacher will know whether the students have integrated new information with preconceptions by inviting them to generate a new proposition or hypothesis. If the students can integrate the new information with their modified preconceptions, without ignoring and distorting the new

knowledge to maintain the consistency of their preconceptions, they are likely to have achieved some changes in their conceptual framework. If the students continue to experience difficulty in integrating the new information and modifying hypothesis, they will be encouraged to repeat the steps in the Socratic Learning Technique.

Figure 2.1: Question for each step in Socratic Questioning Technique



Adapted from; Norman (2011)

- **ELICIT:** what do you already know at this point?
- **CLARIFY:** what do you mean by x? Do you really mean for x to apply in this or other cases?
- **TEST:** how does x account for y? How do you know? Why should I believe that? Can that really be true given?
- **DECIDE:** can you come up with a new proposition given what you have just learned?

Ideally, there should be no termination point for the use of the Socratic Technique. Continuously inquiry is the heart to the Socratic Technique and there are always new information and experiences that invite us to keep "updating" what we think about life and what we know about the world.

Once the student can formulate a proposition that can withstand the test of counter arguments, misunderstanding, contradictions, etc., the student can decide whether he is willing to accept the proposition for now. Nevertheless, it is important for the student to keep in mind that no proposition should be taken for granted or accepted permanently without further examination. The student is encouraged to revisit his/her belief in face of new information.

After all, the ultimate goal for the Socratic Teaching Technique is not to help students to come up with a proposition that they can rest safely with, this would merely contribute to the creation of dogmas/principles or belief. The true goal of the Technique is to help students examine their own beliefs and new information they encounter. In frequently exercising the Socratic Teaching Technique, the students should become independent learners with curiosity and sensitivity toward new information, and gradually develop a mental habit of active inquiry and vigorous thinkingNorman (2011).

Socratic Questions and Critical Thinking.

The term, critical thinking, has a number of different meanings. In the broad sense, it refers to higher-level cognitive functions like analysis, evaluation, comparison, application and synthesis. The Socratic Teaching Technique teaches critical thinking by requiring the student to listen carefully to the question. The student must evaluate, synthesize, analyse, examine, compare, contrast and apply their own knowledge and experience in an attempt to answer the question. The Socratic Technique teaches critical thinking. A student's facts, beliefs, and assumptions will be questioned by the teacher and evaluated by the class. Students are required to articulate reasons behinds their answers and explain the basis for

their assumptions. In a philosophic sense, the focus of knowledge is shifted. Lecture implies that teachers are full of wisdom. Students are empty vessels. The teacher attempts to fill their empty heads with knowledge. In a Socratic classroom the answers lie deep within the students. The teacher's role is to, clarify, challenge and compare the student's answers with their own thinking, facts, beliefs, and assumptions. A student's thoughts and experiences are the focus, not the teacher's.

Socratic Patience and Wait Time.

The average teacher waits less than one second for an answer. Wait 3-5 seconds before calling. on someone. Wait time encourages deeper thought. It provides more time for divergent ideas to emerge. Attention and class focus are better maintained when each student is given time to reflect upon the question. Students tend to formulate an answer as if they might be called on. (Allen & Ornstein in Adamu, 2018).

Typically, teachers wait less than one second for an answer. An optimal wait time of three to five seconds promote/encourage higher cognitive thinking. The length and quality of the answers increase with time. Confidence and motivation are increased. Achievement and complex thinking are also encouraged.

Socratic Procedure.

Socratic Questioning Technique used knowledge level questions to assess ability. Such as; Who, What, Where, When and Why questions to probe deeper thoughts. Prepare the questions in advance. Arrange them in a logical sequence. Repeat the question before taking answers. Write down four or five major questions. Focus in on important questions. Other questions will emerge during the lesson. Make your questions concise, challenging, open ended, evaluative, and divergent. Seek inquiry, discussion and learning. Mix subjective and objective questions. High-level questions demand patience, clarity, timing, sequencing and phrasing. Incorrect answers should be redirected to another student. Or rephrase the

question for the same student. Get the students to clarify their answers. Follow-up yes/no questions with opening ended questions like why. The teaching cycle includes directing, redirecting, probing, structuring, focusing attention, soliciting and eliciting responses. Reacting to responses, modifying and clarifying responses. Positive reactions like, "Good, Correct, That's True," should be used. It's based on this premise that the study seeks to find the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Zaria-Education zone, Kaduna State, Nigeria.

2.5 Academic Performance in Basic Science

Academic performance as observed by Shaibu (2017) is the exhibition of knowledge attained or skills developed by a student in a subject designed by test scores assigned by teachers. It is influenced by a number of factors such as instructional materials available, class size, qualification and experience of science teachers, teaching strategies employed among others (Salisu, 2016). A number of research work was conducted on Academic Performance in Basic Science. According to Adamu (2018) there are number of factors that influences Academic Performance in Basic Science. (Olorukooba & Lawal, 2010) mentioned that one of such factors is the teacher's method of teaching. Various Teaching-learning strategies have been developed to accelerate learning process of student but Basic Science Teachers often put limitations upon themselves and their students by adhering to lecture method of teaching (Cheema & Mirza, 2013). A research Conducted by Olayiwola (2014) showed that many Basic Science Teachers failed to utilize student cantered teaching strategy that will boost the performance of the Basic Science Student. A research conducted by Akpan (2018) in Uyo state shows that the Academic Performance in Basic Science from 2010 -2016 were dropping as a result of poor teaching method used when teaching the subject.

However, Dogara (2018) revealed that STS approach enhance the academic Performance in Basic Science. Olorukooba and Lawal (2010) also affirmed from their findings that the

Academic Performance in Basic Science was enhanced using STS approach. In the same vein, finding from Zarewa (2018) shows that Academic Performance in Basic Science was very effective using guided-discovery method of teaching.

2.5.1 Academic Performance and Socratic Questioning Technique

Academic performance as observed by Shaibu (2017) is the exhibition of knowledge attained or skills developed by a student in a subject designed by test scores assigned by teachers. It is influenced by a number of factors such as instructional materials available, class size, qualification and experience of science teachers, teaching strategies employed among others (Salisu, 2016). A number of research work was conducted on Academic Performance in Basic Science. According to Adamu (2018) there are number of factors that influences Academic Performance in Basic Science. (Olorukooba & Lawal, 2010) mentioned that one of such factors is the teacher's method of teaching. Various Teaching-learning strategies have been developed to accelerate learning process of student but Basic Science Teachers often put limitations upon themselves and their students by adhering to lecture method of teaching (Cheema & Mirza, 2013). A research Conducted by Olayiwola (2014) showed that many Basic Science Teachers failed to utilize student cantered teaching strategy that will boost the performance of the Basic Science Student. A research conducted by Akpan (2018) in Uyo state shows that the Academic Performance in Basic Science from 2010 -2016 were dropping as a result of poor teaching method used when teaching the subject.

The Socratic Questioning technique is an effective way to explore ideas in depth. It can be used at all levels and is a helpful tool for all teachers. It can be used at different points within a unit or project. By using Socratic Questioning, teachers promote independent thinking in their students and give them ownership of what they are learning. Higher-level thinking skills are present while students think, discuss, debate, evaluate, and analyse content through their

own thinking and the thinking of those around them. These types of questions may take some practice on both the teacher and students' part since it may be a whole new approach.

The academic performance was really influenced by Socratic questioning technique in many researches. Including Hadassa (2015) on arts students Performance, research by Eniola (2015) on financial accounting students' performance. And a research by Al-Darwish (2012) on teaching English using Socratic Method influenced student's academic performance among others. It's based on the above tenet that the study seeks to find out the Effect of Socratic Questioning technique on Academic Performance of Basic Science Students of Different Cognitive Styles in Zaria Education-Zone, Kaduna State, Nigeria.

2.6 Concept of Cognitive Style

Cognitive styles are psychological constructs which describes individual's mode of information perception, organization and representation (Moore, 1991: Adamu 2018). Development studies by psychologists indicate that children learn at different rates and through different methods and modalities. People gather and evaluate information in their environment in different ways. In other words, different people have their personal preferences as to how they approach any problem with which they are confronted or faced. In most situations, one can discern a consistent pattern, that is, a general strategy which is the characteristic of the individual concerned in the solution of a problem. These consistencies in the individual modes of functioning in a variety of behavior situations are what are referred to as cognitive styles. The term cognitive style is a hypothetical construct that has been developed by psychologists to explain the process of mediation between stimuli and responses. Yusuf (2002) defined cognitive styles in terms of consistent patterns of organizing and processing information. He further defined the term as the stable individual preferences in mode of perceptual organization and conceptual categorization of the external

environment. In the same vein, Herod (2004) stated that learning styles may be thought of as the way in which people:

i. take in information,

ii. select certain information for processing,

iii. use meanings, values, skills problems,

iv. make decisions, and create new meanings,

v. Change any or all of the processes or structures described in this list.

Barry (2010) explained that over the last twenty years, the field of cognitive identified a lot about how people learn. A central principle that has been generally accepted is that everything we learn, we "construct" for ourselves. That is, any outside agent is essentially powerless to have a direct effect on what we learn. If our brain does not do it, that is, take in information, look for connections, interpret and make sense of it, no force will have any effect. This does not mean that the effort has to be expressly voluntary and conscious on our parts. Our brains take-in information and operate continuously on many kinds of levels, only some of which are consciously directed. But, conscious or not, the important thing to understand is that it is our brains that are doing the learning, and that this process is only indirectly related to the teacher and the teaching. Given these definitions, we may say that cognitive refers to the strategies, which the brain uses to actively se1ect, attend to, organize, perceive, encode, store, and retrieve information. It is relatively a consistent pattern which the individual uses to solve problem. Therefore, towards effective teaching and learning, we need to be aware of learning styles to avoid mismatches in style between instructors and learners. When we teach using our own preferred style, not all of our students will have the identical style. Inevitably, learning will be diminished for some. Secondly, we need to assist our students to identify their learning styles in order that they may build confidence and more effectively manage their own learning. Thirdly, our own preferred learning style can

influence our approach to planning, implementing and evaluating instruction, it is equally important for us to be conscious of our style. We need to become informed about alternate styles, and strengthen our ability to work in these styles in order to develop instructions for students with a broad range of styles. Knowledge of cognitive styles enables teachers to understand those qualities that determine and characterize learners 'preferred approach to problem-solving. It also enables teachers to take appropriate measure to teach the learners to adopt a preferred learning style that can enhance class learning.

Types of Cognitive Style

Different scholars in psychology uses different learning style categories. According to Lazear (1991: Adamu, 2018) multiple intelligence theory maintains that there are at least seven learning styles: intelligences, interpersonal, intrapersonal, auditory and kinaesthetic learner musical/rhythmic and visual learner. Classification of cognitive style include:

i. convergence and divergence
ii. reflexivity and impulsivity
iii. holists and serialist
iv. Field dependent and field independent. among others

Convergence is concerned with the focusing on the best or most appropriate solution to a problem. It deals with producing a particular well-defined response under specific directions. The convergent is masculine, introverted, authoritarian and unemotional. Divergence, on the other hand, is concerned with the search for a variety of ideas or solutions; he seems to actively enjoy the expression of his personal feeling; the divergent is feminine, humorous and extroverted.

Reflective individual considers all the possible alternative responses to a given question before he acts; he is confident and composed; he persists longer in difficult task. Impulsive child acts quickly without weighing alternative, not being a good listener, is easily confused

by changes in routine. Therefore, his responses are often incorrect. Yusuf (2002) distinguished between those who are good at seeing things as parts a whole (holists) and those who are good at stringing sub-problems in sequences (serialist).

In other words, the holist‘s learning style is the ability to receive the entire stimulus situation first before paying attention to the details, while the aerialist’s learning style is the ability to perceive the inter-relationship between the various elements, of the entire stimulus without necessarily having the ability to reproduce or recall the entire stimulus. Thus, while the holist takes broad look at a problem or perceives it as a whole, the serialist perceives the problem as comprising a string of sub problems which has to be tackled sequentially. The contrast between the two learning styles can be clearly seen when studying new material. The holist would prefer to get a general idea about the problem area by skipping over the whole field before embarking on details, whereas the serialist prefers to pursue several lines or detail before trying to form a picture of the whole problem. The holist learner scores high on reasoning tests, adopts a broad perspective and looks for interrelationships. On the other hand, the serialist scores low on reasoning tests, adopts a narrow focus of attention and learns step by step. (Duff, 1998: Adamu, 2018) has identified different agenda among the advocates of learning style measurement. One of such agenda is matching an individual’s learning style preference to specific learning activities in order to improve learning outcomes, but also to counteract weaknesses in an individual‘s learning style. This is done to deal with educational tension, including mismatching, which may stretch learners educationally. Vaughan and Baker (2001) agreed that matching may lead to learners becoming bored. Much has been written and there is a long-standing debate on the relationship between teaching and learning styles and their impact on students ‘performance. Ford and Chen (2001) noted that numerous studies suggested that learning in matched conditions may, in certain contexts, be significantly more effective than learning in mismatched conditions. However, Zhang (2006)

consented that the literature on teacher/student style match/mismatch contains somewhat ambiguous findings. This is because while some arguing the benefits of the match, others contend that the effect of matching is insignificant.

Despite the argument for match/mismatch of students Cognitive Styles to specific learning activities, it will be necessary for teachers to be conversant with students' different learning styles. Each individual has a unique combination of the six learning styles mentioned above. It then, becomes critical for teachers to study and know their students so as to be able to help them through the appropriate use of teaching methods that will enhance learning, as students learn through various methods and modalities. It's based on this premise that the study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Zaria-Education zone, Kaduna State, Nigeria.

2.6.1 Cognitive Style and Academic Performance in Science

Cognitive style has been used by researchers to investigate how individuals process information and make choices in learning in Science. Cognitive style can be viewed as an individual preferred and habitual approach to organizing and representing information (Chen and Macreadie, 2002). Cognitive styles, like reasoning ability, has been extensively studied over many disciplines (Davis, 2006). Cognitive style has been reported to be one of the significant factors that may impact students' Performance on various school subject Cakan (2000). In a research study, Dwyer and Moore (1995: Musya, 2015) investigated the effect of cognitive style on performance with 179 students who enrolled in an introductory education course at two universities in the United States. They found the field independent learners to be superior to field dependent learners on tests measuring different educational objectives. In experiments that attempt to flesh out differences in performance between field independent (FI) and field dependent (FD) individuals, it has been found that FI learners, when faced with

a limited amount of unambiguous task relevant information, will frequently outperform their FD learner peers (Rollock, 1992: Adamu, 2018). In fact, Davis and Cochran (1989 in Adamu, 2018) indicate that research generally shows that field independent students, reflect higher levels of performance than field dependent students do.

Muhammad (2001) pointed that students with field- independent cognitive style has higher academic performance than students with field- dependent cognitive style. The processing mode and other personal characteristics related to cognitive style seem to be conditioning the interaction between the subjects' performance as learners and educational contextual factors, predictably conforming stable and consistent patterns of behavior associated to teaching-learning situation; they could be affective, cognitive and/or meta-cognitive types of patterns. An explanatory model of academic performance was suggested, taking into account cognitive style and learning strategies, and it was confirmed through path analysis, supporting that planning strategies could act as a moderating variable in the influence of cognitive style on academic Performance (Musya, 2015). In addition, the differential tendency to plan own learning, seems to reflect in academic performance, acting as moderator on the influence of cognitive style on academic success or failure. It has been suggested that confidence in the internal references which characterizes field independent subjects is more in harmony with meta-cognitive functioning: this could lead to an earlier and more efficient development of metacognitive abilities (Boutin & Chinien, 1992; Musya 2015). If this is the case, specific training in planning strategies from primary education levels should be regarded as an immediate step in attending learning diversity due to cognitive style in academic contexts. It's based on this premise, the study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education zone, Kaduna State, Nigeria.

2.7Cognitive Style and Socratic Questioning Technique

Cognitive style arises from the fact that individual differences exist as a result of differences in the psychological functioning of person, including the selection and recall of information from memory (Daniel, 2002) Study of cognitive styles has become a broad stream in cognitive psychology and mathematics education. Individuals display their own personal cognitive styles which is a major attribute in what makes an individual to respond to various situations (Anastasi, 1996: Musya 2015). Cognitive style is a term used to describe the way individuals perceive, think and remember information (Lusweti, Kwena & Mondo, 2018). Douglass (2003) found that as many as nineteen (19) different ways of describing cognitive styles have been identified over the years, all of which consist of bipolar distinctions of thinking and thought processing styles. Some of these distinctions are:

i. The Convergent - Divergent construct by Guilford (1956)
ii. The Reflective – Impulsive cognitive style by Kagan, Rosman, Day, Albert, and Philips (1964)
iii. The Holist – Serialist theory by Pask (1976)
iv. The Adaption – Innovation theory by Kirton (1976)
v. The Ornstein's (1973) Hemispherical Lateralization Concept
vi. The Field Dependence–Field Independence model by Witkin, Oltman, Raskin, and Karp (1971)
vii. The Wholist- Analytic and Verbal –Imagery model by Riding and Cheema (1991).

Cognitive styles are the psychological differences between how people obtain information. They are defined as the indicators of how students perceive, interact with, and respond to different learning environments (Sankar & Raju, 2011). By understanding which cognitive styles an individual ascribes to, he or she can better prepare studying and learning methods to help them obtain the greatest amount of information. While each cognitive style is different, no one is better than any other (Sternbarg & Li-fang, 2005). People all learn differently and

understanding how each individual learns best will give that individual the best chance of success. The importance of understanding cognitive style impacting academic success is a large reason it's studied so often. Hence this study focuses Convergent–Divergent cognitive dimension.

The Socratic approach to questioning is based on the practice of disciplined, thoughtful dialogue. Socrates, the early Greek philosopher/teacher, believed that disciplined practice of thoughtful questioning enabled the student to examine ideas logically and to determine the validity of those ideas.In this technique, the teacher professes ignorance of the topic in order to engage in dialogue with the students. With this "acting dumb," the student develops the fullest possible knowledge about the topic. The Socratic Questioning technique is an effective way to explore ideas in depth. It can be used at all levels and is a helpful tool for all teachers. It can be used at different points within a unit or project. By using Socratic Questioning, teachers promote independent thinking in their students nd give them ownership of what they are learning. Higher-level thinking skills are present while students think, discuss, debate, evaluate, and analyze content through their own thinking and the thinking of those around them. These types of questions may take some practice on both the teacher and students' part since it may be a whole new approach.

2.8 Overview of Similar Studies.

In response to the concern of the need to improve the scientific skills, the following empirical studies were overviewed:

Agbowuro (2019), shed light on the effect of Socratic Questioning teaching strategy on the achievementsof public secondary school's biology students in Langtan north, plateau state, Nigeria on the concept of habitat.The design of the study was a Quasi Experimental, specifically the pre-test post-test control group design. There are 14 public secondary schools in Langtang north with a population of 2740 students. Two schools were randomly

sampled. One was randomly assigned to the experimental group and the other to the control group. They were used as intact groups. The sample was made up of 96 students, (50 males and 46 females). Four research questions were answered while six hypotheses were tested at 0.05 level of significance. The instrument used for data collection was a 30-item test. The instrument was validated and its reliability established at 0.84. The data collected was analyzed using mean, standard deviation and the t-test. Findings indicated that the Socratic teaching had significant effect on the students' performance. The use of the Socratic teaching strategy was recommended. Based on this tenet, the present study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Zaria-Education Zone, Kaduna State, Nigeria.

Hadassa (2015) conducted a research on the effects of Socratic Method on student's art performance in secondary schools in Kaduna Metropolis Nigeria. The specific objectives are to find out students' performance when exposed to Socratic Method, determine if male students will perform better than female students when exposed to the Socratic Method, and determine if Socratic Method would have any effect on students' performance in fine arts in both private and public schools. The study was a quasi-experimental design where pre-test and post-test control and experimental group was used. Forty (40) fine arts students (boys and girls) from four selected secondary schools were involved in the study. Simple random sampling was used to select the students. The instrument used for the study was a self-designed Art Appreciation Test (AAT) consisted of twenty (20) multiple choice items which was administered personally by the researcher for the collection of data. Obtained data was analyzed in frequency and percentage. The major findings obtained revealed that students perform better in fine art when taught using Socratic Method as compared to the conventional method. Female students are better in fine art performance when taught using Socratic Method. Private schools perform better than public schools when taught using Socratic

Method. Based on the findings from the study, it was concluded that Students perform better in art when taught using Socratic Method as compared to conventional method. To this effect, the present study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Eniola (2015) also conducted a research on the influence of Socratic and Interactive methods of teaching Financial Accounting on performance of Secondary School Students in Katsina Metropolis, Nigeria. Four objectives and four research questions with four related null hypotheses were formulated. The study was delimited to the use of two teaching methods, and SS11 students both male and female from eight public Senior Secondary Schools covering the four inspectorate division in Katsina State. Works of other researchers relevant to the study were reviewed under eight sub-headings. The research design adopted was quasi experiment design. The population for the study comprises of 1077 SS11 students for 2014/2015 Academic Session. Purposive Sampling Technique was used in the selection of the schools for the experiment, while Hat and Drawn Technique was used for the selection of samples. Percentage was used in analyzing the bio-data of the respondents. Mean and standard deviation were used to answer the four research questions. Independent t-test was used to test null hypotheses one, two and three and Analysis of Variance (ANOVA) and Post Hoc Multiple Comparison Test were used to test hypothesis four, all null hypotheses were tested at 0.05 level of significance. The findings revealed, among others, that there was significant difference in the performances of secondary school students' taught Financial Accounting using Socratic Method and those taught using conventional lecture method. It was concluded, that one of the most effective method of teaching financial accounting to achieve students' academic performance in secondary schools is the interactive method. The present study intended to find out the Effect of Socratic Questioning Technique on Academic

Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Al-Darwish (2012) sheds light on teaching English through two ways of questioning (Socratic & Traditional) methods in Kuwait elementary public schools. Data were collected through a qualitative observational method. The study engaged 15 female participants, seven of whom were newly graduate English language teachers with experience in how Socratic questioning works, while the other eight teachers had 10 years' experience in teaching English as a foreign language. The study revealed that some new and experienced teachers encouraged their students to go further and explore beyond the topic of today's lesson. However, others used the deductive approach by stating questions and expecting certain answers because they did not comprehend or had lack of time. Furthermore, the present study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Keith and Wren (n.d) sketch a theory of creativity which centers on the framing of activity by repetitive thinking and action, and sees creativity as divergences from these routines which is thereby framed against them. Without a repetitive frame creativity is impossible. Mere repetition is not creative, even if new. Creativity disrupts a frame, purposefully. Socratic Dialogue is an ancient technique of engaging a student in a dialogue by asking non-leading questions, aimed at revealing to the student how much knowledge he or she already has on some topic: Socrates' demonstration to the slave-boy (and the audience) that the boy already knows geometry (without any schooling) is the founding example. They aim to illustrate that internalizing the Socratic kind of reflective self-questioning and co-questioning is intimately related to the view of creativity as the reframing of routine. Therefore, they have qualitatively analyzed primary and secondary school pilots in Greece, Austria and the United Kingdom. The illustrations of facilitated Socratic Dialogues with children and young people have been

derived from the analysis of 14 Socratic Dialogues involving a total number of 97 students. They outline the Socratic Dialogue as a method of both researching and teaching creative thinking, and it reveals that the Socratic Method dovetails with this conception of co-creativity. As a research method, Socratic Dialogue aims to elicit information concerning reasoning processes and shared experiences. As a teaching method, Socratic Dialogue aims to get students to internalize the public methodology of Socratic Dialogue, and to adopt it across the range of domains they meet. In the same tenant, the present study intended to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Cassandra (2017) study aim was to examine the effects of teacher-led and student-led Socratic discussion on reading comprehension scores of eighth grade students. The sample consisted of 11 females and 12 males who were enrolled in a Title I public school in East Tennessee. Data were collected using Easy CBM reading comprehension assessments. The tests were administered twice. The first test was administered after students engaged in teacher-led Socratic discussions; the second test was administered after students engaged in student-led Socratic discussions. The data were analyzed using a paired samples t-test. The results indicated that there was no significant difference between students' reading comprehension scores after engaging in teacher-led and student-led Socratic discussions ((22) =1.271. P>0.05). Two independent t-tests were also conducted in order to determine whether there was a difference between males and females' scores after engaging in the respective Socratic discussions. The results indicated that there was not a significant difference between males and females after teacher-led Socratic discussions (t (21) = 0.578, p>0.05). Likewise, the results for the third research question indicated that there was not a significant difference between males and females after student-led Socratic discussion (t (16) =1.77, p>0.05). To this effect, the present study seeks to find out the Effect of Socratic Questioning Technique

on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

In the same vain, Ali Abdi (2014) conducted a researchto investigate the effects of inquiry-based learning method on students' academic achievement in sciences lesson. A total of 40 fifth grade students from two different classes were involved in the study. They were selected through purposive sampling method. The group which was assigned as experimental group was instructed through inquiry-based learning method whereas the other group was traditionally instructed. This experimental study lasted eight weeks. To determine the effectiveness of inquiry-based learning method over traditional instruction, an achievement test about sciences which consisted of 30 items was administered as pre-test and post-test to students both in the experimental and control groups. For the statistical analysis, Analysis of Covariance (ANCOVA) was used. The results showed that students who were instructed through inquiry-based learning were achieved higher score than the ones which were instructed through the traditional method. It's based on this premise that this study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Sara, Maruta and Olarinoye (2016) conducted a research on the relationships between cognitive styles, and achievement in science process skill among senior secondary school biology students in Jigawa State. Three objectives of the study and three hypotheses were stated. Correlation survey was employed as the design for the study. Two instruments were used for data collection. Group embedded figure test (GEFT) and the biology Science process skills achievement test (BSPSAT). 216 students selected by proportionate random sampling were used as subjects for the study. The findings revealed that, cognitive styles of field dependence, field-independence and field Neutral were significantly related to achievement

in science process skills. The study recommends that; efforts should be made to improved secondary school's student's cognition by teachers employing variety of learning content presentation methods. The present study intends to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Finn, (n.d) Investigate the impact schools have on both academic performance and cognitive skills. They related standardized achievement test scores to measures of cognitive skills in a large sample (N=1,367) of 8th-grade students attending traditional, exam, and charter public schools. Test scores and gains in test scores over time correlated with measures of cognitive skills. Despite wide variation in test scores across schools, differences in cognitive skills across schools were negligible after controlling for 4th-grade test scores. Random offers of enrolment to over-subscribed charter schools resulted in positive impacts of such school attendance on math achievement, but had no impact on cognitive skills. These findings suggest that schools that improve standardized achievement tests do so primarily through channels other than cognitive skills. The present study aimed to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Musya (2015) study was based on cognitive styles and academic achievement among secondary school learners in Kenya. The purpose of the study was to find out the extent to which students‟ cognitive styles influence their academic performance in chemistry. The study applied a quantitative research approach, descriptive in nature. The following objectives were addressed: To determine the cognitive styles of students, to determine the differences in students‟ cognitive styles among boys and girls to find out the relationship between the students‟ cognitive styles and their academic achievement in chemistry to address these objectives, 200 form three students taking chemistry responded to

questionnaires. The questionnaires contained three sections: personal information of the students, performance in chemistry and field independence/dependence questionnaire. Sampling was done using stratified and systematic random sampling. Two processes of data arose: One process on performance in chemistry from section B and the other one from section C on students‟ cognitive styles. The data collected was subjected to data analysis using statistical package for social sciences (SPSS). The analysis involved computation of the means of scores in chemistry tests and the standard deviations for the scores. The correlation coefficients were computed using the Pearson Product Moment Correlational Analysis. The results show that both Field independent and Field dependent cognitive styles are evident among the secondary school students. The results also show that more male students were found to be field dependent while more female students were field independent and that field independent individuals scored higher than field dependent individuals. According to the research results the study show that cognitive styles could have significant influence on students‟ academic achievement in chemistry and that there could be a difference in the type of cognitive style between boys and girls. Depending on the cognitive style one has, this could have an influence on academic achievement in a particular discipline. However, there is need for further research with a large sample and various types of learners as well as various disciplines to make a conclusive conclusion on cognitive styles and academic performance. In the same vain, the present study intends to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Sherma (2015) study the influence of Cognitive Style, Achievement in Science and their Interaction on Scientific Creativity of secondary school students. Total 205 students of classes IX and X (mean age 14.8 Years) studying in schools affiliated to Central Board of Secondary Education were taken as sample. Standardized tools, namely, Group Embedded

Figures Test were used to collect data. Marks of students from school records were taken as a measure of their achievement in science. The data were analyzed using 2 × 3 Analysis of Variance. Field Independent Students had significantly higher Scientific Creativity than Field Dependent Students. Also, Students with High Achievement in Science had significantly higher scientific creativity than students with Low Achievement in Science. In the same tenant, the present study intends to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Zaria-Education Zone, Kaduna State, Nigeria.

Zainudeen and Ali (2013) sees Cognitive styles are the area of education psychology research, getting more and more importance, due to advancement of learning technologies that assure individualized learning in line to students' individual cognitive styles, but irrespective of this; there are many issues related to existing models of cognitive styles. There review surfaced some key issues about development and nature of cognitive style models. Although the empirical evidence in individual research efforts about cognitive styles indicate their potential significance and role in helping students in their learning journey but certain key issues; narrows its application in the field. The revealed repetition of the styles in models and difficulties in practicability; can be visualized. The present study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Muhammad (2018), conducted a research on the effects of Collateral Learning on Gender Attitude in Genetics among Convergent and Divergent Secondary Schools Students of Suleja, Niger State Nigeria. The population of the study covered all the eight (8) Senior Secondary Schools (SSSII) those offering Biology in Suleja metropolis with population of two thousand two hundred and sixty-three (2263) Students. 52 convergent (29 males and 23 female) while 41 Divergent (28 male and 13 female) respectively. The study comprised of two objectives

with the corresponding research question and null hypotheses. One validated instrument namely; Genetic Concept Attitude Questionnaire (GCAQ) was used for data collection with a reliability coefficient of 0.71 using Spear Rank Order Correlation (SROC). To this effect, the present study intends to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

Ahmadzade and Shojae (2013) study purports to examine the association between cognitive style (field dependence/independence) and academic achievement in male and female students of Behbahan Islamic Azad University. With regard to objectives, the research is applied and in terms of data gathering, it is correlational. The population of the study consists of 7500 students entering this university in 2010-2011 academic years. The sample used in the project consists of 1009 students selected by means of cluster sampling. The latent patterns test developed by Vikin et al. was used to measure cognitive style (field dependence/independence). In this research, criterion validity coefficient was 82% for men and 63% for women. Test-retest method was utilized to measure the reliability of the latent patterns test which was .82 for both men and women. In order to describe the sample, descriptive statistics were used and in order to answer the research questions, inferential statistics, such as Pearson correlation coefficient, independent samples t-test, one-way ANOVA, and Scheffe post hoc test were run. The findings of this research project showed that there is a significant positive relationship between male and female students' field dependence and field independence and their academic achievement. In addition, regression analysis revealed that cognitive style is a significant predictor of academic achievement. Finally, it was found that girls outperform boys as regards to academic achievement. The present study aims to find out the Effect of find out the Effect of Socratic Questioning

Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Zaria-Education Zone, Kaduna State, Nigeria.

Finally, Syed and Naqvi (2006) prompted that student performance in intermediate examination is associated with students' profile consisted of his attitude towards attendance in classes, time allocation for studies, parents' level of income, mother's age and mother's education. The research is based on student profile developed on the bases of information and data collected through survey from students of a group of private colleges. Public sector educational institutions are not the focus of the study. But the present study intends to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

2.9 Implication of Literature Reviewed for the present Study.

From the review of the empirical study above, the reviewed studies have similarities as well as differences with the present study.

The reviewed study of Agbowuro (2019) was conducted on the Effects of Socratic Questioning Teaching Strategy on the achievement of public Secondary Schools Biology Students in Langtan North, Plateau State, Nigeria.The relationship of the study to the present study is that the study was able to accommodate some of the variables in the present study 'Socratic Method and Academic Performance. The study was also conducted on the Biology students and the case study was Lantang North of Plateau State. To this effect the present study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

the study reviewed of Hadassa (2015) was conducted on the effects of Socratic Method on student ‘s art performance only. The study tried to find out whether Socratic Method has any effect on Academic Performance. The relationship of the study to the present study is that the study was able to accommodate some of the variables in the present study ‘Socratic Method and Academic Performance’ and fail to capture ‘Cognitive Styles’. The study was also conducted on the Arts students alone. To this effect the present study seeks to find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

The reviewed study of Ali Abdi (2014) was conducted to investigate the effects of inquiry-based learning method on students’ academic achievement in sciences lesson. The study was carried out in Iran but the present study was carried out in Nigeria. The study intended to see whether Academic Performance is affected by Inquiry based learning teaching strategy. The study also failed to cover Socratic Technique and Cognitive Style. Therefore, best on this tenant, the present research aimed at find out the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Zaria-Education Zone, Kaduna State, Nigeria.

Similarly, the study of Eniola (2015) was conducted on the influence of Socratic and Interactive methods of teaching Financial Accounting on performance of Secondary School Students in Katsina Metropolis, Nigeria. The study was carried out to see whether two Teaching Strategy: ‘Socratic method and Interactive method’ influences student’s performances in financial accounting. Whereas, the present study was conducted on the use of Socratic Questioning Technique on Academic performance and cognitive style among upper basic science student in Zaria Educational Zone. Kaduna State, Nigeria.

Furthermore, Ahmadzade and Shojae (2013) study purports to examine the association between cognitive style (field dependence/independence) and academic achievement in male

and female students. The cognitive styles used in the study was field dependence and field independence, the study also tried to correlate cognitive style and Academic performance. Whereas the present study intends to find out the effect of Socratic Questioning Technique and Academic Performance of Convergent and divergent male and Female Basic Science Students, in Zaria Educational Zone Kaduna State, Nigeria.

Finally, Muhammad (2018), conducted a research on the effects of Collateral Learning on Gender Attitude in Genetics among Convergent and Divergent Secondary Schools Students of Suleja, Niger State Nigeria. The study was restricted to Biology Students alone. But the present study aimed at finding the Effect of Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Styles in Zaria-Education Zone, Kaduna State, Nigeria.

It's based on this premise that the search for improved strategies for teaching and learning science in order to stem the tide of students under performance is a continuous process. It is on the light of the above that this study considered it necessary that students and teachers in the learning process should be involved in activities where the perceived Socratic Questioning Technique are considered.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

The Study Analyses Socratic Questioning Technique on Academic Performance of Basic Science Students of different Cognitive Style in Zaria-Education Zone, Kaduna State, Nigeria.

This chapter is presented under the following sub-headings:

3.2 Research design

3.3 Population of the study

3.4 Sample and sampling techniques

3.5 Instrumentation

3.5.1 Validity of the Instrument

3.5.2 Pilot Testing

3.5.3 Reliability of the Instruments

3.5.4 Item Analysis

3.6 Administration of the Treatment

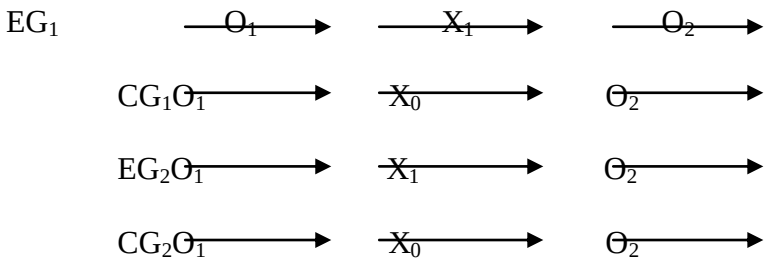
3.7 Data Collection Procedure

3. 8 Procedure for Data Analysis

3.2 Research design

The study employed Pretest Post-test Quasi Experimental control group design. The study involved experimental group taught using Socratic Questioning Technique and a control group taught using Traditional Lecture Method. Both the Experimental and the Control groups consist of Male and Female students. The groups were pretested (O_1) on their Academic Performance before the administration of treatment to ensure their equivalence. The two groups were taught the concept of Environmental Hazards for a period six (6) weeks.

The Experimental group were taught the concept of Environmental Hazard using Socratic Questioning Technique while the Control group were taught the same concept using Traditional Lecture Method (X_0). Posttest (O_2) were administered after treatment to determine the effect Socratic Questioning Technique and Traditional Lecture Method on students' Academic Performance in Environmental Hazard Concepts. The research design is presented in the figure 3.1



KEYS:

EG_1 = Experimental Group one

CG_1 = Control Group one

EG_2 = Experimental Group two

CG_2 = Control Group two

O_1 = Pretest

O_2 = Posttest

X_1 = Treatment

X_0 = No treatment

3.3 Population of the Study

The population of the study comprises all the coeducational public junior secondary schools (JSS II) in Zaria Educational Zone, Kaduna State, Nigeria. There are 37 junior secondary schools in Zaria Educational Zone; 34 are Day schools, 2 Boarding schools and 1 Day/Boarding school. Among the 37 junior secondary schools, 28 were coeducational

schools. But for the purpose of this study, only coeducational schools among the population were used. The total number of the population is 18,508 in both male, female and coeducational schools in the zone. 9601 were male and 8907 were female respectively. To accommodate gender variable, coeducational schools will be used in the research. Table 3.1 represent the breakdown of the population of the study.

Table 3.1: Population of the Study

S/N	Name of School	Type of School	Number of Students Enrolment		
			Males	Females	Total
1.	Alhudahuda College	Male	700	-	700
2.	Barewa College	Male	314	-	314
3.	Govt. Comm. College	Co-education	92	46	138
4.	GSS Awai	Co-education	84	41	125
5.	GSS Gyallesu	Co-education	232	225	457
6.	GSS Likoro	Co-education	205	115	320
7.	GGSS K/Gayan	Co-education	-	1515	1515
8.	GGSS Chindit Jnr	Co-education	483	390	873
9.	GSS K/Jatau	Co-education	332	497	829
10.	GGSS Pada Jnr	Female	-	850	850
11.	GJSS Aba	Co-education	78	22	100
12.	GJSS Gimba	Co-education	135	104	239
13.	GJSS Mangi	Co-education	17	8	25
14.	GSS T/Saibu Jnr	Co-education	270	85	355
15.	GSS Richifa	Co-education	140	25	165
16.	GGSS (WTC) Zaria	Female	-	256	256
17.	GSS T/Wada	Co-education	407	502	909
18.	GSS Magajiya Jnr	Co-education	198	145	343
19.	GGSS D/Bauchi Jnr	Female	-	704	704
20	GSS Muchia Jnr	Coeducation	433	316	749
21.	SIASSS K/Karau	Coeducation	99	19	118
22.	SSS Kufena	Male	233	-	233
23.	GSS Kugu	Co-education	303	135	438
24.	GSS Yakasai	Co-education	90	34	124
25.	GSS K/Kuyanbana	Co-education	312	199	511
26.	GSS Dakace	Coeducation	324	206	530
27.	GSS Zaria Jnr	Male	583	-	583
28.	GSS Bogari	Coeducation	209	49	258
29.	GJSS Chikaji	Coeducation	453	300	753
30.	GJSS R/Doko	Coeducation	694	294	990
31.	SIASSS K/Karau B	Coeducation	401	422	623
32.	GSS K/Doka	Coeducation	696	294	990
33.	GSS Aminu Jnr	Coeducation	400	250	450
34.	GSS T/Jukun	Coeducation	425	607	1032
35.	GSS Dinya	Coeducation	161	34	195

36.	GSS Matari	Coeducation	72	8	80
37.	GJSS Kinkiba	Coeducation	211	36	247
Total			**9601**	**8907**	**18508**

Source: Ministry of Education, Kaduna State, Zaria Zonal Education Office, (2018)

3.4 Sample and Sampling Technique

Purposive and Simple Random Sampling Techniques were used in the study. There are eighteen thousand five hundred and eight students in Junior secondary School Two (JSS II) in Zaria Educational Zone (18,508). Due to gender involvement in the study, coeducational schools were purposely selected from the population. Schools from Rural and Urban were also purposely separated. four schools from each of the Rural and Urban were randomly selected in the zone for participation, the selected schools were; GSS T/Jukun, GSS Pada, GSS K/Kuyanbana and GSS K/Doka from the urban areas while GSS Yakasai, GSS Dinya, GSS Richifa and GSS Dakace were the selected schools from the rural areas. A general Basic Science Performance Test (BSPT) was administered to JSS II Basic Science Students in each of the eight school selected from rural and urban areas to determine their equivalence in terms of Academic Performance. This was achieved by subjecting the students' scores to Analysis of Variance (ANOVA) and Scheffes post hoc test. ANOVA was used to determine the existence of any significant difference in the selected schools while the Scheffes Post Hoc test was used to separate the schools and determine which schools were significantly or not significantly different. GSS T/Jukun and GSS K/Kuyanbana from the rural while GSS Dakace and GSS Yakasai from the urban were found to be relatively similar statistically. The status of the schools was then determined by simple random sampling. As a result of this exercise, GSS K/Kuyanbana became the experimental school and GSS T/Jukun became the control group from the rural area while GSS Dakace became the experimental school and GSS Yakassai became the control group from the urban areas. The total number of Female participants from the four (4) selected schools in Rural and Urban areas was one hundred and seventy-six (176) and the total number of Male participants from the four selected schools

from Rural and Urban was one hundred and twenty-one (121). The total number of the convergent students from rural and urban areas was one hundred and thirty-two (132) while the total number of the divergent students are one hundred and sixty-five (165) both male and female. The total number of both Male and Female participants in the study was two hundred and ninety-seven (297) and this is in consensus with Usman (2010) who noted that the sample of two hundred and ninety-seven (297) was in line with Central Limit Theorem (CLT) which recommended the use of minimum of 30 sample size in a given population. The experimental groups were also labelled "School A and C" while the control groups were labelled "School B and D" respectively. Because of the large number of students in the sample schools, one Arm was purposively used from each of the selected school respectively. Table 3.2 represent the sample for the study.

Table 3.2: Sample of the Study

S/n	School Name	Group	Location	No. of JSSII Students Enrolment		Total
				Male	**Female**	
1	School A	Experimental	Rural	26	37	63
2	School B	Control	Rural	21	29	50
3	School C	Experimental	Urban	42	60	102
4	School D	Control	Urban	32	50	82
Total				**121**	**176297**	

Source: Zaria Education Zonal Office, Kaduna State (2018)

3.5 Instrumentation

Basic Science Performance Test (BSPT) and Alternative Uses Test (AUT) were adopted as the instruments for the study;

Basic Science Performance Test (BSPT)

BSPT Consist of 50 multiple choice items with four options (A-D). Three among them are distracters while the other one is the correct option, it will be developed by the researcher to determine the Academic Performance of Students in Basic Science. The instrument was developed from six topics of Basic Science. That is; Soil Erosion, Deforestation, Desertification, Bush burning, Flooding, and Depletion of Ozone Layer. Table 3.3 represents the details of BSPT.

Table 3.3: Item Specification of BSPT based on Bloom Taxonomy

	Topic	**Weight**	**Know(28%)**	**Comp(20%)**	**App(1 6%)**	**Anal(1 2%)**	**Syn(1 2%)**	**Eva(12 %)**	**Total**
1	Soil Erosion	17%	2 (1)	1 (4)	1 (5)	1 (6)	1 (7)	1 (8)	7
2	Flooding	16%	1 (9)	1 (11,12)	1 (13)	1 (14)	1 (15)	1 (16)	6
3	Bush burning	16%	1 (19)	1 (20)	1 (22)	1 (23)	1 (24)	1 (25)	6
4	Deforestation	17%	2 (26,27)	1 (28)	1 (30)	1 (31)	1 (32)	1 (33)	7
5	Desertification	17%	2 (34)	1 (37)	1 (38)	1 (39)	1 (40)	1 (41)	7
6	Depletion of Ozone Layer	17%	2 (42,43, 44)	1 (45)	1 (47)	1 (48)	1 (49)	1 (50)	7
	Total	**100**	**10**	**6**	**6**	**6**	**6**	**6**	**40**

Source: Researcher (2018)

Keys

Know - Knowledge

Comp - Comprehension

App - Application

Anal - Analysis

Syn - Synthesis

Eva - Evaluation

Alternative Uses Test (AUT)

The Alternative Uses Test (AUT) was adopted from Kudrowitz (2012), which is a medium of identifying Convergent/Divergent thinking capabilities,. AUT requires subjects to list obvious uses for a common object. Participants will be subjected to different items to identify their uses in a specific time. By doing so, a lot of ideas will be generated by the participants who are divergent while the convergent will go directly to the original idea.

3.5.1 Validity of the Instrument

Basic Science Performance Test (BSPT) and Alternative Uses Test was adapted by the researcher and validated by the panel of Science Educators and Psychologists. Five experts comprising Professors, Doctors in the Department of Science Education, Ahmadu Bello University, Zaria; two Basic Science Teachers with minimum of B.Sc. (Ed) Integrated Science and 10 years teaching experiences each and one Professor in the Department of Educational psychology, guidance and counselling, Ahmadu Bello University, Zaria. They are to:

- Check the clarity of the statement
- Check whether the time allocated to the instrument was sufficient.
- Check the Content of the test item if it's appropriate to the objectives of the study
- Verify if the language used is at the same level with the ability level of the participants of the study.

There comments, correction, suggestion and recommendation regarding the face and content validity of the test item were noted and helped in producing the final version of the Instrument.

3.5.2 Pilot Testing

The Instruments were pilot-tested in order to determine its reliability. It was carried out on JSSII students that are part of the population but not in the sample of the study. The purpose of the pilot testing was to clarify the reliability of the instrument as well as its feasibility.

Government Secondary School (GSS) Mangi was the school used for the pilot testing with the total number of 40 students. The school is part of the population but not in the sample of the study. This is done using the test-retest method for an interval of two weeks between the first and the second administration as recommended by Tukman (1975) and Sambo (2008). The statistical tool used to test the reliability of BSPT is Pearson Product Moment-Correlation Coefficient (PPMC). In the same vain, Alternative Uses Test (AUT) was used to identify the convergent and divergent students (Kudrowitz, 2012) for the study.

3.5.3 Reliability of the Instruments

The indices of reliability give an indication of the extent to which a particular measurement is consistent and reproducible, Lakpini (2006). The reliability coefficient of a test is the consistency with which the test repeatedly measures what it supposed to measure.

Reliability of BSPT and AUT

Based on the analysis using Pearson Product-Moment Correlation Coefficient (PPMC) statistics, the reliability coefficient for the BSPT and AUT was found to be $r = 0.79$ and $r = 0.81$.

3.5.4 Item Analysis

Item analysis of BSPT was determined by the result of the pilot test conducted. The analysis was based on the Item Difficulty and Discrimination indices.

FACILITY INDICES (FI) OR DIFFICULTY INDICES (DI)

Facility Indices (FI) or Difficulty indices (DI) describe the level of difficulty of a test. It's a measure of percentage of candidate who got the item right divided by the total number of candidate attempted the item. It's used to separate good item and bad item. However, each item must be relevant to the course content and neither too easy nor too difficult. The item was analyzed to determine the facility index (FI) of a test item. Facility Index of a test item is determined by the formula;

$$FI = \frac{R}{T} \times 100\%$$

Where

FI = Facility Index, R = Number of item answered correctly, T = Total number of items answered by the students tested the item.

Items with facility indices of between 0.30 and 0.80 were recommended and considered by Usman (2000) and Lakpini (2006), as adequate for selecting good test items for achievement test. In this study therefore, the items with facility indices in the range of 0.30 to 0.80 were used for the study. Items with values between 0.029 were dropped because they were found to be too difficult while items with values of 0.80 and above were also dropped because they were found to be too simple.

DISCRIMINATION INDICES (DI)

Discrimination indices is the measure of the extent to which a test item discriminate between high ability and low ability students (Mustapha & Yunusa, 2013). It's the capacity of the test to discriminate been high and low achievers among students in the sample. When item shows positive Discrimination Index, it implies that large proportion of some students got the item right. While negative Discrimination Index indicates that the Students got the item wrong.

Discrimination Index is determined by the formula:

$$DI = \frac{RU - RL}{\frac{1}{2}(T)}$$

Where;

DI = Discrimination Index, RU = Number of candidates among Upper group that got the item correctly, RL = Number of candidates among lower group that responded to the item correctly, T=number of items respondents in each group.

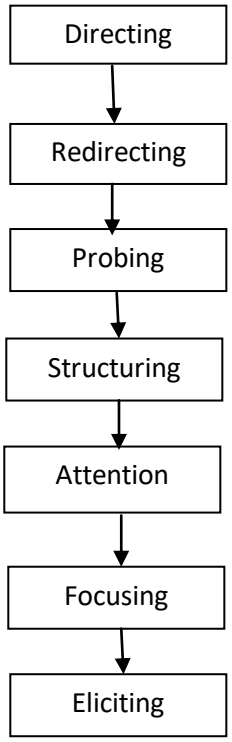
Usman (2008) opined that Items in test with discrimination indices between 0.30 to 0.49 were considered moderately positive while those with 0.70 are highly positive, therefore, discrimination indices with 0.30 to 0.70 obtained for the items in the study will be retained.

Items with 0.29 will be rejected because of its difficulty. While items with 0.30 – 0.70 will be considered in the study as recommended by Usman (2008).

3.6 Administration of Treatment

The study Participants were exposed to Socratic Questioning Technique such as: How? What? When? Where? And Why? Among others to assess their ability. The teaching cycle include the following:

Figure 3.2: Steps of Socratic Questioning Technique



Adapted from; Norman (2011)

The questions were made Concise, Challenging, Open minded and Evaluative. Wait time of 3-4 seconds was given to the subjects. Because the Technique demands: Patience, Clarity, Sequencing and Phrasing. Incorrect answer was directed to another student or rephrase for the same individual. Positive reaction including; good, correct, well done among others was given to every response from the participants in an attempt to answer questions.

3.7 Data Collection Procedure

An introductory letter was collected from the Department of Science Education and Zaria Education Zonal Office which introduces the researcher to the authorities of the sampled schools and pilot testing school. The researcher administered the Instrument Basic Science Performance Test (BSPT) and Alternative Uses Test (AUT). The participants were instructed to identify the correct option provided. The students were given 45 minutes for the test based on the pilot study conditions as suggested by Usman (2000). The student's response was scored and recorded for the analysis. Furthermore, Alternative Uses Test (AUT) was also presented to identify the Convergent/ Divergent students. The participants were instructed to give the uses of a given item in a fixed time. The student response was also scored and recorded for analysis.

3.8 Procedure for Data Analysis

Statistical Package for Social Sciences (SPSS) IBM version 2.0 was used to analyses the data collected. Mean and Standard Deviation statistics were used to answer the research questions. The null hypotheses was answered at $P \leq 0.05$ level of significance to establish the predictive level of Socratic Questioning Technique on Convergent and Divergent Upper Basic Science Students.

Research Questions

The following questions were formulated to guide the study:

i. What is the difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

ii. What is the difference between the mean Academic Performance scores of Male and Female Convergent and Divergent Upper Basic Science Students taught

Environmental Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

iii. What is the difference between the mean Academic Performance scores of Rural and Urban Convergent and Divergent Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

iv. What is the difference between the mean Academic performance scores of Rural and Urban Convergent and Divergent Male and Female Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

v. What is the difference between the mean Academic performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique?

Null Hypotheses

The following hypothesis are set to be tested at $P \leq 0.05$ level of significance:

HO1: There is no significant difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method.

Null hypothesis one was tested using One-Way Analysis of variance (ANOVA) statistical tool

HO2: There is no significant difference between the mean Academic Performance scores of Male and Female Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method.

Null hypothesis Two was tested using Analysis of Covariance (ANCOVA) statistical tool

H03: There is no significant difference between the mean Academic Performance scores of Rural and Urban Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method.

Null hypothesis three was tested using Analysis of Covariance (ANCOVA) statistical tool

HO4: There is no significant difference between the mean Academic Performance scores of Rural and Urban Convergent and Divergent Upper Basic Science Male and Female Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same concept using traditional lecture method.

Null hypothesis four was tested using Analysis of Covariance (ANCOVA) statistical tool

HO5: There is no significant difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique within the Experimental group.

Null hypothesis five was tested using independent t-test statistical tool

CHAPTER FOUR

ANALYSIS, RESULTS AND DISCUSSIONS

4.1 Introduction

This study seeks to Analyses Socratic Questioning Technique on Academic Performance of Upper Basic Science Students of different Cognitive style in Zaria Education-Zone, Kaduna State, Nigeria. The data collected were analyzed using Statistical Package for Social Science (SPSS) andthe level of significance adopted for rejecting or retaining the stated hypotheses were set at $P \leq 0.05$. This chapter is presented under the following sub-headings: "Bio data, Results, Research Questions, Null hypotheses, Summary of findings and Discussions".

4.2 Bio Data of Respondents

The bio data shows the distribution of Groups, Gender, Location and Cognitive Styles in the study. Table 4.2 represents the Bio Data Distribution of the Respondents.

'**Table 4.2:** Bio Data Distribution of Respondents

Distribution		**Frequency**	**Percentage**
Group	Experimental	165	55.6
	Control	132	44.4
Gender	Male	121	40.7
	Female	176	59.3
Location	Rural	184	62.0
	Urban	113	38.0
Cognitive Style	Convergent	132	44.4
	Divergent	165	55.6

Table 4.2 shows the frequency and the percentage of the Groups, Gender, Location and Cognitive Styles of the respondents.

4.3 Answering Research Question

The research questions were answered using descriptive statistics of mean and standard deviation.

4.3.1 Research Question one

What is the difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

To answer this research question, data from the Basic Science Performance Test (BSPT) were subjected to Descriptive statistics of mean and standard deviationand the summary of the result is presented in Table 4.3.1

Table 4.3.1: Mean Performance of Convergent and Divergent Students between the Experimental and Control Groups in Environmental Hazard.

Group	Cog Style	N	Mean	Std. Deviation	M.D
Experimental	Convergent	75	39.6	2.92	
Control		57	31.0	3.81	0.89
Experimental	Divergent	90	45.5	4.36	
Control		75	33.0	4.55	0.91

From the descriptive statistics in table 4.3.1, among the Experimental group the mean score for students in the convergent group was 39.6, while the mean scorefor their counterpart in the control group was 31.4 with the mean difference of 0.89 in favor of the experimental group. In the same vein, among the experimental group the mean score for students in the divergent group was 45.5 while the mean score for their counterpart in the control group was 33.0867 with mean difference of 0.91 in favor of the experimental group respectively.

4.3.2 Research Question Two

What is the difference between the mean Academic Performance scores of Male and Female Convergent and Divergent Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

To answer this research question, data from the Basic Science Performance Test (BSPT) were subjected to Descriptive statistics of mean and standard deviation and the summary of the result is presented in Table 4.3.2

Table 4.3.2:Mean Performanceof Gender and Cognitive Style between the Experimentaland ControlGroups in Environmental Hazard.

Gender	Group	Cognitive style	N	Mean	Std. Deviation	M.D
	Experimental	Convergent	45	40.0	2.11	
		Divergent	52	45.3	4.33	2.22
Female	Control	Convergent	35	31.8	3.83	
		Divergent	44	33.2	3.67	0.16
Male	Experimental	Convergent	30	39.0	3.79	
		Divergent	38	45.8	4.42	0.64
	Control	Convergent	22	29.7	3.43	
		Divergent	31	32.9	5.63	2.19

From the descriptive statistics in table 4.3.2, among the Experimental group the mean score for female students inconvergent and divergent group was40.0 and 45.3 with mean-difference of 2.22 in favor of the divergent students. While the mean score for their counterpart in the control group was 31.8857 and 33.2 with the mean-difference of 0.16 in favor of the divergent students. In the same vein, among the experimental group the mean score formale students in the convergent and divergent group was 39.0 and 45.8 with the mean-difference of 0.64 in favor of the divergent student. While the mean score for their counterpart in the control group was 29.7 and 32.9 with the mean- difference of 2.19 in favor of the divergent respectively.

4.3.3 Research Question Three

What is the difference between the mean Academic Performance scores of Rural and Urban Convergent and Divergent Upper Basic Science Students taught Environmental Hazard

concept using Socratic Questioning Technique and those taught the same concept using Traditional Lecture Method?

To answerthis research question, data from the Basic Science Performance Test (BSPT) were subjected to Descriptive statistics of mean and standard deviation and the summary of the result is presented in Table 4.2.3

Table 4.3.3: Mean Performance of Location and Cognitive stylebetween the Experimental and Control Groups in Environmental Hazard.

Location	Group	Cognitive style	N	Mean	Std. Deviation	M.D
	Experimental	Convergent	50	40.2	3.04	
		Divergent	52	46.5	4.56	1.52
Rural	Control	Convergent	32	31.3	3.06	
		Divergent	50	34.2	4.05	0.99
Urban	Experimental	Convergent	25	38.3	2.16	
		Divergent	38	44.1	3.69	1.53
	Control	Convergent	25	30.7	4.63	
		Divergent	25	30.7	4.63	0.00

From the descriptive statistics in table 4.3.3, among the Experimental Group the mean score for rural student's in the convergent and divergent group was 40.2 and 46.5with mean-difference of 1.52 in favor of divergent. While the mean score for their counterpart in the Control Group was 31.3 and 34.2 with mean-difference of 0.99 in favor of divergent students. In the same vein, among the experimental group the mean score for urban students in the convergent and divergent group was 38.3 and 44.1 with mean-difference of 1.53 in favor of the divergent students. While the mean score for their counterpart in the control group was 30.7and 30.7 with mean-difference of 0.00 respectively.

4.3.4 Research Question Four

What is the difference between the mean Academic performance scores of Rural and Urban Convergent and Divergent Male and Female Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique?

To answer this research question, data from the Basic Science Performance Test (BSPT) were subjected to Descriptive statistics of mean and standard deviation and the summary of the result is presented in table 4.3.4

Table 4.3.4: Mean Performanceof Gender, Location and Cognitive style Between the Experimental Groups in Environmental Hazard.

Location	Gender	Cognitive style	N	Mean	Std. Deviation	M.D
	Male	Convergent	20	40.0	4.08	
		Divergent	22	46.9	4.42	0.37
Rural	Female	Convergent	30	40.4	2.14	
		Divergent	30	46.2	4.71	2.57
Urban	Male	Convergent	10	37.1	2.26	
		Divergent	16	44.2	4.07	1.81
	Female	Convergent	15	39.0	1.77	
		Divergent	22	44.0	3.48	1.71

From the descriptive statistics in4.3.4, among the Experimental group the mean score for rural male students in the convergent and divergent group was 40.0 and 46.9 with mean difference of 0.37 in favor of divergent. While the mean score for rural female students in the convergent and divergent group was 40.4 and 46.2 with mean-difference of 2.57 in favor of divergent. In the same vein, the mean score for urban male students in the convergent and divergent group was 37.1 and 44.2 with mean-difference of 1.81 in favor of divergent. While

the mean score for urban female students in the convergent and divergent group was 39.0 and 44.0 with mean-difference of 1.71 in favor of divergent students respectively.

4.3.5 Research Question Five

What is the difference between the mean Academic performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard concept using Socratic Questioning Technique?

To answerthis research question, datafrom the Basic Science Performance Test (BSPT) were subjected to Descriptive statistics of mean and standard deviation and the summary of the result is presented in Table 4.3.5

Table 4.3.5: Mean PerformanceofSocratic Questioning Techniqueon Convergent and Divergent Students in the Experimental Groups in Environmental Hazard Concept.

	Cog Style	N	Mean	Std. Deviation	M.D
Mean_ACad_Performance	Convergent	75	39.6	2.91	1.44
	Divergent	90	45.5	4.35	

From the descriptive statistics in table 4.3.5, among the Experimental group the mean score for students in the convergent group was 39.6 while the mean score for students in the divergent group was 45.5 with mean-difference of 1.44 in favor of the divergent students respectively.

4.4 Hypotheses Testing

The stated null hypotheses were tested and the level of significance adopted for rejecting or retaining the stated hypotheses was set at $P \leq 0.05$ level of significance.

4.4.1 Null Hypothesis One

Null hypothesis one states that there is no significant difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught

Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method.

Table 4.4.1 and 4.4.1.1: shows the Analysis of Variance (ANOVA) and Scheffes Post Hoc test statistics on the difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional lecture method.

Table 4.4.1: Analysis of Variance (ANOVA) on the difference between mean scores of Convergent and Divergent Students in Experimental and Control group

	Sum of Squares	Df	Mean Square	p-value	Remark
Between Groups	9869.095	3	3289.698	.001	Sig
Within Groups	4667.147	293	15.929		
Total	**14536.242**	**296**			

Table 4.4.1.1: Scheffes Post Hoc Test on the difference between mean scores of Convergent and Divergent Students in Experimental and Control group

Group and Cognitive Style	N	Subset for alpha = 0.05			
		1	2	3	4
Control Convergent	57	31.0			
Control Divergent	75		33.1		
Experimental Convergent	75			39.6	
Experimental Divergent	90				45.5
Sig.		1.000	1.000	1.000	1.000

Results of the Analysis of variance (ANOVA) statistics in table 4.4.1 shows that significant difference exist between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method. Reasons being that the calculated p value of 0.001 between the group statistics is lower than the 0.05 alpha level of significance atdf 1. from table 4.4.1.1 the Scheffes Post

Hoc test shows the difference in the mean scores between the groups, thus indicating the significant difference from table 4.4.1 is in favor of the divergent students among the Experimental group.From the descriptive statistics, among the Experimental group the mean score for students in the convergent group was 39.6, while the mean score for their counterpart in the control group was 31.4 with the mean difference of 0.89 in favor of the experimental group. In the same vein, among the experimental group the mean score for students in the divergent group was 45.5 while the mean score for their counterpart in the control group was 33.1 with mean difference of 0.91 in favor of the experimental group respectively. This shows that the experimental mean scores for both convergent and divergent students is extremely higher than their counterparts in the control group. Also, among the control group the divergent students with the mean academic performance scores of 33.1also perform better than the convergent students with the mean academic performance scores of 31.0 in the control group. The difference in the control group is in favor of the divergent students also and this may be as a result of their abilities to look for a variety of ways in solving problem unlike convergent students which look for the most appropriate solution to a problem.The significance difference in the experimental group is as a result of the treatment Socratic Questioning Technique exposed to those students in the experimental group. Therefore, the null hypothesis that stated there is no significant difference between the mean Academic Performance scores of Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method is hereby rejected.

4.4.2 Null Hypothesis Two

Null hypothesis two states thatthere is no significant difference between the mean Academic Performance scores of Male and Female Convergent and Divergent Upper Basic Science

Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method.

Table 4.4.2:Represents the Analysis of Covariance (ANCOVA) statistics on the difference between the mean Academic Performance scores of Convergent and Divergent, Male and Female Upper BasicScience Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional lecture metho

Table 4.4.2:Analysis of Covariance (ANCOVA) on the difference between mean scores of Cognitive style and Gender in Experimental and Control Groups.

Source	Type III Sum of Squares	df	Mean Square	p-value	Remark
Corrected Model	9957.134[a]	7	1422.448	.000	
Intercept	385669.701	1	385669.701	.000	
GENDER	37.364	1	37.364	.126	
GROUP	7844.537	1	7844.537	.000	
COGSTYLE	1201.125	1	1201.125	.000	
GENDER * GROUP	18.361	1	18.361	.283	
GENDER * COGSTYLE	48.192	1	48.192	.082	
GROUP * COGSTYLE	248.857	1	248.857	.000	
GNDER * GROUP * COGSTYLE	.719	1		.831	N.S
Error	4579.109	289	15.845		
Total	446030.250	297			
Corrected Total	14536.242	296			

Results of the Analysis of Covariance (ANCOVA) statistics in table 4.4.2 shows that there is no significant difference between the mean Academic Performance scores of Convergent and Divergent, male and female Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method. Reasons being that the calculated p value of 0.831 in the GENDER * GROUP * COGSTYLE statistics is higher than the 0.05 alpha level of significance at df 1. From the descriptive statistics, among the Experimental group the female convergent and divergent mean scores was 40.0 and 45.3 with mean-difference of 2.22 in favor of the divergent students. While their counterpart in the control group scores were 31.8857 and 33.2 with the mean-difference of 0.16 in favor of the divergent students. In the same vein, among the experimental group the male convergent and divergent scores were 39.0 and 45.8 with the mean-difference of 0.64 in favor of the divergent student. While their counterpart in the control group mean score was 29.7 and 32.9 with the mean- difference of 2.19 in favor of the divergent respectively. This shows that the experimental scores for both convergent and divergent students is extremely higher than their counterparts in the control group. This is as a result of the treatment Socratic Questioning Technique the students were exposed to in the experimental group. Therefore, the null hypothesis that stated there is no significant difference between the mean Academic Performance scores of Male and Female Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method is hereby retained.

4.4.3 Null Hypothesis Three

Null hypothesis three states that there is no significant difference between the mean Academic Performance scores of Rural and Urban Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using Traditional Lecture method. Table 4.4.3: represents the Analysis of Covariance (ANCOVA) statistics on the difference between the mean Academic Performance scores of rural and urban Convergent and Divergent Upper Basic Science Students taught Environmental Hazard Concepts using Socratic Questioning Technique and those taught the same Concept using lecture method.

Table 4.4.3:Analysis of Covariance (ANCOVA) on the difference between mean scores of Cognitive style and Location in Experimental and Control group.

Source	Type III Sum of	df	Mean Square	p-value

Teacher	ADAMU, Abdullahi
Registration Number	P17EDSC8092
School	GSS T/jukun and GSS K/Kuyanbana
Class	JSS Two
Number of Students	One hundred and fifty-six (156)
Age	16years
Gender	Mixed
Duration	Forty (40) minutes
Date	November
Subject	Basic Science
Topic	Soil Erosion
Instructional Material	Umbrella, Floodwater, Filter Paper and Funnel.
Instructional Method	Socratic Questioning Technique
Previous Knowledge	Pollution
Behavioral Objectives	By the end of the lesson, the students should be able to: i. Define Soil Erosion ii. Identify the causes of soil erosion iii. Describe the methods of controlling soil erosion iv. Mention the practical methods of preventing erosion
Introduction	The teacher introduces the lesson by asking the students questions based on their previous lessons and also tells them what to be thought in the class.
Presentation	The teacher presents the lesson by the use of the following steps
Step I	The teacher asks the students: What is Soil Erosion?
Step II	The teacher asks the Students: What are the causes of soil erosion? How does soil erosion occur?
Step III	The Teacher asks the students: How to control soil erosion? What are the methods of controlling soil erosion and how do we use them?
Step IV	The teacher asks the students: How to prevent erosion? What are the practical method of preventing soil erosion and how do we apply them in our environment?
Pupil activities	The pupils have to engage fully in the lesson. Example

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Appendix II: Lesson plan for control group using traditional lecture method

Teacher	ADAMU, Abdullahi
RegistrationNumber	P17EDSC8092
School	GSSYakassai and GSSDakace
Class	JSSTwo
Numberof Students	Onehundredand fifty-six(156)
Age	16years
Gender	Mixed
Duration	Forty(40)minutes
Date	November
Subject	Basic Science
Topic	SoilErosion
Instructional Material	Umbrella, Floodwater,Filter Paper andFunnel.
Instructional Method	Lecture Method
Previous Knowledge	Pollution
BehavioralObjectives	Bythe end of thelesson,thestudents should be able to: i. DefineSoilErosion ii. Identifythe causes of soil erosion iii. Describethemethods ofcontrollingsoil erosion iv. Mention th e p r a c t i c a l methods o f p r e v e n t i n g erosion.
Introduction	Theteacherintroducesthelessonby askingthestudents questionsbase ontheirpreviouslessonsandalsototell them what to bethoughtin the class.
Presentation	Theteacherpresentsthelessonbytheuseofthefollowing steps
StepI	The teacherdefines soil erosion:Soilerosionisthewearingawayofsurfacesoilby natural or artificial agents.

StepII	Theteachermentionthecauses of soil erosionas follows: a) Bush burning b) Farming c) Road construction d) Buildingof houses.Etc.
StepIII	The Teachertell the studentshow tocontrolsoilerosion.As follows: a) Plantingof tress orgrasses b) Terracing c) Cover crops d) Mulching e) Strip cropping
StepIV	Theteachermentions the ways of preventingerosion practically? as follows: a) Usingsand bags b) Usingshort piecesgmelinaplant
Evaluation	Theteacherevaluates thelesson by: Askingthepupilsquestionbasedonwhathetaughtthem. As follows: i. What is SoilErosion? ii. Howdo weidentifythecauses of soilerosion? iii. Howtodescribethemethodsofcontrollingsoil erosion? iv. What are thepracticalmethodsofpreventingerosion?
Summary	The teachersummarizesthe lessonbasedonwhathe taught thepupils. Example: soil erosion is thewearing awayofsurfacesoil.Soilerosioncanbecontrolled by plantingtrees or grasses, makingridges across the bridge.Etc

Conclusion	Theteacherconcludesthelessonby giving thepupilsclassworkandhomeworkbasedonwhathe taught them. Example: i. DefineSoilErosion ii. Identifythe causes of soil erosion iii. Describethemethods ofcontrollingsoil erosion iv. Mention the p r a c t i c a l methods of preventing erosion

Lesson	Lesson Two
Topic	Flooding
Instructional Material	Shovels, hoes, water, bucket
Instructional Method	Lecture Method
Previous Knowledge	Soilerosion
BehavioralObjectives	Bythe end of thelesson,the students should be able to: i. Defineflooding ii. Statethe causes offlooding iii. Describehow floodingcan beprevented iv. Identifythe effects of flooding
Introduction	Theteacherintroducesthelesson by theaskingthe student'squestionsbasedontheirpreviouslessonandalso to tellthem what to betaught in the class.
Presentation	Theteacherpresentsthelessonbytheuseofthefollowing steps:
StepI	The teacher definesflooding.As follows: floodingisthecoveringofapieceoflandby waterfromheavyrainfallorfromnearbyriverorfromsea.
StepII	Theteachermentions thecoursesof flooding.As follows: i. Rain water ii. Seawater iii. Flood caused byriver
StepIII	Theteachertells thestudentshowtopreventflooding. As follows: i. Construction ofdam ii. Construction ofriver orsea embankment iii. Clearingofgutters
Step IV	Theteacherthe effects of flooding inthe environment.As follows: i. Changein habitat ii. Destruction of crops iii. Loss of lives

Evaluation	Theteacherevaluates thelesson by: Askingthe students questions based onwhathetaught them in the class. As follows: i. What isflooding? ii. What are the causes of flooding? iii. How flooding can beprevented? iv. What are the effect of flooding?
Summary	Theteacher summarizesthe lesson based on what he taught thestudents. Example: floodingis the coveringof pieceoflandfrom heavyrainfallor from nearbyrivers or sea. Changein habitat, destruction of cropsand loss of rivers are effect of flooding.
Conclusion	Theteacherconcludes thelesson bygivingthe students classwork and homeworkbased on what hetaught them in the class. Example i. Defineflooding ii. Statethe causes offlooding iii. Describehow floodingcan beprevented iv. Identifies the effect of flooding

Lesson	Lesson Three
Topic	Bush Burning
Instructional Material	Sciencenote book, matches, fire wood
Instructional Method	Lecture Method
Previous Knowledge	Flooding
Behavioural Objectives	Bythe end of the lesson thestudents should be able to: a) Definebush burning b) Identifythe Causes of bush burning c) Mention the effect of bush burning d) Listthe agencies concerned with bush burning
Introduction	Theteacherintroduces thelessonby asking thestudents questionsbasedontheir previouslessonsandalsototell them what to betaught in the class.
Presentation	Theteacherpresentsthelessonbytheuseofthefollowing steps:
StepI	The teacher defines bushburning.As follows:bushburning isthesetting ofbushonfire intentionallyor accidentally.
SteII	The teachertell the students howbushburning occur.As follows: a) Huntersmaysetabushonfiretocausethegameto run out. b) Burningbushmay beaccidental.thestumpofa cigarettemay bethrowncarelessly insideabush. This maytrigger theburningof thebush.
StepIII	Theteachermentions theagenciesthat areconcernedwithbushburningandwhyaretheyformed. As follows: a) TheFederalEnvironmentalProtectionAgencies (FEPA) b) The National F o r e s t Conservation Council of Nigeria(NAFCON)

StepIV	The teachermentions the effects of bushburning in the environment.Asfollows: a) Exposureofthesurfaceofthegroundtopossible erosion b) Environmentalpollutionbythesmokefrombush burning c) Loss of plantation and crops.Etc.
Evaluation	Theteacherevaluates thelesson by: Askingthe students questions based on what he taught the in the class as follows: a) What isbush burning? b) What are the Causes of bush burning? c) Howdoesbush burningaffects theenvironment? d) Whataretheagenciesconcernedwithbushburning and whyaretheycreated?
Summary	The teachersummarizesthelessonbasedonwhathe taughtthestudents.Example:Bushburning isthesetting ofbushonfireintentionallyoraccidentlybyanindividual. Bushburning canaffect thewildlife,plantsaswellasthe soilfertility.
Conclusion	Theteacherconcludesthelessonby giving thestudents classworkandalsohomework basedonwhat he taught them in the class. Example: a) Definebush burning b) Identifythe Causes of bush burning c) M e n t i o n the effect of bush burning d) Listthe agencies concerned with bush burning

Lesson	LessonFour
Topic	Deforestation
InstructionalMaterial	Sciencenote book, wood, cutlass
Instructional Method	Lecture Method
Previous Knowledge	Bush burning
BehavioralObjectives	Bythe end of thelesson the students should be able to: 1. Definedeforestation 2. Listthe effects of deforestation 3. Statethe causes of deforestation
Introduction	Theteacherintroduces thelessonby asking thestudents questions based on theirprevious lesson and also to tell them what to betaughtin the class.
Presentation	Theteacherpresentsthelessonbytheuseofthefollowing steps:
StepI	Theteacherdefinedeforestation.As follows: deforestationisthecutting downoftreesforthe purposeof construction ofhouses or anyother thing.
StepII	The teacher tellsthe studentshow deforestation effects the environment.As follows: 1. Depletion of firewood 2. Loss of shade andcoolingeffect providedbytrees 3. Oxygen–carbon dioxide b a l a n c e m a y b e c o m e threatened. 4. Likelyincreasein occurrenceoferosion
StepIII	Theteachermentions thecausesof deforestation.as follows: 1. Expansion of towns and villages 2. Sitingof industries in forest locations 3. Construction ofnew roads throw forest are
Evaluation	Theteacherevaluates thelesson by: 1. Askingthestudentsquestionsbasedonwhathe taught them in the classas follows:

	i. What isdeforestation? ii. How does deforestation affect the Environment? iii. What are the causes of deforestation?
Summary	The teachersummarizesthelessonbasedonwhathe taughtthe students.Example:Deforestationisthe cutting downoftreesforthe purposeofhousing orany other means.Effectof deforestationinclude depletionof firewood,increasein occurrenceoferosion and likely destruction ofozonelayer
Conclusion	Theteacherconcludesthelessonby giving thestudents classworkandalsohomework basedonwhat he taught them in class. As follows: i. What isdeforestation? ii. How does deforestation affect the environment? iii. What are the causes of deforestation?

Lesson	LessonFive
Topic	Desertification
Instructional Material	Sciencenote book, charts
Instructional Method	Lecture Method
Previous Knowledge	Deforestation
Behavioural Objectives	Bythe end of thelesson thestudents should be able to: 1. Definedesertification 2. Mention the effects of desertification 3. Identify the geographicalzoneprone to desertificationin Nigeria 4. Describe different human practices that lead to desertification 5. Describehow to controldesertification
Introduction	Theteacherintroduces thelessonby asking thestudents questions based on theirprevious lesson and also to tell them what to betaught in the class.
Presentation	Theteacherpresentsthelessonbytheuseofthefollowing steps:
StepI	The teacher definesdesertification. as follows: desertificationisthe change of anareacovered byvegetation(plant)intoonewithscantyornovegetation.
StepII	The teacher explain how desertification affects the environment?As follows: i. Famine ii. Death of cows and otheranimals iii. decreasein soilfertility
StepIII	theteachermentions thegeographicalareas proneto desertification in Nigeria?as follows: i. sokoto ii. kano iii. katsina iv. jigawa v. borno

StepIV	theteacher explain howhuman practices lead to desertification.Asfollows: i. overgrazinginwhichcasethe grassof aparticular areaiseatencompletely by animalsmaking the land bared ii. bushburningwhichalsoexposesthesoiltowind and rainfallthat maycause erosion iii. cutting downoftreesforfirewoodandotheruses, therebymakingthe landan arid place.
StepV	Theteacher explains howandwhyto control desertification?as follows: i. regulations againstovergrazing ii. Enlighteningthepeopleoncausesofdesertification iii. Afforestationbyplanning of trees
Evaluation	The teacher evaluates thelesson by: Asking thestudentsquestionsbasedonwhathetaught them in the class as follows: i. What isdesertification? ii. How does desertification affects environment? iii. Whatarethegeographicalzoneproneto desertification in Nigeria? iv. Whatarethehumanpracticesthatleadto desertification? v. Howdo we control desertification?
Summary	The teacher summarizesthe lessonbasedonwhathe taughtthe students. Example:desertificationisthe transformationofafertilelandintoanarid landordesert. Desertificationcanoccur asa resultof absence of rainfall, overgrazingand bush burning.
Conclusion	Theteacherconcludesthelessonby giving thestudents classworkandalsohomework basedonwhathe taught them in the class as follows: i. What isdesertification? ii. Howdoesdesertificationaffect the environment? iii. What are thegeographical zoneproneto desertification in Nigeria?

	iv. Whatarethe human practices that lead to desertification? v. Howdo we control desertification?

Lesson	Lesson six
Topic	Depletion of ozonelayer
Instructional Material	Charts
Instructional Method	Lecture Method
Previous Knowledge	Desertification
Behavioural Objectives	Bythe end of thelesson the students should be able to: 1. Defineozonelayer 2. Identify where o z o n e layer is located in the atmosphere 3. Statethe importanceof theozonelayer 4. Explain the depletion of ozonelayer 5. Statethehazardsofdepletionofozonelayertolife on earth 6. List controlmeasures against depletion of the ozonelayer
Introduction	Theteacherintroduces thelessonby asking thestudents questions based on theirprevious lesson and also to tell them what to betaught in the class .
Presentation	Theteacherpresentsthelessonbytheuseofthefollowing steps:
StepI	Theteacherdefinesozonelayer.As follows:Ozone layer ispartof ouratmosphere.It'sa molecule ofthree atomsof oxygen.
StepII	The teacher explain the location ofozone layer in the atmosphere.Asfollows:theatmosphere isdividedintomany layers.Butozone layer waslocatedinthe lower stratosphere,between10kand80kmabove theground surfacewithitshighestconcentrationatabout25kmabove the ground.
StepIII	Theteacher tells the students why ozonelayeris important?Asfollows:the sungivesoutdifferentkindof energyradiation, theseincludes: i. Heat,whichkeeptheearthandallthingsonearth warm

	ii. Visiblelight,whichenableustosee,andprovide energyfor photosynthesis. iii. Ultravioletrays,whicharenotvisibletohuman being and areveryharmful.
StepIV	The teacherexplainsthe depletionof ozonelayer.Asfollows:depletionof ozone layeristhedecreaseinthethicknessofozonelayer.Ozone layerisdepletedby thereactionofchlorofluorocarbon (CFC)withozone toformchlorine monoxide (ClO) and carbondioxide (CO_2).
StepV	Theteachermentions thehazardsof ozonelayer depletion tolifeon earth? As follows: i. Cancer ii. Reducecropyield iii. kills or harm small waterplant iv. global arming
StepVI	The teachermentions the control measuresagainstdepletionoftheozonelayer.Asfollows: i. eliminationofchemicalsthatdepletetheozone layer ii. many nationshavestopped the production of chlofluorocarbon iii. Substitute chemicals that are environmentally friendly,arebeing developedandusedinplaceof those that destroytheozonelayer
Evaluation	The teacher evaluates thelesson by: Asking thestudentsquestionsbasedonwhathetaught them in the class. Example: i. what is ozonelayer? ii. Whereis ozonelayer located in the atmosphere? iii. What are the importanceof theozonelayer? iv. Howdoesozonelayer deplete? v. Whatarethehazardsassociatedwithdepletionof ozonelayer to lifeon earth? vi. Whatarethecontrolmeasuresagainstdepletionof the ozonelayer?

Summary	The teachersummarizesthelessonbasedonwhathe taughtthe studentsinthe class.As follows:ozone layer protectsliving thingsontheearthfromtheharmfulrays (ultraviolet rays)given out bythesun. Depletion ofozone layercan becontrolled by stopping production of chlofluoro carbon.
Conclusion	Theteacherconcludesthelessonby giving thestudents class work andalso home work asfollows: 1. What isozonelayer? 2. Whereis ozonelayer located in the atmosphere? 3. What are the importanceof theozonelayer? 4. Howdoesozonelayer deplete? 5. Whatarethehazardsassociatedwithdepletionof ozonelayer to lifeon earth? 6. Whatarethecontrolmeasuresagainstdepletionof the ozonelayer?

Appendix III

Alternative Uses Test (AUT)

AHMADU BELLO UNIVERSITY, ZARIA

FACULTY OF EDUCATION

DEPARTMENT OF SCIENCE EDUCATION

Alternative Uses Test (AUT)

(Convergent and Divergent dimension)

Section A: Demographic Information

School……, Class……

Age…… Gender……Time: 40minutes

Section B: Alternative Uses Test (AUT)

Instruction: Below are the diagrams of six common things or objects you see every day. Please think of as many uses you can for each objects. No need to write in sentence, only the uses. For example: Broom-sweeping.





1. **Bucket**



4. **Basket**
5. **Fire**

2. **Broom** 

3. **Cup** 



6. **knife**

Appendix IV

Marking Scheme for Alternative Uses Test (AUT)

List of Objects

1. Broom
2. Bucket
3. Basket
4. Cup
5. Fire
6. Knife

Uses of Objects

1. Broom: broom has the following uses:
    i. Sweeping our houses
    ii. Sold to get money
    iii. For cleaning wall and ceiling
    iv. For decoration
    v. For lightening fire
    vi. For sweeping offices
    vii. For removing cob waves
    viii. For sweeping our compounds
    ix. For driving flies or mosquito away
    x. To spread insecticides
2. Bucket; bucket has the following uses:
    i. For bathing
    ii. For flushing toilet
    iii. For feeding
    iv. For selling things
    v. For measurement
    vi. For washing clothes
    vii. For commercial uses
    viii. As a dustbin
    ix. To fetch water
    x. For decoration
3. Basket; basket has the following uses:

i. For fishing
ii. For carrying things
iii. For decoration
iv. For preservation
v. For commercial uses
vi. For shopping
vii. For picking harvested plants.eg; tomatoes and onion
viii. To hawking
ix. For picking tuber crops
x. As dustbin

4. Cup; cup has the following uses:
    i. For drinking water
    ii. For decoration
    iii. For drinking soft drinks
    iv. For storage
    v. For measurement
    vi. For drinking tea
    vii. For commercial uses
    viii. To feed babies
    ix. For bathing
    x. For collecting specimen
5. Fire; fire has the following uses:
    i. For warming our body
    ii. For boiling water
    iii. For cooking food
    iv. For bush burning
    v. For welding
    vi. For roasting
    vii. For burning refuse waste
    viii. For the processing charcoal
    ix. For acrobatic display
    x. For heating our rooms
6. Knife: knife has the following uses:
    i. To dissect animal

ii. For opening container
iii. To slaughter animals
iv. To cut grasses
v. For carving wood
vi. To finger nails
vii. For cutting vegetables
viii. For sporting activities
ix. Sold to get money
x. For fighting

Each question carries ½ mark. ½ x 10 = 5marks

Total =5 + 5 + 5 + 5 + 5 + 5 = 30marks

Rating scale: 0 to 14 = convergent learner

15 to 30 = Divergent learner

Appendix V

Basic Science Performance Test (BSPT)

Instruction: Answer all question by ticking ( ) the correct option

Section A: Demographic Information

School……, Class……

Age…… Gender……Time: 40minutes

Section B: Items of Basic Science Concept

1. Soil Erosion can be defined as;
    A. Process of improving soil fertility
    B. Wearing a way of surface soil
    C. Tearing of the soil components
    D. Process of digging soil
2. The following causes soil erosion except;
    A. Building of Houses
    B. Growth of towns
    C. Mulching
    D. Road Construction
3. Soil erosion can be controlled by the following except:
    A. Planting of trees
    B. Terracing
    C. Bush Burning
    D. Planting of cover crops
4. Soil erosion can be prevented before
    A. Rainfall

B. Humidity
C. Soil erosion threatens
D. Raining season

5. Which of the following is effect of soil erosion?
   A. Destruction of soil
   B. Improving soil fertility
   C. Destruction of ozone layer
   D. Improved tuber crops
6. One of the following differentiate between soil erosion and deforestation
   A. Removal or wearing a way of soil surface and cutting don of trees
   B. Planting of timber trees
   C. Cultivating crops
   D. Planting of tuber crops
7. The following describe the method of controlling soil erosion except:
   A. Cross bars
   B. Terracing
   C. Mulching
   D. Subsistent farming
8. Which of the following summarizes soil erosion?
   A. Covering of piece of land by water from heavy rainfall
   B. Wearing away of the surface soil by water or wind which can be controlled by planting trees, and strip cropping. Etc.
   C. Accumulation of sand in a particular area
   D. Volcanic eruption
9. Flooding can be defined as the
   A. Covering of piece of land by water from heavy rainfall or from nearby river or sea.
   B. Wearing away of soil surface
   C. Process of constructing Dams
   D. Percolation of water into the soil
10. One of the following is an indication of flooding
   A. Little water in the water body
   B. Overflowing of water from water bodies
   C. Water body become dried
   D. Infiltration of water into the soil

11. Flooding can occur after heavy rainfall on
    A. A well-constructed road with good drainage
    B. A well-constructed road without any drainage
    C. A road not well constructed road but with good drainage
    D. A road made of sandy soil
12. The following occur as a result of flooding except:
    A. Destruction of houses
    B. Destruction of properties
    C. Destruction of crops
    D. Increase soil fertility
13. Flooding could be due to all these except
    A. Heavy rainfall
    B. Overflowing of river or sea
    C. Sandy soil
    D. Blocked gutters
14. Flooding can be prevented due to the following except
    A. Construction of Dams
    B. Construction of river or sea embankment
    C. Cleaning of gutters
    D. Building of houses
15. The following describes the harmful effect of flooding except
    A. Change in habitat
    B. Destruction of property
    C. Increases the availability of water
    D. Loss of lives
16. Which of the following summarizes flooding?
    A. Addition of more rainfall in the water bodies
    B. Large amount of water going into the water bodies which can be absorbed by aquatic animals
    C. Covering of piece of land by water from heavy rainfall or from nearby river or sea which causes loss of lives and can be prevented by constructing dam. Etc.
    D. precipitation
17. Bush burning is the process of
    A. Planting trees in the bush

B. Setting bush on fire

C. Cutting down of trees and grasses in the bush

D. Fencing bush to avoid intruders

18. One of the following is an example of burning area

A. Dark, smoked and destroyed area in the bush

B. An area with a lot of trees planted

C. Bush area were all trees are cut down

D. Brownish area in a farmland

19. The following can be predicted as the outcome of bush burning except:

A. Destruction of wild life

B. Reduces soil fertility

C. Contribute to global warming

D. Increases soil macro nutrient

20. The following are the courses of bush burning except

A. Planting of trees

B. Stumps of smoked cigarette

C. Wind

D. Hunting of game

21. Which of these is not an effect of bush burning

A. Loss of forest reserve

B. Loss of wild live

C. Loss of property

D. Building of houses

22. The following are discovered to be the economic effect of bush burning except

A. Exposure of the surface of the ground to possible erosion

B. Environmental pollution by smoke from the bush burning

C. Loss of plantation and crops

D. Provision of oxygen to the environment

23. Identify the agency that regulates bush burning from the following:

A. The Federal Environmental Protection Agency (FEPA)

B. Universal Basic Education (UBE)

C. Petroleum Trust Fund (PTF)

D. Science Students Association (SSA)

24. Bush burning can be summarized as:

A. Fire outbreak
B. Uncontrollable fire outbreak in the bush as a result of natural or artificial cause that have the potentials to cause loss of forest reserve
C. Burning of areas for the purpose of farming
D. Maintaining farm land

25. The following are the criticism of bush burning except:
A. Potential harm to micro and macro organism
B. Destruction of green plants that provide oxygen to animals for respiration
C. Destruction of ozone layer by emitting much carbon dioxide
D. Clearing and beautifying the burning area

26. Deforestation is defined as the:
A. Cutting down of trees
B. Planting of trees in the bush
C. Maintaining trees in the forest
D. Killing wildlife

27. One of the following is predictor of the outcome of deforestation:
A. Balance of oxygen and carbon dioxide is threatened
B. Increase of oxygen in the atmosphere
C. Decrease of carbon dioxide in the atmosphere
D. Increase in soil organism

28. Deforestation is caused by the following except
A. Felling of trees for industrial use
B. Passage of new roads through forest
C. Expansion of towns and village
D. Planting of trees

29. Which of these is responsible for the felling of greatest number of timber
A. Usage of timber in paper industry
B. Usage of timber in making drugs
C. Usage of timber in making chemicals and gum
D. Usage of timber to build vehicle

30. What differentiate deforestation and afforestation from the following?
A. Cutting down of planted trees and planting of trees in the forest
B. Availability of trees in a particular area
C. Application of fertilizer to newly planted trees

D. Proper nurture of plantations

31. Identify the effect of deforestation from the following?
    A. Increase of oxygen
    B. Loss of shade and cooling effect provided by tree
    C. Beautifying the environment
    D. Increase soil fertility
32. The following should be done to discourage deforestation except
    A. Regulations on illegal felling of trees should be enforced
    B. Planting of trees should be encouraged
    C. Grazing should be encouraged
    D. Paper should be recycled to save trees
33. One of the following summarizes deforestation
    A. Planting of trees for the purpose of making life better
    B. Replanting of missing trees in an area
    C. Cutting down of trees by either natural or artificial forces which may lead to erosion and global warming, and can be controlled by planting of trees
    D. Overflow of water
34. Desertification can be defined as
    A. Wearing away of soil surface
    B. Transformation of a fertile land into an arid land or desert
    C. Over flowing of water from sea or river
    D. Cutting down of trees
35. The following are artificial causes of desertification except
    A. Overgrazing
    B. Bush burning
    C. Cutting of trees
    D. Planting of trees
36. The following are the geographical areas prone to desertification in Nigeria except
    A. Sokoto
    B. Borno
    C. Zaria
    D. Katsina
37. Desertification can be controlled by the following except
    A. Digging the ground

B. Enforced a laws or regulations restricting overgrazing areas prone to desertification
C. Educating nomads on effect of desertification which causes famine
D. Enforcement of regulation on indiscriminate burning of bush and felling of trees

38. One of the following distinguish desertification and soil erosion:
    A. Desertification occur when there is completely absence or low rainfall in an area while soil erosion occurs as a result of heavy rainfall that lead to wearing a way of surface soil
    B. Heavy rainfall causes desertification and decline soil erosion
    C. Both desertification and soil erosion occurs as a result of low rainfall
    D. Cutting down of trees
39. One of the following is a natural cause of desertification
    A. Bush burning
    B. Absence of rain
    C. Deforestation
    D. Afforestation
40. One of the following summarizes desertification:
    A. Transport and transformation of soil nutrient
    B. Transformation of fertile land into an arid land that occurs as a result of natural and artificial forces which can be controlled by enforcing laws and regulations restricting overgrazing in areas prone to desertification
    C. Poor health condition
    D. Overcrowding of soil micro and macro organism
41. One of the following is the justification of desertification danger:
    A. Inability of living organism to reproduce in an areas prone to desertification
    B. Loss of live
    C. Better health condition
    D. Poor health condition
42. Ozone layer can be defined as:
    A. Soil profile that contains silt and gravel
    B. A layer beneath the crust that consist of minerals
    C. A layer in stratosphere that contains concentration of ozone sufficient to block most ultra violet radiation from the sun
    D. Revolving of earth around the sun
43. Ozone is composed of oxygen
    A. One atom of oxygen

B. Two atom of oxygen

C. Three atom of oxygen

D. Four atom of oxygen

44. Which of the following predicts the consequences of ozone layer depletion?

A. Decrease in temperature

B. Addition of oxygen in the atmosphere

C. Decrease of carbon dioxide in the atmosphere

D. Global warming

45. The ozone layer is located at the atmosphere about

A. 0 to 9km

B. 10 to 80km

C. 80 to 150km

D. 150 to 250km

46. The following predicts the importance of atmosphere except:

A. Provision of oxygen

B. Rainfall

C. Provision of carbon dioxide for photosynthesis

D. Formation of clouds

47. One of the following predicts the importance of ozone layer to the environment

A. Absorbs ultraviolet rays which are emitted by the sun

B. Increases the capacity of the layers of the atmosphere

C. Causes global warming

D. Prevent precipitation

48. The following outliners the effect of depletion of ozone layer except

A. Skin cancer which may result in death

B. Probable reduction in crop yield

C. Killing of small plants, which form food chains for aquatic organism

D. Improve the health of living organism

49. The following are the effect of global warming except

A. Increase in atmospheric temperature

B. Melting of polar ice in arctic and Antarctic region

C. Decrease in atmospheric temperature

D. Climate change

50. `which of the following summarizes depletion of ozone layer?

A. Reduction of the thickness of ozone layer as a result of the accumulation of chlorofluorocarbon (CFC) in the atmosphere
B. Increases certain number of gasses in the atmosphere
C. Decreases certain number of gasses in the atmosphere
D. Increases rainfall

Appendix VI

Marking Scheme for Basic Science Performance Test (BSPT)

1) B
2) C
3) C
4) C
5) A
6) A
7) C
8) B
9) B
10) B
11) B
12) D
13) C
14) D
15) C
16) C
17) B
18) A
19) D
20) A
21) D
22) D
23) A
24) B
25) D
26) A
27) A
28) D
29) C
30) A
31) B
32) D
33) C

34) B
35) D
36) C
37) A
38) A
39) B
40) B
41) B
42) C
43) C
44) D
45) B
46) D
47) A
48) D
49) C
50) A

1 mark each question

Total = 1 x 50 = 50 marks

Appendix VII

Reliability of (AUT) Instrument for Pilot testing

S/No	X	Y	X^2	Y^2	XY
1	16	16.5	256	272.25	264
2	15	17	225	289	255
3	12	10	144	100	120
4	7	9	49	81	63
5	10	13	100	169	130
6	16	21	256	441	336
7	9	9	81	81	81
8	16	15	256	225	240
9	17	15.5	289	240.25	263.5
10	15	19	225	361	285
11	15	15	225	225	225
12	18	23	324	529	414
13	10	11	100	121	110
14	17	16	289	256	272
15	11	9	121	81	99
16	18	16	324	256	288
17	15.5	15	240.25	225	232.5
18	17	18	289	324	306
19	11	14	121	196	154
20	15	15	225	225	225
N=20	∑x=280.5	∑Y=297	∑X2=4139.25	∑Y2=4697.5	∑XY=4363

X = test scores at pre-test,the formula for Pearson Product Moment Correlation test, re-test is given below:

$$R = \frac{N(\sum xy) - (x)\sum Y}{((N(X^2) - (NY^2) - (Y)^2)}$$

Where:

N=Number of respondents, Y = test scores at retest, ∑x= scores at pretest is summed, ∑y= scores at Post test is summed, $\sum x^2$ = scores at test is squared and summed, $\sum Y^2$ = scores at post test is squared and summed, $(\sum x)^2$ = scores at test is summed and squared, $(\sum Y)^2$ = scores at retest is summed and squared Where:

∑x=280.5	∑Y=297	$\sum X^2$=4139.25	$\sum Y^2$=4697.5	∑XY=4363

Pearson Product Moment Correlation formula is:

$$r = \frac{N(\sum xy) - \sum (x)\sum Y}{((N(\sum X^2) - (N*\sum Y^2) - (\sum Y)^2}$$

Substituting the values in the formulae:

$$= \frac{20*4363 - 280.5*297}{20*(4139.25)^2 - 20*4697.5-(297)^2}$$

= .79

r=.81

S/n	X	Y	X^2	Y^2	XY
1	21	27	441	729	567
2	25	31	625	961	775
3	32	26	1024	676	832
4	23	32	529	1024	736
5	37	40	1369	1600	1480
6	20	20	400	400	400
7	23	27	529	729	621
8	24	32	576	1024	768
9	21	19	441	361	399
10	28	30	784	900	840

Appendix VIII

Reliability of (BSPT) Instrument for Pilot testing

11	28	33	784	1089	924
12	30	23	900	529	690
13	30	27	900	729	810
14	21	22	441	484	462
15	25	24	625	576	600
N=20	∑x=516	∑Y=546	$\sum X^2$=13684	$\sum Y^2$=14462	∑XY=14306
16	28	31	784	961	868
17	24	31	576	961	744
18	29	27	841	729	783
19	23	23	529	529	529
20	29	25	841	625	725
N=20	∑x=516	∑Y=546	$\sum X^2$=13684	$\sum Y^2$=14462	∑XY=14306

X = test scores at pre-test, the formula for Pearson Product Moment Correlation test, re-test is given below:

$$R = \frac{N(\sum xy) - (x)\sum Y}{\sqrt{(N(X^2) - (NY^2) - (Y)^2)}}$$

Where:

N=Number of respondents, Y = test scores at retest, ∑x= scores at pretest is summed, ∑y= scores at Post test is summed, $\sum x^2$ = scores at test is squared and summed, $\sum Y^2$ = scores at post test is squared and summed, $(\sum x)^2$ = scores at test is summed and squared, $(\sum Y)^2$ = scores at retest is summed and squared Where:

N=Number of respondents, Y = test scores at retest, ∑x= scores at pretest is summed, ∑y= scores at Post test is summed, $\sum x^2$ = scores at test is squared and summed, $\sum Y^2$ = scores at post test is squared and summed.

Pearson Product Moment Correlation formula is:

$$r = \frac{N(\sum xy) - \sum (x) \sum Y}{((N(\sum X^2) - (N*\sum Y^2) - (\sum Y)^2}$$

Substituting the values in the formulae:

$$= \frac{20*14306 - 516*546}{20*(13684)^2 - 20*14462 - (546)^2}$$

= .76

r=.79

Appendix IX

Request letter for the validation of the Instrument

Department of Science Education,

Ahmadu Bello University,

Zaria,

October 5, 2018

Professor. S.S Bichi,

Department of Science Education,

Ahmadu Bello University,

Zaria.

Dear Sir,

Validating Research Instrument in Respect of

ADAMU, Abdullahi (P17EDSC8092)

The Above M.Ed science education student is researching on the Analysis of Socratic Questioning Technique on Academic Performance and of Upper Basic Science Students of different Cognitive style Zaria Educational-Zone, Kaduna State, Nigeria. He has developed an instrument for data collection. Kindly go through the instrument and validate it to enable him collect reliable data. Research questions, Objectives of the study as well as the null hypotheses from Chapter 1 are attached here with for your reference.

Thank you.

Yours faithfully,

Prof. I. A. Usman

Dr. Ms. TudunKaya

Student supervisors

Department of Science Education,

Ahmadu Bello University,

Zaria,

October 5, 2018

Professor. Mrs. Lakpini,

Institute of Education,

Ahmadu Bello University,

Zaria.

Dear Sir,

Validating Research Instrument in Respect of

ADAMU, Abdullahi (P17EDSC8092)

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Thank you.

Yours faithfully,

Prof. I. A. Usman

Dr. Ms. TudunKaya

Student supervisors

Department of Science Education,

Ahmadu Bello University,

Zaria,

October 5, 2018

Dr. M.K Falalu,

Department of Science Education,

Ahmadu Bello University,

Zaria.

Dear Sir,

Validating Research Instrument in Respect of

ADAMU, Abdullahi (P17EDSC8092)

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Thank you.

Yours faithfully,

Prof. I. A. Usman

Dr. Ms. TudunKaya

Student supervisors

Department of Science Education,

Ahmadu Bello University,

Zaria,

October 5, 2018

Dr. Aminu Sambo,

Institute of Education,

Ahmadu Bello University,

Zaria.

Dear Sir,

Validating Research Instrument in Respect of

ADAMU, Abdullahi (P17EDSC8092)

The Above M.Ed science education student is researching on Analysis of Socratic Questioning Technique on Academic Performance and of Upper Basic Science Students of different Cognitive style Zaria Educational-Zone, Kaduna State, Nigeria. He has developed an instrument for data collection. Kindly go

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Thank you.

Yours faithfully,

Prof. I. A. Usman

Dr. Ms. TudunKaya

Student supervisors

Department of Science Education,

Ahmadu Bello University,

Zaria,

October 5, 2018

Mal. Salisu Muhammad,

School of Science,

Federal College of Education,

Zaria.

Dear Sir,

Validating Research Instrument in Respect of

ADAMU, Abdullahi (P17EDSC8092)

The Above M.Ed science education student is researching on Analysis of Socratic Questioning Technique on Academic Performance and of Upper Basic Science Students of different Cognitive style Zaria Educational-Zone, Kaduna State, Nigeria. He has developed an instrument for data collection. Kindly go through the instrument and validate it to enable him collect reliable data. Research questions, Objectives of the study as well as the null hypotheses from Chapter 1 are attached here with for your reference.

Thank you.

Yours faithfully,

Prof. I. A. Usman

Dr. Ms. TudunKaya

Student supervisors

Appendix X

Summary Table for Items Analysis of the Instrument (BSPT)

S/n	FI	DI
1	0.39	0.45
2	0.81**	0.90**

3	0.21*	0.28*
4	0.42	0.45
5	0.38	0.41
6	0.47	0.50
7	0.54	0.63
8	0.46	0.60
9	0.45	0.60
10	0.88**	0.94**
11	0.40	0.60
12	0.45	0.52
13	0.31	0.42
14	0.33	0.45
15	0.44	0.50
16	0.35	0.47
17	0.81**	0.93**
18	0.50	0.73
19	0.53	0.75
20	0.49	0.57
21	0.83**	0.90**
22	0.39	0.47
23	0.45	0.59
24	0.34	0.45
25	0.52	0.63
26	0.42	0.48
27	0.39	0.46
28	0.52	0.67
29	0.21*	0.28*
30	0.45	0.52
31	0.36	0.48
32	0.44	0.54
33	0.52	0.61
34	0.56	0.70
35	0.23*	0.28*

36	0.21*	0.25*
37	0.62	0.79
38	0.49	0.56
39	0.52	0.64
40	0.38	0.46
41	0.56	0.71
42	0.38	0.49
43	0.70	0.79
44	0.54	0.61
45	0.33	0.42
46	0.20*	0.24*
47	0.65	0.79
48	0.62	0.71
49	0.48	0.54
50	0.55	0.67

Note that question 3*, 29*, 35*, 36*, 46*, were dropped because they were found to be very difficult below 0.30 scores hence rejected while question 2**, 10**, 17** and 21**, were also dropped because they were found to be very simple, that is those above 0.80.

APPENDIX XI

Equivalents test for the sample schools

Descriptives

SCORE

	N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Minimum	Maximum
					Lower Bound	Upper Bound		
GSS DAKACE	5	57.6000	5.22494	2.33666	51.1124	64.0876	53.00	66.00
GSS K/ KUYANBANA	5	57.0000	5.24404	2.34521	50.4887	63.5113	52.00	64.00
GSS T/ JUKUN	5	26.8000	9.03881	4.04228	15.5768	38.0232	19.00	41.00
GSS T/ SAIBU	5	28.6000	9.63328	4.30813	16.6387	40.5613	18.00	41.00
GSS K/ DOKA	5	37.8000	3.83406	1.71464	33.0394	42.5606	33.00	42.00
GSS RICHIFA	5	37.2000	3.03315	1.35647	33.4338	40.9662	34.00	42.00
GSS T/ WADA	5	36.4000	3.20936	1.43527	32.4151	40.3849	33.00	41.00
GSS MANGI	5	34.6000	4.82701	2.15870	28.6065	40.5935	29.00	41.00
Total	40	39.5000	12.32675	1.94903	35.5577	43.4423	18.00	66.00

ANOVA

SCORE

	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4778.800	7	682.686	19.043	.000
Within Groups	1147.200	32	35.850		
Total	5926.000	39			

Post Hoc Tests

Multiple Comparisons

Dependent Variable: SCORE
Scheffe

(I) SCHOOL	(J) SCHOOL	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
					Lower Bound	Upper Bound
GSS DAKACE	GSS K/ KUYANBANA	.60000	3.78682	1.000	-14.6366	15.8366
	GSS T/ JUKUN	30.80000*	3.78682	.000	15.5634	46.0366
	GSS T/ SAIBU	29.00000*	3.78682	.000	13.7634	44.2366
	GSS K/ DOKA	19.80000*	3.78682	.003	4.5634	35.0366
	GSS RICHIFA	20.40000*	3.78682	.002	5.1634	35.6366
	GSS T/ WADA	21.20000*	3.78682	.001	5.9634	36.4366
	GSS MANGI	23.00000*	3.78682	.000	7.7634	38.2366
GSS K/ KUYANBANA	GSS DAKACE	-.60000	3.78682	1.000	-15.8366	14.6366
	GSS T/ JUKUN	30.20000*	3.78682	.000	14.9634	45.4366
	GSS T/ SAIBU	28.40000*	3.78682	.000	13.1634	43.6366
	GSS K/ DOKA	19.20000*	3.78682	.005	3.9634	34.4366
	GSS RICHIFA	19.80000*	3.78682	.003	4.5634	35.0366
	GSS T/ WADA	20.60000*	3.78682	.002	5.3634	35.8366
	GSS MANGI	22.40000*	3.78682	.001	7.1634	37.6366
GSS T/ JUKUN	GSS DAKACE	-30.80000*	3.78682	.000	-46.0366	-15.5634
	GSS K/ KUYANBANA	-30.20000*	3.78682	.000	-45.4366	-14.9634
	GSS T/ SAIBU	-1.80000	3.78682	1.000	-17.0366	13.4366
	GSS K/ DOKA	-11.00000	3.78682	.328	-26.2366	4.2366
	GSS RICHIFA	-10.40000	3.78682	.400	-25.6366	4.8366
	GSS T/ WADA	-9.60000	3.78682	.506	-24.8366	5.6366
	GSS MANGI	-7.80000	3.78682	.746	-23.0366	7.4366
GSS T/ SAIBU	GSS DAKACE	-29.00000*	3.78682	.000	-44.2366	-13.7634
	GSS K/ KUYANBANA	-28.40000*	3.78682	.000	-43.6366	-13.1634
	GSS T/ JUKUN	1.80000	3.78682	1.000	-13.4366	17.0366
	GSS K/ DOKA	-9.20000	3.78682	.560	-24.4366	6.0366
	GSS RICHIFA	-8.60000	3.78682	.643	-23.8366	6.6366
	GSS T/ WADA	-7.80000	3.78682	.746	-23.0366	7.4366
	GSS MANGI	-6.00000	3.78682	.919	-21.2366	9.2366
GSS K/ DOKA	GSS DAKACE	-19.80000*	3.78682	.003	-35.0366	-4.5634
	GSS K/ KUYANBANA	-19.20000*	3.78682	.005	-34.4366	-3.9634
	GSS T/ JUKUN	11.00000	3.78682	.328	-4.2366	26.2366
	GSS T/ SAIBU	9.20000	3.78682	.560	-6.0366	24.4366
	GSS RICHIFA	.60000	3.78682	1.000	-14.6366	15.8366
	GSS T/ WADA	1.40000	3.78682	1.000	-13.8366	16.6366
	GSS MANGI	3.20000	3.78682	.998	-12.0366	18.4366
GSS RICHIFA	GSS DAKACE	-20.40000*	3.78682	.002	-35.6366	-5.1634
	GSS K/ KUYANBANA	-19.80000*	3.78682	.003	-35.0366	-4.5634
	GSS T/ JUKUN	10.40000	3.78682	.400	-4.8366	25.6366
	GSS T/ SAIBU	8.60000	3.78682	.643	-6.6366	23.8366

	GSS K/ DOKA	-.60000	3.78682	1.000	-15.8366	14.6366
	GSS T/ WADA	.80000	3.78682	1.000	-14.4366	16.0366
	GSS MANGI	2.60000	3.78682	.999	-12.6366	17.8366
	GSS DAKACE	-21.20000*	3.78682	.001	-36.4366	-5.9634
	GSS K/ KUYANBANA	-20.60000*	3.78682	.002	-35.8366	-5.3634
	GSS T/ JUKUN	9.60000	3.78682	.506	-5.6366	24.8366
GSS T/ WADA	GSS T/ SAIBU	7.80000	3.78682	.746	-7.4366	23.0366
	GSS K/ DOKA	-1.40000	3.78682	1.000	-16.6366	13.8366
	GSS RICHIFA	-.80000	3.78682	1.000	-16.0366	14.4366
	GSS MANGI	1.80000	3.78682	1.000	-13.4366	17.0366
	GSS DAKACE	-23.00000*	3.78682	.000	-38.2366	-7.7634
	GSS K/ KUYANBANA	-22.40000*	3.78682	.001	-37.6366	-7.1634
	GSS T/ JUKUN	7.80000	3.78682	.746	-7.4366	23.0366
GSS MANGI	GSS T/ SAIBU	6.00000	3.78682	.919	-9.2366	21.2366
	GSS K/ DOKA	-3.20000	3.78682	.998	-18.4366	12.0366
	GSS RICHIFA	-2.60000	3.78682	.999	-17.8366	12.6366
	GSS T/ WADA	-1.80000	3.78682	1.000	-17.0366	13.4366

*. The mean difference is significant at the 0.05 level.

Homogeneous Subsets

SCORE

Scheffe

SCHOOL	N	Subset for alpha = 0.05	
		1	2
GSS T/ JUKUN	5	26.8000	
GSS T/ SAIBU	5	28.6000	
GSS MANGI	5	34.6000	
GSS T/ WADA	5	36.4000	
GSS RICHIFA	5	37.2000	
GSS K/ DOKA	5	37.8000	
GSS K/ KUYANBANA	5	37.3333	
GSS DAKACE	5	36.5655	
Sig.		.328	

Means for groups in homogeneous subsets are displayed.

a. Uses Harmonic Mean Sample Size = 5.000.