TEACHER-PUPIL PROJECT COLLABORATION, HANDS-ON ACTIVITIES AND PUPILS' LEARNING OUTCOMES IN BASIC SCIENCE IN THE IBADAN METROPOLIS

BY

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CERTIFICATION

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DEDICATION

This academic research is dedicated to God the Almighty, the preserver of my soul, my instructor and director whose love for me cannot be quantified.

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ABSTRACT

Basic science lays the foundation for future science learning and career in science-related disciplines. Reports have shown that pupils' learning outcomes (Basic Science Process Skills - BSPS; Basic Science Achievement - BSA and Attitude to Basic Science - ABS) in primary schools in the Ibadan metropolis are poor, and these are attributable to instructional methods adopted by the teachers. Previous studies have established that primary school science teachers largely deployed direct instructions more than pupil-centred strategies, such as Teacher-Pupils Project Collaboration (TPPC) and Hands-on Activities (HoA) strategies. Therefore, this study was carried out to determine the effects of TPPC and HoA strategies on pupils' BSPS, BSA and ABS in the Ibadan metropolis. It also examined the moderating effects of gender and school type.

Jean Piaget's Cognitive Development and Lev Vygotsky's Sociocultural theories served as the framework, while the pretest-posttest control group quasi-experimental design with a 3x2x2 factorial matrix was adopted. Three Local Government Areas (LGAs) were randomly selected from the Ibadan metropolis. One public and one private school with qualified and professional science teachers were purposively selected from each LGA. The schools were randomly assigned to TPPC (54), HoA (58) and conventional (49) groups. The instruments were Basic Science Process Skills Rating Scale (0.73), Basic Science Achievement Test (0.83), Questionnaire on Pupils' Attitude to Basic Science (0.81) and instructional guides. The treatment lasted 11 weeks. The data were analysed using descriptive statistics, Analysis of covariance and Scheffe's Post-hoc test at 0.05 level of significance.

Majority of the participants were male (52.8%) and 52.2% were from private schools. The treatment had a significant main effect on pupils' BSPS ($F_{(2;148)} = 5.38$; partial $\eta^2 = 0.07$). The participants in TPPC had the highest mean score (9.63), followed by those in control (8.45) and the HoA (8.36) groups. The treatment had a significant main effect on pupils' BSA ($F_{(2;148)} = 3.54$; partial $\eta^2 = 0.05$). The pupils in HoA had the highest basic science achievement mean score (12.88), followed by those in TPPC (12.46) and the control (11.09) groups. School type had a significant main effect on pupils' BSPS ($F_{(1;148)} = 39.65$; partial $\eta^2 = 0.21$). The participants from private schools had a higher BSPS mean score (9.99) than those from public schools (7.63). School type also had a significant main effect on pupils' BSA ($F_{(1;148)} = 42.04$; partial $\eta^2 = 0.22$). The pupils from private schools had a higher BSA mean score (14.10) than those from public schools (10.18). The treatment had no significant main effect on pupils' ABS. Gender had no significant main effect on pupils' BSPS and BSA. The two-way and three-way interaction effects were not significant. Teacher-pupil project collaboration, more than hands-on activities instructional strategies, enhanced pupils' basic science process skills, while hands-on activities enhanced basic science achievement than teacher-pupil project collaboration among primary school pupils in the Ibadan metropolis with particular attention to school type. Therefore, basic science teachers should adopt both strategies.

Keywords: Teacher-pupil project collaboration, Hands-on activities, Basic science learning outcomes

Word count: 485

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LIST OF ABBREVIATIONS

ANCOVA Analysis of Covariance

BEC Basic Education Curriculum

BS Basic Science

BSA Basic science

SAT Science Achievement Test

BSAT Basic Science Achievement Test

BSPS Basic Science Process Skills

BSPSRS Basic Science Process Skills Rating Scale

BST Basic Science and Technology

CESAC Comparative Education Studies and Adaptation Centre

CL Collaborative Learning

CoS Conventional Strategy

CPS Collaborative Project Strategy

CPS Collaborative Project Strategy

ESSPIN Education Sector Support Programme in Nigeria

FME Federal Ministry of Education

FRN National Policy on Education 2013

GCIS Guide for Convectional Instructional Strategy

GCIS Guide for Conventional Instructional Strategy

HoA Hands-on Activities

HoAIG Hands-on Activities Instructional Guide

JSSCE Junior Secondary School Certificate Examination

MDGs Millennium Development Goals

NEEDS Nigeria Economic Empowerment and Development and strategy

NERDC Nigeria Education Research Development Council

OECD The Organization for Economic Cooperation and Development

PBL Project Based Learning

PBLM Project Based Learning Meth

QPABS Questionnaire on Pupils' Attitudes to Basic Science

RAs Research Assistants

SDGs Sustainable Development Goals

SEC Social Economic Status

SPSRS Science Process Skills Rating Scale

ST Science and Technology

STAN Science Teachers Association of Nigeria

SUBEB State Universal Basic Education Board

TPPC Teacher-Pupils Project Collaboration

TPPC_IG Teacher-Pupil Project Collaboration Instructional Guide

UBE Universal Basic Education

UNESCO The United Nations Educational, Scientific and Cultural Organization

UNICEF United Nations Children's Fund

UNSDGs United Nations Sustainable Development Goals

UPE Universal Primary Education

WAEC West African Examination Council

ZPD The Zone of Proximal Development

APPENDICES

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Today's world is plagued by a number of challenges.These challenges include unemployment, global warming, health issues, population explosion, natural disaster, poverty, war, economic recession, terrorism as well as immigration issues to mention but a few, and solutions to these challenges have been tied to education. This is because education proffers solution to whatever challenge a nation has. Therefore, every nation tailor its educational system to meet its social, political, economic, technological, and cultural challenges. In other words, every nation rides on the wind of education for economic growth, political development, technological advancement, cultural development, problem-solving, and other areas of national development. United Nations Sustainable Development Goals UNSDGS (2015) reiterates the significance of education in poverty eradication, global peace, prosperity, and protection of the world by 2030. In the same vein, the educational philosophy of Nigeria believes in education as a tool for national development and social change (FRN, 2013).

Moreover, education is a unifying instrument for people with different opinions on peaceful living. It encourages self-awareness, social awareness, and self-confidence. Eimuhi (2011) and Chakraborty et al. (2018) see education as the most influential factor for social change. One of the aims of education is to promote sustainable development that advocates lifelong learning to meet every day challenges Ferrer-Estevez, (2021). There is a consensus that education fosters lifelong learning and potential to function effectively at work and the skills to solve problems encountered on daily basis. Research studies have shown that quality education can lead tothe acquisition of necessary knowledge with abilities for efficient growth of the nation(Ohunene and Ozoji,2014).

Education begins at home and parents are the first teachers who impact the rudiment of literacy, numeracy, socio-emotional and cultural values to their children. These attributes form a foundation for formal education. Formal education is put in place to blend the old and the new societal order to proffer solutions to challenges in society (Bello, 2017). Formal education begins at the foundational level of education and it is the education provided in a formal settingfor children between the ages of 6 and 12 years plus (FRN, 2013). It provides a solid basis for study at higher levels (Aaron, 2003).

Primary level of schooling is crucial to expose children to formal education. In the sense that it is also a level at which literacy skills, numeracy skills, intrapersonal and interpersonal relationships, and the basis for acquiring knowledge of the world are further developed in children. In other words, the success of any society is determined by the structure of its primary school system because it lays the foundation for meaningful learning. SDGS (2015) (Sustainable Development Knowledge Platform) states that primary education has many positive effects such as decreasing poverty, decreasing child mortal rate, encouraging gender equality, and increasing environmental concerns.

In Nigeria, primary education offers opportunities to all children, regardless of age, gender, colour, or country of origin.The nine-year basic education, which includes primary schooling, consists of lower basic, middle basic and upper basic education. It was inaugurated and launched nationally in 1999.Basic education's objectives involve supplying a variety of fundamental knowledge and abilities for entrepreneurship, income creation, and educational growth and also tofurnish children the chance to acquire manipulative abilities to be able to participate fully in society. It is a means to achieving national unity and harmony and for maximizing the divers' inherent abilities of the individual for personal enhancement and societal growth (FRN, 2013).Osanyin (2018) summarizes the significance, purposes, and outcomes of elementary education as the capacity to learn skills, relate to a culture, function well at home, be physically fit, be engaged in the environment, be socially relevant, and be morally and intellectually sound. This also implies that the foundation for a useful and productive education is laid at the foundational level.

Developing a well-grounded foundation for research-based, technological, critical, and philosophical thinking is one of elementary education's goals (Akinbote, 2007; FRN, 2013). Critical and reflective thinking is required for the creative ability to solve societal problems. This objective of primary education has to do with science education and taking cognizanceof science in national growth, incentives were made for teachers and pupils to encourage the study of science at all levels. Science does not only contribute to scientific and technological development but also helps an individual to solve problems encountered on daily basis.

Holbrook (2011) opined that the study of science should be one that seeks to solve societal problem and not as accumulation of knowledge but that the knowledge gained be applied not only to solve societal problem but to make informed decisions.

The study of science has the potential to help pupils gain knowledge about their environment, this knowledge is important to conserve some natural resources that might go into extinction. Furthermore, many scientific discoveries have helped in the cure or management of some health challenges. Science has helped in the development of all areas of human endeavours such as medicine, agriculture, transportation, housing, communication, technology (Amusan, 2014). It can be inferred that the application of science enables us to live a better life. Everything that has to do with life is tied to science including its application in academic spheres like Social Science and Education.

Budapest conference (1999) asserts that relevant, high-quality science and mathematics instruction can foster critical and creative thinking for problem solving. In addition, science education that is effective fosters the development of people who can promote sound political, economic and social advancement of the society by using their analytical and inventive abilities to address societal issues (Ewesor and Itie, 2015). The main focus of education is to grow individuals who canharness their critical thinking and creative skills to solve societal problem. Therefore, it can be implied that the goal of science is the goal of education since the two aim to promote the development of individuals who can use their critical thinking faculty to solve societal problems. Consequently, the foundational educational level that establishes meaningful learning should receive the correct amount of attention.

The significance of science in the growth of a country cannot be overstated. Presently, we depend on science to solve the global pandemic COVID-19 in terms of vaccine production and healing of those afflicted with the disease. The emphasis now is on global knowledge economy. Many countries have used their knowledge of science and technology to develop their economy, therefore, for Nigeria not to be left out and in particular in the area of economic development, there is need for science to be taught effectively right from the foundational stage, which is the pre-primary and primary schools. This is because whatever skills that are acquired at this level of education promote future learning that would enhance economic development, career opportunity in science and by extension national development.

Science is taught at the foundational level as basic science and technology. The objectives of basic science at this level in Nigeria are: the ability to apply knowledge and skills from science and technology to meet personal and society's needs, the growth of problem-solving abilities, the awareness of job opportunities provided by science and technology(ST), the development of interest in ST, and the cultivation of a positive attitude toward science learning in the world of works, to become prepared for further studies in science and technology, to avoid drug abuse and related vices and to be safety and security conscious (NERDC, 2013). These objectives of science and technology have implications for self and societal advancement. First, the knowledge of science and technology helps an individual to take care of himself/herself in terms of good healthcare and second, science and technology make societal life better. Even our everyday decisions are influence by science.

In spite of the significance of science and technology to society, only a small percentage of secondary school students study disciplines that are connected to science and this is an indication that the objective of inculcating science interest and positive attitude to the study of science among primary school students might not be achieved. A survey of twelve secondary schools in Ibadan metropolis was carried out by the researcher, Table 1.1 reveals the result.

According to Table 1.1, less than half of all students in these institutions are enrolled in science related subjects. Out of the twelve schools only two schools, Government College (68.4%) and Queen Schools with 52.2% have total number of students studying science above 50%. This may be explained by the fact that first, these are schools with high demand for best students and are ministry of education schools where the entrance requirement is very high. Apart from this, the two schools are schools with well-equipped laboratories, which explains why the demand for the schools is competitive. When a school is highly demanded for, it is makes it easy to pick good students, this may explain why the population of science students in these two schools is on the higher side than other schools in Ibadan metropolis. Table 1.1 signifies that the objective of inculcating science interest in pupils at the primary level is yet to be achieved. This is reflected in the table with only 39.4 % of students studying science in prominent schools in Ibadan metropolis. The twelve schools are urban schools, if this is the situation in urban schools that are relatively equipped with science equipment one can imagine what goes on in rural schools that are not as well equipped as these urban senior secondary schools. It should be noted that interest and attitude go together as interest generate positive attitude.

Moreover, the objective of laying building blocks for acquiring basic scientific skills and knowledge is yet to be achieved as stated by Bamidele (2016) and Enemarie et al. (2019). This is because secondary students are not doing well in the sciencesand their poor performance is evidence of this in certificate examinations.The foundation has been held accountable for the secondary students' poor performance. For instance, Omilani et al. (2018) expressing the opinion of stakeholders in educationblamed the inadequate grounding in basic science and technology at the elementary school level for the poor performance of secondary school students. To corroborate this assertion, (Osuafor and Okoli, 2013; Education Sector Support Program in Nigeria 2016)also support the claim that the poor results provided by a body like the West African Examination Council (WAEC) mirrors theinadequate education in primary schools.

Table 1.1:**Science Enrolment in some Selected Secondary Schools in Ibadan Metropolis**

		SS1		SS2		SS3		TOTAL		
S/N	Name of School	Total student enrolment	Sc. based	Student enrolment	Sc. Based	Student enrolment.	Sc. based	Total	Science	% of Sc. based
1	St. Louis, Mokola	318	60	327	70	133	55	775	185	23.9
2	M.G.S. Bodija	390	136	369	124	183	75	942 .	335	35.6
3	Immanuel College, Samonda	247	85	187	63	138	56	572	204	35.7
4	Ikolaba Gr. Sch	99	32	102	37	87	29	288	98	34.0
5	Ibadan Gr. Sch	495	173	501	184	413	166	1409	523	37.1
6	Queen Sch Ibadan	380	196	270	138	208	120	858	454	52.2
7	St. Anne's Molete	283	104	265	100	223	75	771	279	36.2
8	G. C. I.	406	279	476	324	301	208	1183	811	68.6
9	A.C.G. Orita -mefa	235	34	244	39	158	27	637	100	15.7
10	St. Sec. Sch Molete	196	78	173	73	208	79	577	230	39.9
11	Onireke high sch	82	25	83	25	79	18	244	68	27.9
12	Oluyole high sch	152	32	113	29	102	36	340	97	25.5
Total								**8,596**	**3,384**	**39.4**

Enemarie et al. (2019) established that pupils' success in basic science is a good indicator of their success in higher-level science.Moreover, the studies of (Erinosho, 2013; Ehikhamenor, 2014;Adegoke, 2016) all demonstrate students' poor performance in secondary school examination, is related to the weak scientific foundation at the lower levels of education. Results of JSSCE basic science results from 2008 to 2013 reveal that students are not doing well in basic science Bamidele (2016). The implication is that basic science is not well grounded at the primary school level.

Some of the causes of secondary school students' inadequate performance in the sciences, according to Bamidele (2016) are that students lack manipulative skills, poor expression, wrong observation, and inferences, lack of familiarity with typical laboratory equipment, inability to connect theoretical knowledge with real life situations, inability to draw logical inference from the observation made on a prescribed test, poor practical exposure. Most of the issues raised above, ought to have been addressed at the primary school level and this is an indication that all is not well with knowledge and skills acquisition at the primary level of education. Furthermore, Balarabe (2016) cited in Enemarie et.al (2019) opined that Inadequate student exposure to activities, poor preparation, a lack of effective teaching strategies, gender insensitivity, and a shortage of trained science teacherssignificantlyaffect students' success in Basic Science. These are a pointer to poor learning outcomes which is an indicator of a faulty science foundation.

Moreover, Adewale cited in Enemaire et al. (2019) inferred that thesubpar performance of secondary students, is a result of students’ poor knowledge of basic science and this may be attributed to teacher factors as observed by different organizations. One of the contributing factors to the pupils' poor performance at the pre-primary level of education in the nation, according to the reports of Development of Education (FME, 2008) and (ESSPIN, 2016) in respect of primary school pupils learning in the last decade is the fact that majority of teachers who are supposed to facilitate knowledge lack basic teaching skills and subject content knowledge.

Also, reiterating teacher factor as responsible for poor performance at the primary level of education, Wanbugu et al. (2013) indicates that teachers' strategy of teaching is responsible for students' inadequate performance in the sciences which is consequent upon the training received at the pre-service stage and this is corroborated by Omilani et al. (2018) states that science and technology education in the nation has not received the needed attention for pupils' problem-solving skills. Most experts agree that one of the reasons why primary school pupils' academic performance is low is due to teachers' teaching strategy. They are of the view that many teachers still lack the requisite skills and competencies to deliver the primary school curriculum as of 2016.

Salami (2014) and ESSPIN (2016) argue that teachers are not exclusively to be blamed for the poor performance of the pupils because teachers are the product of a system of pre-service and in-service education that does not equip them with skills to teach literacy and numeracy effectively at the primary level of education. In addition, Osuafor and Okoli (2013), asserts that the majority of the basic science and technology teachers in primary schools are non-science specialists who were not exposed to practical activities during pre-service training whereas science is an activity-based discipline. Osuafor and Okafor (2010) in Adesuyi, (2018) shows that pupils taught by science specialists significantly performed better than those taught by non-specialist teachers.

The issue of an unqualified teacher is a very serious matter because teachers are supposed to facilitate learning.They are very important in the educational process as their input determines the educational output. Hence if teachers are not properly prepared for teaching science it should be a matter of serious consideration. Aladejana, (2018) corroborates the general view that effective teaching is a prerequisite for great success in the educational system.U.S. Department of Education Research (2003) cited in Aladejana (2018) notesthat the greatest influence on kids' progress is their teachers.

It may be argued that the issue of a lackluster level of achievement among pupils in primary school particularly in science education can be attributed to many factors such as classroom environment, teacher and learner's attitude, motivation and teaching strategies Hanadi and Husseing (2017), but of all the factors, teacher factor predominates, particularly the teaching approach. Aina, Keith and Langenhoven (2015) are of the opinion that teachers' strategy of teaching is among the causes of poor learners' performance in science.

According to research, most teachers in Nigerian schools, use (rote, memorization) teacher-centred strategy to teach science, (Osokoya, 2013; Oduolowu and Akintemi, 2017 and Aladelajana, 2018). Rote and memorization strategies are teacher-centred, passive, and not activity based. This is against the stipulation in FRN (2013) that teaching of science be activity based, explorative, and reflective to develop intellectual and scientific skills in pupils which are needed to understand natural phenomena and to solve problems. It is in understanding of natural phenomena that leads to questioning how and why some natural resources are what they are and how we can improve on them (Chatila, 2017).

It is pertinent to say that science teaching in Nigeria has not yielded the required technological development as a result of the way the subject is handled by teachers coupled with non-availability of resources. Chiang and Lee (2016) are of the opinion that there is no connection between what is learnt in school and the real life. In other words, we can say that science teaching in primary school has not promoted the engagement of pupils with their environment and consequently has not fostered the development of critical thinking skill needed for creativity. Therefore, the knowledge of science gained has not produced the technological advancement needed for technological development. According to UNESCO (2006), many instructors lack the credentials necessary to teach science in the primary grades. The Oyo State Universal Basic Education Board (SUBEB, 2009), which assessed primary school teachers on teaching, found out that the teachers' performance was below average across the board and significantly worse in the sciences. According to the survey, elementary school instructors are struggling academically in both pedagogy and the science process skills of the subject.Therefore, there has to be a change in how science is taught, moving away from accumulation of facts and moving toward interactions with the natural world that can lead to solutions to problems that are faced on a daily basis.

Aktamis and Yenice (2010) opine that science education should aim at educating individuals who can adapt to different conditions, question, think critically and be able to solve problem. Pupils' problem-solving ability is what Omilani et al. (2018) argued that science and technology education in Nigeria should address. Furthermore, problem solving skills are needed to solve societal problems for technological breakthroughs and ability to proffer solution to everyday challenges.

Children by nature are inquisitive, they want to know about the world around them. Darling- Hammond et al. (2018) refer to them as natural learners and that they instinct inlyacquire knowledge on daily basis as they engage with their world. All young children inquire like scientists in that they observe, ask questions and explore their environment (Browne, 1991). Although children are natural learners, the learning environment and teachers who will structure the environment for effective learning are lacking. ESSPIN (2016) and Balarabe (2016) cited in Enemaire (2018) both stressed the inadequacies of teaching resources and unqualified teachers. Salami (2014) pointed out that pre-service teachers are not adequately exposed to inquiry-based teaching that will equip them for the strategies that foster exploration approach at the primary level of education. If teachers are adequately equipped and if they are able to structure the environment to promote inquiry learning, then children's inquisitive potential may be promoted right from primary school, this may therefore assist pupils to acquire necessary skills needed for lifelong learning particularly in the sciences. Jackman (2009) opined that young children's natural curiosity and their need to know why, which and what should be nurtured in order to encourage future scientific exploration and enthusiasm.

Children naturally have ability to construct knowledge by engaging with their physical and social environment. This engagement involves exploration, play, inquiry and discovery. Education thinkers such as Friedrich Froebel, John Dewey, John Locke, Amos Comenius and Jean-Jacques Rousseau all advocated play as the best learning strategy for children. Play learning strategy fosters the holistic development of the child. Maria Montessori (1870 -1952) in Oduolowu, (2011) believes that children learn best in an environment where freedom is given to explore, when they have choice related to material, activities and have control over the amount of time they engage in activities. She also believed that as children play, their sensory stimulation is charged which enables them to show instant interest in learning (Oduolowu, 2011).

Friedrich Froebel (1782-1852) in Oduolowu, (2011) opine that child learn best when given the opportunity to manipulate real material.Children can manipulate their environment to engage more with it and learn more systematically. John Locke (1632-1704) advocated freedom for children to explore their environment with their senses while John Amos Comenius (1592-1670)Oduolowu, (2011) lay emphasis on active learning. It can be inferred that child learning is shaped by three main factors - environment, material and exploration which are all components of play. Problem solving, thinking skills, creativity, cooperation and communication can be developed through play-based learning and these are higher–order thinking skills (Kashin, 2020)

High-order thinking may be referred to as critical thinking which may entail analysis, conclusion and synthesis Halpern (1998). It can therefore be said that play, if properly utilised during the early years, can promote the development of the 21st century skills needed for science process skills and knowledge acquisition in science. Furthermore, play promotes the development of self-confidence, self-esteem, and positive attitude towards learning which are all attributes of science, Fraser Mustard cited in Kashin (2020). Kashin argued that play, inquiry and exploration are pedagogical approaches in early childhood and that inquiry-based learning is project work, which requires children to investigate a question or a problem over time. It can therefore be inferred that play is a systematic process of learning which in a sense can be seenas inquiry-based learning.

Play is an active learning model and pupil-centred, which Hartikainen et al. (2019) states is associated with positive learning outcomes. Learning outcomes are targeted learning behaviour expected of pupils at the end of their engagement with the learning environment or experience. To achieve the targeted learning outcomes, learner-centred teaching strategy is crucial for thedevelopmentof science conceptual knowledge, science process skills(SPS) and positive attitude in science (Chebii et al.,2011).

Teacher-centred strategies usually adopted by science teachers at the primary level of education have been found not to promote effective science learning. Gultepe (2016) opines that science consists of both SPS and content. More of the SPS is required at the foundational level. This is sequel to the fact that science skills promote science achievement at this level. Gultepe (2016) argued that the western societies view SPS as one of the most important parts of science curricula. He argues further that ability to do inquiry equip pupils to investigate real life and to acquire science knowledge.

The ability to carry out inquiry (how children learn) are therefore the means by which a learner interacts with the world around him/ her using science procedure to satisfy his/her curiosity. Process skills allow children to process new information through concrete experiences (Jackman, 2009). Ehikameanor (2014) is of the view that the practical test in the sciences is always a test of the science practical abilities. SPS are a set of broadly transferable abilities and potential appropriate to science disciplines and reflective of the behaviour of a scientist (Padilla, 1990; Tek et.al, 2004).

Maranan (2017) defineSPS as one of the processes that scientists engage with when they study and investigate science. In other words, it is needed for inquiry. Bourdeau and Arnold (2009) cited in Olaniyi (2011) opine that science process skill is how scientists work, think, and study problems. Skills acquired can be utilized in all subject areas and may help in the growth of all domains of child advancement. In other words, it helps in the physical, emotional, social, and cognitive growth of pupils. In spite of the usefulness of science process abilities in conceptual understanding of science, they have not been given adequate attention by the teacher at the primary level by reason of the teaching strategy adopted by them. However, science process skills may be imbibed by pupils in primary school by using learner-centred approach. Sciences practical abilitiesarecategorized as basic or integrated skills (Collette and Chiappetta, 2004; Gultepe, 2016; Hernawati et al. 2018). The basic skills are fundamental to the integrated skills and it includes such procedures as observation, classification, prediction, measurement, inference, and communication Maranan (2017). Maranan referred to them as thinking skills when engaging in science activities.

Accomplishment of science practical abilities require the use of an active learning approach. This signifies pupils as an important agent in the learning process. Although there are so many factors responsible for learning, the learner takes the central stage, the need, therefore, arises to ensure that pupils take responsibility for their learning (Gubacs, 2004; Moylan,2008;Grant, 2011; Stefanouset et al.,2013) taking into consideration that teachers who are supposed to facilitate knowledge are not well equipped for the job. To be responsible for own learning and to imbibe the objectives of the 9-year basic education and the Basic Science and Technology curriculum, project-based learning is desirable as argued that inquiry learning is project-based learning (Kashin, 2020). The project-based learning approach may infuse all it takes to learn science as exploration, inquiry, reflective, and discovery. It affords children to be involved in direct learning and be able to develop critical and creative abilities (Kashin, 2020; Awodun and Osuntuyi, 2021).

Kortam et al. (2018) submits that project-based learning helps in promoting the objectives of Basic Science teaching at the foundational level. Also, it helps in the development of interest and promotes exploration, reflection, activity, and inquiry-based learning. It enhances the development of analytical and creative thinking for solution finding. Project-based learning through the activities of problem-solving; critical thinking, reflection, social interaction, communication, and shared responsibility promotes intellectual power development (Edelson et. al, 1999) which may help Nigeria not to be left out of the global economy. Furthermore, it is a teaching approach which is learner-centred as the curriculum content is driven by the project. It entails an investigation of an authentic question by the pupil to acquire skills and knowledge. The responsibility of learning lies more with pupils while the teacher scaffolds knowledge by monitoring and giving feedback to pupils as they progress in the investigation of the world around them using the curriculum content.

The study of science for national development necessitates the acquirement of abilities such as reasoning skills, creativity, collaboration, problem-solving, and communication which are needed to enter a knowledge-based economy. Most of the 21st-century skills are embedded in project-based learning such as collaboration, creativity, critical thinking, and communication. Therefore, there is a need to reform our science curriculum, particularly at the primary school level to inculcate 21st-century skills. One of the teaching strategies that may be adopted at this level is project-based learning which can enhance the global working environment (Wilkinson, 2014).

Although, no teaching strategy is totally bad, however, it is essential that the pupil who is who at the center of teaching and learning process be equipped to reason and apply knowledge gained to everyday situations and solve problems or challenges that may come their way. Studies have shown that pupils taughtusing qualityeducation,acquire more knowledge than other pupils (Darling Hammond, 2000; Goldhaser and Brewer, 2000).

High quality learning involves learning through activity and one of the best ways to learn is the ones that give room for learning through discovery and experience which may be achieved by using project-based strategy. FRN (2013) stressed the use of teaching approaches that are participatory, exploratory, experimental and child-centred. The child-centred approach involves engaging pupils in outdoor and indoor activities, the use of senses, learning of new facts, application of knowledge in new situation, collaboration and production of concrete objects; these are all embedded in project-based learning. When pupils interact with the learning environment, they ask questions thereby arousing their curiosity.

The approach also enables the pupil to interact with the material environment. Teacher-pupil project collaboration is a knowledge-based partnership between the teacher who is a more knowledgeable person and the learner who is guided by the teacher. The teacher scaffolds pupils' acquisition of science objectives using the project as the driving force to gather information on the science subject matter to solve a problem. The teacher identifies a problem in the community that is related to the topic of consideration. He or she formulates an authentic question that links the problem to the subject matter of consideration. The learners thereafter brainstorm using their acquired experience of the subject content to bring solution to challenges in their environment. This entails gathering information and use of critical and creative ideas. The teacher guides the learner by giving them necessary feedback at every stage of the project which may or may not involve the creation of an artifact. Finally, the result of the end product is communicated to an audience. The audience may be fellow pupils or the whole school.

Research has revealed that when pupils share views on what they are experiencing in and out of the classroom they learn more. Ertle et al(2007) posit that collaborative knowledge constructions add more impact on individual learning outcomes than individual prior knowledge.

When pupils collaborate, team spirit is promoted among them. Research has shown that peer influence is a key factor in socialization and learning.According to Sopekan, (2008) students who work in groups to solve the same problem can benefit from one another's knowledge and interest, which may have an impact on their decisions and the final product's quality and lead to the development of positive interest in science. He also emphasized that the collaborative learning approach seems to better facilitate pupils' problem-solving skills. It has been observed that each child is unique, and children have different academic abilities in a given classroom. Based on this, collaboration may be used to bridge the gap between high academic ability pupils and low academic ability pupils. Collaboration involves working together to get a task accomplished. There is a need to learn collaboration from primary school for lifelong utilization. It is a skill needed to relate successfully with peers and associates outside the school system to maneuver one's way through life. It is a skill needed in a job for a successful career. Team work improves the quality of lessons (Russel et. al, 2008).

Collaboration may be used to correct the impression that scientists work in isolation and to impress the view that the quality of inquiry is improved by the work of many people. There is a need to inculcate the idea that cooperative work improves scientific findings more than individual input (Baines et al, 2008). The skill of listening to others' views and knowing how to present our views is a lifelong skill that can be developed by science. There is the view that by working together to develop science achievement and processes, pupils are learning to live together. Moreover, Brophy, (2004) opined that class management and or cooperative teaching in science laboratories can help in science process skill acquisition. Teacher-pupil project collaboration is a cognitive and affective partnership between the teacher and the pupils on one side and teamwork between pupils on another side. The teacher is the more knowledgeable person in this collaborative enterprise who raises authentic question(s) in respect of the science concept to be learned. Pupils now put their heads together to solve problem in the community using their conceptual knowledge. On regular basis, the teacher gives feedback to the learners as to the progress made. Teacher-pupil project collaboration involves an oral presentation to an audience that criticizes the presentation. The criticisms now act as a guide to the correction of the project.

Teacher-pupil project collaboration involves gathering information from many sources such as text- books, online research, use of the library, gathering of information from resource persons and use of technology. In sum, teacher-pupil collaboration helps pupil to put their thinking abilities together by using science curriculum content to solve problem related to conceptual knowledge to be learned by the pupil. Project-based learning involves a complex procedure to execute, Coyne et al. (2016) cited in Kortam et al. (2018) argues that project-based learning strategy enables pupils to be more knowledgeable and grow their abilities through inquiry and involvement in complex problems and challenges and considering that most of the science teachers at the primary level are non-science teachers, there may be need to explore other strategies that will enable pupils to find out science fact on their own.

Moreover, science should be taught as stipulated in the national policy using discovery, explorative, inquiry and reflective approaches. Vision (2020) also stressed the importance of learner-centred approach believing that participation is essential to learning achievement. It is believed that pupils construct their own knowledge by interacting with the environment. Every child comes into the formal learning environment with preciously built knowledge, but when they interact with materials, there is the likelihood of modifying previous experience.

Science teaching should be explorative, discovery, inquiry and one of the strategies that is experiential is hands-on activities. Hands-on activity is a learner-centred approach in which the teacher facilitate knowledge.Hands-on activity approach allows children to be actively engaged with learning by using their hands and mind to gather information on the subject matter of the lesson. It is referred to as learning by doing. It is an experiential learning experience in which the learner engages in learning by participating in their education. This is however, contrary to memorization and rote strategy of teaching in the conventional classroom or teacher-centred mode of learning.

This learning approach is very crucial because it is specifically indicated in the national policy. FRN (2013) emphasizes the use of hands-on activities. However, this approach is not utilized by teachers at the primary level of education (Oshokoya, 2013 and Oduolowu and Akintemi, 2017) show that primary school teachers use teacher-centred strategy in the teaching of Basic Science. This is to be expected as primary school teachers were not trained to use activity learning strategy in the teaching of science (Salami, 2014).

Furthermore, learners have varying learning styles or learning preferences. For instance, some pupils learn more be sighting, while some learn more by hearing or touchingor as esthetic learners. According to Cleaver (2012), concepts are explained through tactile procedures, promoting skill acquisition as children practice new ideas and test out their hypotheses. When they engage in hands-on activities, their manipulative skills are promoted resulting in physical, emotional, and intellectual development. It is also believed that hands-on activities have implication for good health as it encourages pupils to move about both indoors and outdoors. Hands-on activities have positive outcomes as it engages and enables pupils to be focused(Awodun and Osuntuyi, 2021). Research has shown that the best way to engage kids' brains is by having them move their hands. Hands-on activity activates children's brains.

Scholastic (2009), argues that learning comes easily through visual and spatial activities between the ages of 4-7 years as the right side of the brain is developing.

Early childhood education research reveals that the first three years of life are crucial in terms of brain development. Hands-on activities involve movement, talking, listening, and thereby activating multiple areas of the brain. Dodge in Scholastic (2009) reasoned that the more parts of the brain one use, the more likely to retain information. It is an approach that encompasses all child development including language skill development because, in the process of interacting with the material environment, questions are posed to children that they need to answer. Hands-on activities are means of promoting play, the recommended means of learning in early childhood which Ekwueme et al(2015) sees as the medium where students are guided to acquire knowledge by experience.

In science education, attitude plays a significant role, this is because attitude determines behaviour and positive behaviour correlates with high achievement (Amjad and Muhammed, 2012). Kortam et al. (2018) believe that pupils' attitude is important for ensuring maximum learning and academic success. It has both cognitive and affective dispositions and it can be referred to as a mental predisposition towards objects, people, subjects, or events. Attitude has to do with our feeling about an object, people, or event (Mensah, Okyere, and Kuranchie, 2013; Lovelace and Brckman, 2013; Awolere, 2015) opined that attitude is the feelings we have for an object or someone which can be positive or negative and can influence our action towards such object or person. Attitude is crucial to academic achievementJackman, (2009) suggests that attitudes are formed early, therefore science education should be introduced to children at a very tender age. This will in effect equip children with the skills needed to study science and eventually lay the solid foundation requires to pursue science as a career.

Attitude to science determines if a learner will pursue a career in the sciences (Olasehinde, 2008). The intellectual ability or pupils' achievement which is consequent on the teaching strategy adopted by teachers affects pupils' attitude to science. The motivational ability of the teacher and the style of teachingare factors that have positive influence on pupils' attitude to science. A positive attitude is an indication of interest (Tenzin, 2019) which is one of the goals of Basic Science curriculum. A positive attitude to science will determine the level of commitment, and perseverance in the face of not-too-good learning environmental conditions. A high level of commitment and perseverance may foster higher achievement and the ability to make a career in science. It is therefore assumed that a project-based learning approach will influence pupils' positive attitudes toward science. Attitude as a concept has been researched yet the findings are inconclusive because attitude is influenced by several factors including gender. Alanamu (2014) posits that the belief and opinions of people affect girls' attitudes to science.

As earlier pointed out, learning outcomes are affected by many factors, although the teaching strategy predominates, other factors also contribute to the way pupil process information and retention of knowledge which affect the learning outcomes. Some of these factors include gender. Gender issue in science is predetermined by society which is a direct reflection of the culture and belief of the people in society. In Nigerian Society, the male is expected to have a compelling character such as being bold, strong, less dependent on adults, and to be daring when it comes to challenging activities while girls are expected to be gentle, submissive, and finally settle in the kitchen later in life. This may explain why female gravitates towards biological sciences while male towards physical sciences. Some studies indicate that girls, women, and some minorities are brainwashed into the belief that science is for boys and men.

Gender stereotypes started in most cases at home. Some parents believe that certain ability activities are meant for different sexes. In the past and even today some parents in the northern part of the country, Nigeria do not send their girl child to school, hence the prevalence of child marriage (UNICEF, 2014; Agusiobo,2018). Gender stereotype is not limited to home but rather enhanced by School.As earlier said, sex stereotype is advanced by School (Berks, 2011). Research findings revealed that boys are always favoured when it comes to answering questions in class. This may have a negative impact on girls who may feel neglected in the learning process.

Megalokonomou, (2021)shows that teacher bias against females is responsible for low enrollment of female in science, technology, and Mathematics. It has also been revealed that teachers also promote gender stereotypes as they encourage boys to handle challenging tasks in class while the not-so-challenging ones are left for the girls. The resultant effect is that primary school children begin to view some subject skills for boys and others for girls. According to Eccles, Jacobs, and Harold (1990), children see reading, spelling, art, and music as more for girls while they view Mathematics, Athletic, and Mechanical Skills as more for boys. Therefore, boys feel more competent in Mathematics, Science, and Athletics whereas girls feel more competent than boys in Language Arts, (Berk, 2012).

The media is not spared from this gender discrimination as television show scientist as a man. Gender-biased activities are exhibited in a television advertisement. Boys are given toys like an airplane, guns, toy cars, or trucks while girls are given toys like spoons, pots, plates, needles, and sewing material unconsciously inculcating the notion that some abilities are for boys and others for girls. Achor et al. cited in Adegoke (2016) thinks that gender discrimination seems to impede academic achievement in Nigeria.

Research has shown that women are underrepresented in science careers – girls, minorities, and people from lower socio-economic groups(Abdullahi et. al.,2019; Nzewi, 2010).These gaps may be bridged by using suitable teaching strategies that will enable girls to favourably be at par with their male counterparts Nzewi, (2020). Gender issue is of paramount importance in science skills development and this may explain why one of the goals of SDGs (2015) is gender equality. Although gender differences in the areas of mental ability have narrowed in advanced countries Halpern,(2000) it is still a factor in a place like Nigeria where cultural expectation plays a curial role in the educational system.

As earlier stated,differences between boys' and girls' mental abilities is narrowing partly due to the realization that science plays important role in everyday life and decision-making. According to Berks (2012), the educational status of parents is recently influencing gender abilities for both boys and girls, particularly in the area of physical sciences such as chemistry, physics, and mathematics. Agranovich and Assaraf (2013) argued that gender differences start manifesting right from primary school in that boys tend to like the physical sciences such as physics, chemistry, and mathematics while girls gravitate towards topics related to the human body, healthy lifestyles, and communication between animals. Empirical work had been carried out on gender influence on the acquisition of Science Process Skills (Iroegbu, 1998; Babajide, 2012; Bello et al. 2014).

These studies revealno significant moderating effect of gender on pupils' practical skills in Basic Science while (Shaibu and Mari, 1997; Ani, et al, 2021) show a statisticallysignificant difference in achievement of male and female exposed to experimental activities. Because of the disagreement, this research workwill examine the moderating effect of gender on pupils' learning outcomes inBasicScience. Also, the moderating effect of school type (public and-private) primary schools will also be studied.

Type of school in this research refers to public-owned and funded schools and privately owned and funded schools. Aransi (2018) define public school as a type of school funded by the government of the country with a low fee structure or without fee which can be at the national, state, or local government levels. While private school is a type of school funded by a private organization or non-governmental organization with a fee structure to meet the finances of such institutions and for profit making. When comparing public and private schools, several factors have been put forward in favor of the two schools.

Research is inconclusive on the issue of school type as it affects academic achievement. Research findings by Aransi (2018) shows a significant difference between private and public schools in terms of school facilities available, supervision, teacher quality, pupils' interest, the ability of pupils, introduction of incentives for performance; discretion in the choice of curricula and instructional strategies, taking into consideration pupils' interests and abilities, meeting parents demands concerning curricula, teaching strategies, discipline. Research has shown that many of these factors responsible for pupils' low performance in science can be grouped as teacher factors and school-related factors. The teacher-related factors are inadequate pupils' activities, poor instructional strategy, inadequate preparation, and inability to comprehend questions while the school-related factor includes inadequate instructional material, teacher's motivation, supervision, teacher's mastery of curriculum content to mention a few Balarabe cited in Enemaire (2019). Other school-related factors according to Dronkers et al. (2005) are school climate such as administration, availability of resources, with teacher quality all of these affect science Process Skills acquisition.

Dronkers et.al (2005) argues that private schools are more effective than public schools in cognitive outcomes in reading and mathematics after controlling for parent composition. They explain that a better school climate in private government dependent school is a plus to the development of science-practical activities. Although the same study reveals that public schools are more effective than private government independent schools in 19 OECD countries. Aktamis and Yenice (2010) shows that pupils who attended schools with high socioeconomic status had higher Science Process Skills than pupils from middle and low socioeconomic. Ashinwo (2011) reveals the moderating effect of school typeon the academic achievement of secondary school students in Biology. Jack (2013) found that there is no significant difference using school type as an independent factor in the study of influence of identified students and school variables on pupils' science process skills acquisition. Therefore, there is the need to reckon with school type in a study that involves instructional strategies and science learning.

1.2 Statement of the problem

The importance of science as a tool for technological advancement and problem-solving in any nation cannot be over-emphasized. Therefore, acquisition of necessary scientific knowledge, skills and the right attitude to science is crucial for science learning outcomes that will enhance positive development. Studies have shown that teacher-centred approach adopted by the teacher at the primary school level has failed to connect the school curriculum with societal needs and circumstances and this has led to poor academic performance in science, poor attitude and inadequate science process skills. Quality science education requires learners' active participation that will relate what they learn in the classroom to their environment. In other words, science classroom activities and societal issues have not been linked at the foundational levelAlso, teacher–centred teaching strategy has not enabled learners to acquire the needed skills to explore their community and consequently, their knowledge of science is shallow which in turn affects academic achievement. At the foundational level, skill acquisition is germane to achievement which invariable lead to the development of positive attitude. The not-good attitude pupils carry to other levels of education affects the basic science objective of career opportunities in science and positive decision making in society.

Interventions in basic science have always placed emphasis on improving pupils' academic achievement and skill acquisition neglecting to connect classroom activities to community issues. The reason being that majority of the teachers are not science specialists and since there is no instructional package with identified community-based projects related to the science topic for them to use. This study, therefore, designed an instructional package that will guide teachers on how to use the curriculum content to address community challenges. The study is presenting a simple way of planning and assessing activity-based instruction. It was intended to determine the effect of teacher-pupil project collaboration and hands-on activity-based strategies on acquisition of science process skills, knowledge and attitude to science in basic science at the primary school level. The main effect and interaction of gender and school type on the acquisition of the science process skills, knowledge and attitude to science were also studied.

1.3 Objectives of the study

The main objective of this study is to determine the effect of teacher-pupil project collaboration and hands-on activity-based strategies on science SPS, knowledge and attitude to science development in basic science at the primary school level. The specific objectives of this study will include the following:

I. Determination of the impact of the intervention (treatment), pupils'sex (gender) and type of school on the learning outcomes of pupils in BS

II. Determination of the 2-way interaction effects among intervention (treatment), pupils'sex(gender) and school type on learning outcomes of pupils in BS; and

III. Determination of the 3-way interaction effects of intervention (treatment), pupils'sex (gender) and school type on learning outcomes of learners.

1.4 Hypotheses

Seven hypotheses were tested at 0.05 level

H_o1: There is no significant main effect of treatment on pupils':

1. Basic Science Process Skills
2. Basic Science Achievement
3. Attitude to Basic Science

H_o2: There is no significant main effect of gender on pupils':

1. Basic Science Process Skills
2. Basic Science Achievement
3. Attitude to Basic science

$H_0$3: There is no significant main effect of school type on pupils':

1. Basic Science Process Skills
2. Basic Science Achievement
3. Attitude to Basic Science

$H_0$4: There is no significant interaction effect of treatments and gender on pupils':

1. Basic Science Process Skills
2. Basic Science Achievement
3. Attitude to Basic science

$H_0$5: There is no significant interaction effect of treatment and school type on pupils':

1. Basic Science Process Skills
2. Basic Science Achievement

3. Attitude to Basic science

$H_0$6: There is no significant interaction effect of gender and school type on pupils':

1. Basic Science Process Skills
2. Basic Science Achievement
3. Attitude to Basic science

$H_0$7: There is no significant interaction effect of treatment, gender and school type on pupils':

1. Basic Science Process Skills
2. Basic Science Achievement
3. Attitude to Basic science

1.5 Scope of the study

This study was carried out on primary five pupils in both private and public schools from six primary schools drawn from three local government areas that were randomly selected from Ibadan metropolis of Oyo State in Nigeria. Ibadan metropolis was chosen because of the heterogeneous nature of the city. All ethnic groups in the country are fully represented in Ibadan metropolis. Primary five was chosen because they are at a concrete operational stage of cognitive development. At this stage, they can reason and view other's points of view and they can communicate their thought. All these attributes are necessary to carry out a study adopting project-based learning.

This study focused on teacher-pupils project collaboration, hands-on activities, conventional strategy, with the effect on pupils' learning outcomes(BSPS, BSA and ABS) in Basic science in primary school. The study also took cognizance of the fact that other factors apart from the teaching strategies affect pupils' performance, therefore gender and school type moderating effects were considered.

It has been argued that girls do well in the biological sciences than boys while boys perform better in the physical sciences than girls. Therefore, the topics for this study were purposively selected to show the integrated nature of basic science. The concepts selected for the study are human bones and joints, reproduction in plants, acidsand bases, and heat and energy. The topics were selected from the science curriculum for primary five.

1.6 Significance of the study

The purpose of this study was to establish the efficacy of teaching science with teacher-pupils project collaboration and hands-on activity. It is therefore, expected that this study would enable pupils to learn science more effectively as teacher –pupil project collaboration would foster better academic achievement which may enable pupils to change their attitude to science learning.Consequently, pupils may be encouraged to pursue a career in science and technology. This may advance the development of science and technology needed for national development.

It would enable pupils to have first-hand interaction with the process of science which would enhance their manipulative skills, communication skills and collaborative skills which may help them to have a better chance to compete effectively in the labour market.

There would be opportunity for teachers to improve their teaching strategy as both the learner and teacher benefits from the learning process. It would expose teachers to project -based lesson plan that would relate what is taught in the classroom to real life situations and thereby improve pupils' problem-solving skills.

Furthermore, it may enhance the production of resources for pupils to learn from as teachers will be left with no choice than to make materials available for pupils to interact with or at best improvise for the teaching and learning process. Teacher –pupil project collaboration promotes not only the cognitive domain but may foster the development of other domains of learning such as affective, psychomotor.

The result of this study may further enhance restructuring of the primary school curriculum to reflect the nature of science as activity-based subject and the need for concerned authority to ensure and enforce the teaching of science as active and child-centred activity rather than the passive approach employed. The production of artifacts may positively influence better teaching as the artifacts produced may be used for teaching.

1.7 Operational definition of terms

For the study, the following terms are operationally defined as follows:

Teacher-pupils project collaboration: This is project-based learning in which the teacher and pupils work together on a project derived from a science concept in a problem-solving manner to get an understanding of the conceptual knowledge of the curriculum content and to acquire needed skills. The project links the classroom to society by using knowledge acquired in the classroom to solve real-world problems.

Hands-on activities: This is an activity-based strategy that involves pupils handling and manipulating objects to gain knowledge or understanding of a concept.

Learning outcomes: These are the specific objectives the study measured. They are basic science process skills, basic science achievement, and attitude of pupils to basic science.

Basic science process skills: The ability to pay close attention to many details about objects using our senses to identify the characteristics of such objects, to differentiate them from other objects and the ability to carry out simple scientific procedures and arrive at conclusions based on observation. The skills for this study are observing, classifying, predicting, inferring, and communicating usually classified as basic science process skills. The skills were assessed by usingBasic Science Process Skills Rating Scale (BSPSRS)

Attitude: Thisis the feeling with behaviour of pupils toward science learning. The ability to persevere and be committed, not giving up in the face of perceived difficulty. These were assessed by use of a Questionnaire on pupils' Attitudes to Basic Science (QPABS)

Basic Science achievement: This has to do with pupils' academic performance in a given set of achievement tests based on selected basic science concepts. This has to do with pupils'knowledge of science concepts which can be testedin the ability to remember, understand and utilize scientific concepts and it will be assessed usingBasic Science Achievement Test (BSAT)

Gender: This has to do with the sex of pupils and placing them as either male or female.

School type: This has to do with a school being owned and funded by the government or owned and funded by an individual or group of people. The school owned by the government is referred to as a public school while the one owned by individuals or group of people is referred to as a private school.

CHAPTER TWO

LITERATURE REVIEW

2.1 Theoretical background

This study is based on two educational theories. First, the Cognitive Development theory of Piaget (1936) and secondly, Lev Vygotsky's (1934) theory of social learning.

2.1.1 Piaget's Theory of Cognitive Development.

Jean Piaget (1936), states that children actively construct knowledge of the world around them as they manipulate and explore their world (Berk, 2012). To Piaget, cognitive development was a continuing building up of mental processes as a result of brain development and environmental experiences(McLeod, 2018). In other words, new knowledge is acquired as the child matures biologically combined with theirinteracts with new experiences. This intellectual growth Piaget said, is a result of a process called adaptation (adjustment) to the world. This happens through assimilation and accommodation (Wadsworth, 2004). The process of assimilation involves incorporating new experience in an already existing guideline which Piaget called schema without changing the framework while accommodation is the process of tailoring one's mental representation of the external world to fit new experiences. Assimilation and accommodation are the basis of active, discovery, and inquiry learning and can be used to acquire problem-solving skills because problem–solving skills cannot be taught, they must be discovered (McLeod, 2018).

Children's interaction with the real world allows them to handle concrete objects and, in the process, their prior knowledge is modified if the new experience or the task does not fit into the already existing schema. This modification is what is explained by Piaget's assimilation and accommodation processes in cognitive development. Piaget believed that the prior knowledge is transformed if it does not agree with learners' new experience which he termed the state of disequilibrium, but that equilibrium is restored as the new information fits into the existing schema. Oktay and Oktay (2016) believe that prior knowledge, the teacher's role, the learner's role, the classroom and parent participation are important in knowledge construction. Learners construct knowledge by interacting with their environment and by the process they manipulate or handle materials as they carry out the project work. Each child comes into the learning environment with a preconceived knowledge called prior knowledge which may be wrongly constructed. When learners come in contact with a concrete object, a state of disequilibrium is established but equilibrium is restored when the new information is successfully assimilated and accommodated. Bearing in mind Piaget's transformation of knowledge, as learners manipulate an object, they may experience something new, initially, their previous knowledge may not agree with the new experience. The previous schema of knowledge is therefore modified to accommodate the new experience which Piaget called accommodation.

Children should be active participants and not passive in their learning. In order words, they should learn through activities. Knowledge construction and experience are two important factors in Piaget's cognitive development, meaning that children should act on the environment for knowledge construction. This brings us to the issue of nature and nurture in knowledge construction. Research has shown that children's experiences during the first years of life are strongly associated with long-term cognitive, emotional, and social outcomes (Duncan, Ziol-Guest, and Kalil, 2010).

The second issue is the manipulation of the environment. Manipulation involves handling, touching, moving, use of objects in the wiring of the brain and the object for manipulation must be from the real world. It is because of this that hands-on activity is a variable in this study because hands-on activities foster first-hand knowledge of a structure. Through a hands-on activity, learners interact with the learning material, they can handle, touch and examine the texture, structure, and features of the material for learning. Consequently, they can construct new knowledge and modify their prior knowledge if it does not tally with the new experience. When a child is guided in task completion, the opportunity opens for learning by doing and thinking which research shows is effective in promoting positive learning outcomes. In other words, learners can acquire science skills, knowledge of the subject content, and the desired attitude toward science.

Based on Piaget's theory, the educational implication is that pupils should be centrally placed in education while the teacher is a guide or knowledge facilitator Therefore, the teacher should focus on the process of learning and not the product. The use of active, participatory, and inquiry strategy of education, such as project and activity learning should be adopted by the teacher. The environment of the child should be enriched with material resources from the community which they can interact with for cognitive development, particularly at the primary school level for long-term cognitive, emotional, and social learning outcomes.

The shortfall in Piaget's cognitive theory as pointed out by criticism is that children's activities in the environment alone accomplish no knowledge construction but that factors like the input of the teacher, and the social and cultural experiences of the pupil also are curial in cognitive growth. For instance, the significant others and the culture of the child are key in knowledge construction (Vygotsky 1936). Also, Piaget's theory was criticized for neglecting to include training, variation in children's thinking, context, and culture in his theory. They argued that when tasks given to children are simplified from one level of difficulty to another and made relevant to their daily experience, they can construct knowledge in a way that is closer to adult reasoning and that children's performance on Piagetian problems can be improved with training (Berk, 2011). Therefore, constant training and scaling down the science curriculum from known to unknown and considering pupils' prior knowledge in curriculum planning is essential for positive pupil learning outcomes which this study will undertake. Constant training in terms of using their hands to manipulate and production of artifacts are some of the factors to cater for in lesson preparation.

Moreover, research work has established that children acting on the environment alone does not foster advanced knowledge construction. It has been suggested that other avenues like verbal teaching and corrective feedback be included in lesson preparation (Brainerd, 2003 cited in Berk, 2011). The verbal teaching and corrective feedback may be given by an adult, in particular, the teacher. If children can act on the environment alone for knowledge construction, they need not go to school. The implication of this in the educational setting is the need for facilitators who can guide pupils in knowledge construction that may be in form of scaffolding and corrective feedback. In other words, the place of the teacher as a facilitator in teaching is also very important apart from the child who is at the center of learning. The role of the teacher as a more knowledgeable adult giving corrective feedback and scaffolding is explained by Lev Vygotsky's theory of socio-cultural learning.

2.1.2 Lev Vygotsky's Sociocultural Theory of Learning

According to Lev Vygotsky's social learning theory (1934), people learn from one another and co-construct knowledge. Vygotsky was of the opinion that learning is socially created between the learner and an adult or peer with greater experience (Berk, 2014).

His theory is primarily focused on three themes: social-cultural, zone of proximal development, and scaffolding. In the sociocultural perspective,a child's mind is moulded by the society in which they live and learning is based on the materials available in that society.According to this theory, learning is centered on the child and knowledge is placed and collaborative (Gauvain, 2013).The adult, who can be a teacher or a more experienced peer, aids the child in building knowledge. Santrock (2014) urgesthat cooperation and social engagement are the best ways to advance knowledge.In this way, the teacher facilitates learning, but the students collectively construct the project.

The Zone of Proximal Development (ZPD):Lev Vygotsky held the opinion that children learn best in their zone of proximal development.He said that some things that are challenging for pupils to complete on their own could be completed with the assistance of an adult or more experienced peer.He emphasized the impact of culture and significant people in a child's life, saying that these factors have a big impact on how children think. He held the opinion that some challenging tasks that a young child cannot complete on their own can be completed with the assistance of a more experienced individual.Additionally, he thought that a child's culture had a big impact on how they learned things.There are two sides to this claim. The impact of help from others, such as a teacher or a classmate with greater experience, comes first. This encourages a type of group knowledge construction that a child cannot achieve on their alone.He coined the term "zone of proximal development" (ZPD) to describe the child's new level that was obtained with aid from others. The zone of potential development (ZPD) has two dimensions: the level the learner can reach on his or her own and the level he or she can reach with others, which is referred to as the level of potential development (Santrock, 2014).

According to Tappan (1998), dialogue is an important tool of scaffolding. Santrock (2014) believes that the adult or more skilled peer can help the learner to organize his thought through dialogue. He also believed that the task in the ZPD is too difficult for the learner to perform alone.Therefore, he or she needs help from an adult or a more experienced peer. He is also of the mind that as learners experience verbal instruction or demonstration, they organize the information into existing structures so that they can eventually perform the skills or task alone.

As mentioned earlier, the sociocultural aspect of the area of instruction is very important in cognitive development. The background of the learner is very important in the development of their thinking abilities. According to research, interacting with other pupils, adults, and the real world helps children develop their cognitive skills. Thus, from the social constructivist perspective, it is crucial to take the background and culture of the child or learner into consideration when designing their learning curriculum as this significantly impact the knowledge and the truth that the learner creates, discovers and attains in the learning process (Wertsch, 1917). Therefore, whatever project is to be produced should be something related to the local environment of the child or learner.

The application of Vygotsky's theory in this study is that knowledge is cooperatively constructed between the more knowledgeable person who is the teacher and the learner. Learning material is selected from the environment of the learner through the guidance of the teacher who creates an open-ended question on which the learner now formulates a project in line with the topic of the curriculum. The project formulated has to do with solving the problem in society and this is done by grouping learners together in project production. The project serves as a new experience that the learner interacts with for knowledge construction. Through project production, the thinking faculty of the learner develops, and gradually she becomes a critical thinker. The teacher acts as a guide. He or she clarifies difficult issues as learners make progress in the learning process.

The second aspect of Lev Vygotsky's sociocultural theory is the impact of socialization on learning. In science learning, collaborative work with others is very important. Science discoveries were done as a result of the collaborative work of many scientists. It is therefore imperative that children start working with others right from primary school. This skill will not only help in learning science but will equip the child with skills needed for the workforce. According to Vygotsky (1962), social interaction promotes children's scientific development, especially where it is supported by concrete experience that has its foundation in previous knowledge (Piaget, 1929).

A lot has been said about knowledge construction by the child. This knowledge construction is based on a child's experience which can be limited. It is the responsibility of a more experienced person like the teacher to guide the child in knowledge clarification by giving feedback to the child as he/she learns. The child has the privilege of learning from the teacher or peer and learning are consolidated as there is a pool of brainstorming. Young children by nature can make a sophisticated and detailed observations, they can get distracted easily and may need support to refocus. This is the main reason why Teacher- pupils' project collaboration comes in. A knowledgeable teacher helps to scaffold children's scientific knowledge processing and at the same time learn from the learning process.

The project collaboration strategy is a learner-centred instruction that enables child interaction with the learning objects. It ensures that the learner in partnership with the teacher is exposed to concrete objects through the guidance of the teacher to a local project in the community which will stimulate the thinking faculty of the learner to knowledge construction.The ability to achieve in science is strongly influenced by early learning. It is believed that the window for assimilation of scientific skills that open at the early stage is a good beginning for science learning. This is a result of the findings that what children fail to do at an early stage may lead to developmental delay. Therefore, this study will encourage children to feel, see, hear, and use all their senses to explore the world around them as early as possible. This may enable them to be better scientists in terms of skills acquisition and may improve their attitude to science.

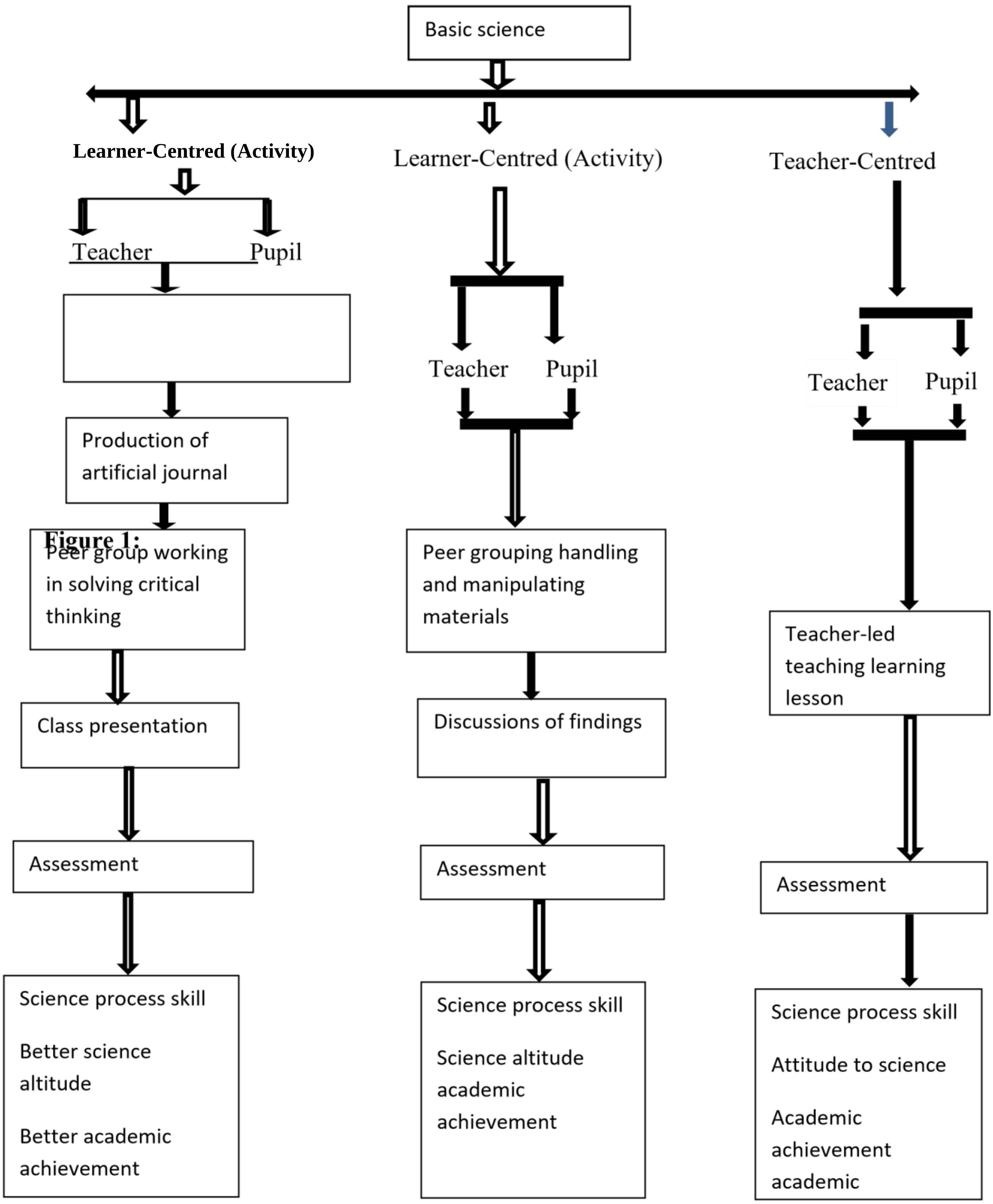

Fig 2.1: Conceptual framework of teacher-pupil collaboration, Hands-on activities and convectional teaching strategies

2.2 Conceptual review

2.2.1 History of BSeducation at the primary level in Nigeria.

The primary level of education is very important because it lays the foundation for future learning and it is the level at which children decide their career choices. Therefore, the need to put a searchlight on Basic Science education at the primary school in Nigeria.

The outcome of any educational programme is determined by the objectives, goals, aims, and implementation of such a programme. This, therefore, explains the output of the missionary and colonial government's educational activities in the 19th century. The purpose for which education was introduced by the missionary was to produce assisting workers for their missionary endeavours (Osokoya,2011). To achieve their goal, the curriculum was structured basically for literacy acquisition. Consequently, science education was not given the required attention it deserved. Science was taught as nature study in primary schools established by the missionaries in the 19th century because the aim was not to develop the nation scientifically. This is not surprising as the goal of educational operators at that time was to achieve their personal goals against national development.

In 1908, an education ordinance by the colonial government stipulates the condition for which grant-in-aid could be awarded to missionary schools. It was this ordinance that prompted the missionary and colonial government to introduce science education in Nigerian schools. The grants in aid helped in the procurement of laboratory equipment for science education by the missionaries. On the part of the colonial masters, the few secondary schools established by them taught science to the required standard. For instance, Kings College Lagos was the only school that offered science to the standard of Cambridge for many years. Some of the problems of science teaching during this period (colonial and missionary era) were inadequate teaching materials, inadequate teaching staff, and lack of uniform curriculum, and foreign curriculum content.

All the aforementioned problems are still plaguing science education in Nigeria till today. The foreign curriculum content with inadequate teaching material led to the teaching of science in abstraction, using rote and memorization strategy, these teaching approaches are still very much with us. However, the establishment of the West African Examination Council in 1950 and the need to indigenize the educational system led to the change in the examination syllabus.

The Nigerian science teachers met in 1957 to launch the Science Teachers Association of Nigeria (STAN) after recognizing the value of science in national development. STAN as a body was instrumental to change in teaching of science content and strategy.STAN was also instrumental to establishment of the integrated science project. Since the establishment of the integrated science project, science education has not remained the same. Nevertheless, the national curriculum conference of 1969 led to the development of science curriculum for primary level of education.

It can be inferred that the foundation for science teaching was not properly laid. Teaching of science at the primary school could have laid a solid foundation for science education but instead science education started at the secondary school.According to Brown (2015), the Ford Foundation, along with the Federal Ministry of Education, established the Comparative Education Studies and Adaptation Centre (CESAC), situated in the University of Lagos, in 1967 as one of the initiatives taken to organize science teaching. The modus Operandi of CESAC was to study the educational system of the nation and proffer solutions that are dynamic to meet the needs of Nigerian society. CESAC as a body concentrated on curriculum development for secondary schools instead of starting at the primary school level. This also shows that science education in Nigeria had always focused on secondary level of education than the pre-primary or primary level.

Primary education in Nigeria, is a constituent of basic education which covers a period of 9years.Nigeria's basic education consists of three years of junior secondary school and six years of primary school (FRN, 2013).. It is generally called Universal Basic Education (UBE). This level of education has evolved right from when missionaries introduced formal education in Nigeria. The curriculum then was the 3Rs (Reading, Writing and Arithmetic). Due to regionalization of education in 1954, each region in Nigeria started its educational programme.

The western region launched the Universal Primary Education (UPE) in 1955 while the eastern part launched its Universal Primary Education in 1957 (Osokoya, 2011). Launching of Universal primary Education did not take place in the north until after independence due to the following factors: religious and cultural issues and human and material resources shortage and inadequate data collection procedure (Obidi, 1988). Despite independence in 1960, education policy was still controlled by British policy until the federal government took over schools in the nation. However, in 1976, the national Universal Primary Education was born in Nigeria (Iroegbu, 2017) but the federal government could not cope with the huge financial responsibility of education.Due to financial limitations, UPE was amended in 1981 and 1990, and in 1993, federal, state, local governments took on the responsibility for paying UPE. In 1999, UPE underwent revisions to become UBE.With this new scheme there was need for a new curriculum (NERDC, 2013).

Due to Nigeria's participation in international education issues like Education for All (EFA) and the Millennium Development Goals (MDGs), the 9-year Basic Education Curriculum (BEC) was created and implemented in Nigeria in 2008 to fulfill the objectives of the Nigeria Economic Empowerment and Development and strategy (NEEDs).The aim of NEEDs was to bring value orientation, reduce poverty, create jobs, generate wealth and use education to empower people. However, the 9-year basic education was reviewed and compressed because the subjects were many therefore, twenty subjects were compressed to ten. The review was necessary because of global best practices and emergent issues.

At the onset, the aim of developing the (BEC) was to ensure that learners who had completed the 6years of primary education and 3years of junior secondary school should have acquired basic numeracy, literacy and long-life skills, basic knowledge in science and technology. Basic rudiments for creative thinking and development of the foundation for technical, vocational and entrepreneurship culture and finally to imbibe high moral values and ethical standards. Out of the ten subjects, Basic Science and Technology became a core subject. It consists of Basic Science, Basic Technology, Physical and Health Education, and Information Technology. These subjects also form the theme while the broad topics form the subthemes.

Basic Science and Technology (BST) curricular goals according to teachers Guide are to enable learners: develop interest in science and technology, acquire basic knowledge and skills, application of scientific and technological knowledge and skills to meet societal and personal needs, to become aware of the numerous career opportunity provided by science and technology, to become prepared for further studies, avoid drug abuse and related vices and be security conscious.The curriculum content is arranged in spiral form which means the topics have been spread across classes from primary one to primary six. The topics in the curriculum re-occur at different class levels. But each time a topic occurs, it is treated in greater depth and broader scope based on the age and intellectual capacities of the learner. Going from simple to complex as they advance in age and intellectual capacities. According to the teacher's Guide, as the age capacity of learners increases, the curriculum contents increase in scope and depth. The implication of this is that it helps learners to build on their previous experience or knowledge as they move from one level to another.

The BST curriculum is a compound one in the sense that four themes have been fused into one. The curriculum aims at teaching and learning to be activity based, to use plenty of resources from the school and community of the learner and if possible, the learner should bring some of the resources from their homes, which it views as part of learning through activity. To use plenty of learner's activities, the strategy of teaching should always be learner-centred and the teacher as knowledge facilitator who guides pupils by giving suggestions and answering all their questions or lead them to find answers themselves. Collaboratory efforts or group work will help make the learners teach one another or learn from one another.

The emphasis now is on teaching of basic science using inquiry and discovery strategy. Inquiry and discovery approaches are learner-centred that necessitate the use of activity-based teaching strategy. Activity based learning approach is better utilized using different strategies and this can be done by using the project teaching strategy. Project-based teaching strategy is inquiry, discovery, explorative and it is an interwind of many teaching strategies. For instance, project-based learning involves the use of brainstorming, cooperative learning, peer tutoring to mention but a few.

2.2.2 Strategies commonly adopted to teach Basic Science in Nigeria

Teaching strategies are the totality of what the teacher puts into the learning process to assist pupils to learn. These include the structure, system, methods, techniques, procedures, and processes the teacher use while teaching(Aladejana, 2018), while the teaching strategies are the various styles adopted by the teacher to achieve the subject objectives. Teaching strategies in science can be broadly grouped as teacher-centred or pupil-centred strategies

Teacher-centred strategy

The teacher serves as the knowledge source in this content-focused teaching methodology. The main goal of this strategy is to teach and measure the pupils' knowledge based on assessment and tests. In the teacher centred teaching strategy, the strategy commonly used is the lecture and demonstration strategy's (Osokoya, 2013; Salami, 2014; Aina and Keith, 2015; Muhammaand, et al., 2016; Kortam, et al. 2018). The lecture strategy of teaching is characterized by memorization, rote learning and asking of rhetoric questions (Osokoya, 2013). The pupils sit passively while the teacher does the talking and make use of the chalk board. It is not activity based or explorative. The advantage of the lecture strategy is that many topics can be covered within a short time in a large class. The disadvantage of this strategy is that it does not promote critical thinking, creativity, problem solving and science process skills that a science pupil should possess.

Lecture strategy is a teacher centred strategy of teaching because it is dominated by teacher activities and the pupils taught by this strategy do not learn as much as those taught by pupil centred strategy (Franklin, Sayve, Clark cited in Aina et al, 2015). The lecture strategy is characterized by rote learning and memorization. It is a one-way learning process and the emphasis is on information rather than the learner (Salami, 2014; Aina el al, 2015). Lecture strategy is mostly used in upper classes than at the foundational level.

Despite the requirement that fundamental science instruction be practical, activity-based, immersive, and supported by IT (FRN, 2013), yet most teachers in primary schools still use the lecture strategy for a number of reasons. Firstly, most science teachers in primary schools are non- science specialists (Osuafor et al, 2013). A single teacher is made to teach all subjects irrespective of her/his subject qualification. According to (Osuafor, et al, 2013; Salami, 2014), the training of these teachers at the pre-service level was mainly theory oriented, in other words, the teachers were not exposed to activity-based learning which therefore informed their teaching strategy. For instance, Salami (2014) finds out that pre- service teachers were taught by either highly modified lecture or slightly modified lecture strategy. None were discovered utilizing a student-centered or activity-based approach to teaching mathematics.The students' poor performance in the Basic science examination result analysis provides evidence that this teaching technique is ineffective(Osuafor et al, 2013). The implication is that pupils' learning is influenced by how they are taught (Abbulhamid cited Muhammand et al, 2016). Consequently, this demands a change of teaching strategy that will foster pupils thinking and creative abilities.

The demonstrative method is yet another approach that is frequently utilized in the instruction of fundamental science. This strategy can be teacher centred or teacher and pupil centred depending on the teacher. If after demonstration by the teacher, the pupils are allowed to practice, then it becomes both teacher and pupil centred. Demonstration strategy is teacher centred. Demonstration strategy involves some experimentation (Igboegwu and Egbutu 2011).According to Nwachukwu and Nwosu (2007), the demonstration approach can be used by the teacher for students to watch or participate, or by a student for the teacher and other students to see. The advantage of this strategy is that the teacher can demonstrate where there are limited instructional materials, dangerous chemicals or where the equipment is complex for children to handle or the class is too large. This may involve small group or individual pupils (Igboegwuand Egbutu, 2011). This strategy can be learner centred if the pupils are given opportunity to practice after teacher's demonstration. Nevertheless, it is activity based.

2.2.3 Child-centred instructional strategies

The child is an active participant in the learning process when using child-centered instructionaltechniques. The teacher relies on peers helping each other, but communication is essential. Several teaching strategy may be employed by the teacher to promote science learning. Miles cited in Aina, et al (2016) are of the opinion that any instructional strategy that will promote significant result is a strategy that promotes the best social interaction which can be between pupils themselves or between teacher and pupil. Salami, (2014) is of the opinion that teaching objectives are achieved when there is maximum interaction between teacher and pupil and between pupil and pupil. Using real life objects is the primary characteristic of an activity-based educational technique, which is child-centred and that this strategy can birth learning of novel skills,and gaining of other experiences through active engagement of learner in the process of knowledge acquisition. Child-centred strategies that promote social interactions include cooperative, brainstorming, jigsaw, role play, project, demonstration, and problem-based teaching strategies.

Cooperative learning strategy is an educational approach by whichstudents collaborate in small groups, everyone participates in collective task clearly assigned without direct or immediate supervision from the teacher (Oortwijin et al. 2008; Okoli,2009). Cooperative learning is child-centred. It promotes team spirit or social interaction and participation of learners by using their critical and creative skills. It involves brainstorming as learners' ideas are brought into the learning process to accomplish the common task. According to Koya (2015) cooperative learning promote deep learning of materials, it helps pupils to achieve better grades than individual learning, enhances social skills and personal growth development.It is one of the competencies required for the workforce and for 21st-century teaching and learning processes. A lot of discoveries have been made due to the cooperative attitude of scientists. Studies have revealed that this teaching strategy is effective in promoting academic development of pupils (Johnson and Johnson, 1998). Tran, (2019) finds cooperative learning to better promote students' motivation than lecture strategy. Studies show that student learn more effectively when working together than apart and it is also known to improve self confidence in learners (Muttaqin, 2016).

2.2.4 Collaborative Project Strategy (CPM)

Collaboration is one of the 21st-century skills.The focus of collaborative learning (CL), according to Swain (2000), is on the reciprocal discovery of a subject through social interaction with peers and with students and teachers. Collaborative learning is one of the most significant and successful ways that learning may occur.A situation in which two or more people attempt to learn something jointly is described by Dillenbourg (1999) as collaborative learning. In this meaning, "two or more people" might refer to a couple, a small group of three or five learners who collaborate to complete a task.Group of students work together to solve problems, perform tasks, or develop products as part of the collaborative learning method of teaching and learning.Collaborative learning is founded on the premise that learning is a naturally social act in which the participants converse among themselves, according to Gerlach (1994). According to Smith and MacGregor (1992), collaborative learning follows a set of assumptions in the learning process

- Learning is an active process in which students take in the knowledge and connect it to a foundation of prior knowledge.

Learning necessitates a challenge that allows the learner to interact with peers, digest material, and synthesize it as opposed to memorization and regurgitation.

- Students gain from exposure to varied points of view from persons from various backgrounds.
- Learners thrive in a setting where there is conversation between students. The students develop a structure and meaning for the dialogue during this intellectual discussion.

As they listen to various points of view and are asked to explain and defend their opinions, students in the CL environment face social and emotional challenges. By doing this, the student starts to develop their own special conceptual framework that does not depend on the framework provided by an expert or text. Thus, in a CL situation, students have the chance to interact with peers, defend ideas, exchange different opinions, challenge other people's conceptual frameworks, and actively participate. A long-term project, asking a question, and asking students to exchange their thoughts with their neighbors are some of the CL procedures. A paradigm change has occurred from a teacher-centered to a learner-centered approach to teaching.

The Collaborative Project Strategy (CPS) is a project-based, investigative learning process. In their definition of project learning from 2016, Chiang and Lee said that it is a method by which knowledge is created by transforming experience. Based on the constructivism ideas of Piaget and Inhelder (1969) and Lev Vygosky (1978), it is a child-centered approach. Yager (2002) and Aldabbus (2016) opine that PBL helps pupils to solve problem in authentic situations by collaborating with peers. This problem -solving exercise is necessary in project -based learning because in order to use PBL, a problem is created but the way the problem is resolved by the pupil in collaborative manner promotes pupil’s problem-solving skills. Project can be done individually or in groups (Kizkapn, et. al, 2017; Aldabbus, 2018).However, project-based learning promotes teamwork in order to address an issue which can be a challenge in the society (Larmer and Mergendoller, 2010; Aldabbus, 2018; Chiang and Lee, 2016; Kizkapan and Bektas, 2017; Kortam et. al 2018). Teacher- pupil project collaboration encourages the teacher to prompt learners thinking process. This is a kind of scaffolding approach that helps pupils to organize their thinking process around a project. Dialogue is involved in the teacher and pupil collaboration. It helps the teacher to establish prior knowledge of pupil thereby facilitating curriculum planning and lesson coordination. Both the teacher and the learner benefit from the learning process.

Research has shown that when children are given a significant opportunity to use a large number of diversified activities when learning science, they benefit a lot. Children experience their world by activities such as exploration, communication and explanation, consequently, their problem solving, critical, and creative skills are developed (Harris, 2002 and Solomon, 2003). Hernawati, et al (2018) urged that project work help to fill the gap between technical theoretical education and real-world.In solving problems, pupils are forced to look for information and resources outside the classroom, which broadens their conceptual knowledge and skills. In problem solving, the thinking skill is employed to maneuver the problem they encounter which may foster their thinking and creative abilities. Chiang and Lee, 2016 are of the opinion that PBL facilitates learning achievement and motivation of pupils in many studies. Consequently, pupils' motivation promotes pupils' positive attitude.

Frank and Barzilai (2004);Filippatous and Kaldi(2010); Aldabbus (2018), and are of the opinion that PBL is a student-centred teaching strategy based on constructivism which is very effective in science classes. It encourages teacher, peer and pupil collaboration by generating a constructive feedback to each other. In this process the pupil is able to revise and modify their work according to the feedback received from the teacher or peer. This type of classroom environment ensures self-education rather than rote learning. Aldabbus (2018) regards PBL as an advanced strategy of teaching that can be used in many contexts, for fast learners as well as slow learners. He is of the opinion that this strategy can be used to promote many experiences. Many experiences reduce abstraction according to Dale cone of learning experience.

Bell (2010) believes that PBL promotes cooperative group work with the goal of producing an end product to address a topic, solve an issue, or take on a challenge.The characteristics of project strategy include the following for the learner. The learner is now in charge of their own education instead of the teacher, in other words the learner does not sit passively in the classroom absorbing knowledge from the teacher. They construct knowledge by active production of artifacts through seeking knowledge from many sources. It promotes the following skills in learners; cognitive, psychomotor, affective. Thomas (2000) shows that pupils who learn by project-based learning develop better social interactions, problem solving, self -evaluation, communication, self–learning, critical thinking, decision making and collaborative skill. Some of these skills are 21st century skills needed to enter a knowledge-based economy. The strategy confers independence on the learner and sharing of roles to be able to solve the problem posed by the task of the project.

In order for learners to develop their cognitive domain, high level of information is required which is promoted by searching for information from many sources and they also demonstrate the acquired information in real-world situation (Chiang and Lee 2016). It demands the use of technology and sourcing information from field specialists. Chiang and Lee (2016) discuss the advantages of project-based learning as listed thus: It develops students' thinking skills which allows for creativity, (ii) it encourages teamwork which leads them to access information on their own and demonstrates this information. (iii)Questioning, active learning, sharing, and reflection are the main ways that learners generate knowledge and give it meaning. It is linked to multidisciplinary, learner-centered, collaborative, and integrated with real-world concerns and practices educational possibilities.Teachers' roles are to facilitate, advice, give guidance and feed back to learners. According to Wolk (2010) the teacher acts as a guide who helps learners achieves the educational goals.

The project strategy can be divided into the following stages According to the Hebrew ministry of education (2014). Students are given wide, open-ended inquiries from which they can infer their own questions. The direction of the topic they will work on or conduct their research on is determined by the theme that is developed from the questions. Students are free to independently select the materials they will utilize for their project or final product. The project or product ought to have practical use.
During the learning process the teacher concentrates on the area of evaluation such as textualanalysis and computer skills.

The learner is given the freedom to choose their own sources of information while the teacher employs a range of methods to communicate the fundamental concepts required for the project. There is presentation of learners' finding to different groups in the class. The presentation is criticized and a feedback is given on the presentation to improve the work. The presentation can be done as many times as possible to improve the immediate work and to arrive at a final improved work.Each group presents her product and the audience participates by asking questions. The learner reflects on the learning process and assesses his learning growth and the area of challenge. An advanced method of instruction that connects practical and cognitive tasks is the project approach of teaching. (Solomon, 2003) argues that it promotes an association between prior knowledge and new knowledge.

Ravitz, Hixson, English, and Mergendoller (2012) identify the following skills when collaborative project strategy is used:

1. Scientific abilities: These comprise the capacity to recognize a problem, using data from different areas to address the problem, research the issue, and draw a conclusion.
2. Cooperative working abilities: the capacity to collaborate successfully with others
3. Interpersonal communication is the capacity to impart knowledge to others verbally or in writing
4. Creativity is the capacity to gather data, identify a problem, and then deliver the results in a unique and imaginative way.
5. Self-regulation: The capacity to accept accountability, study on one's own, watch and evaluate one's own work, and react to feedback.
6. Additional research-related abilities, such as language proficiency and photography
7. Use of technology: the ability to use technology appropriately.

Aldabbus (2018) reveals that the PBL strategy can be used in the teaching-learning process by taking learners through the following steps:

Step1. The teacher activates learners' prior knowledge through short discussion, eliciting question and by displaying a video or going on trips.

Step2. Learners come with driving question that are challenging open-ended and directly related to the core of the project. Learners are given freedom to choose their own project. They use own idea to create the project the project allows the development of critical thinking skills, effective communication, use of technology among others.

Step3. Learners learn from the process of conducting the project by modifying their work through the feedback they receive from teacher or peer.

4. Finally, the presentation of end product.

Student projects for teacher's collaboration calls for students and teachers to work together to accomplish a learning objective. A relationship between students and teachers is established through collaborative learning, which fosters a healthy sense of dependency between them (Srinivas, 2010). Through collaborative learning, teachers can engage students in doing and reflecting on what they are doing while also reaching students who might not otherwise be interested. Collaboration between teachers and students on projects promotes active student engagement in individual or small group learning. Every student has the opportunity to contribute and value others' efforts in collaborative classrooms where they all learn from the teacher and each other.

Stephen,et.al (2013), states that collaborative classrooms have the following four general characteristics:

Knowledge exchange: Teachers impart to students their extensive knowledge of the course's skills, instruction, and content. In a collaborative classroom, the instructor also draws from the knowledge, unique perspectives, language, approaches, and cultural elements that students offer to the learning environment.

Sharing skills: In a collaborative classroom, the teacher encourages students to apply their own knowledge, makes sure they share their information, expertise, and learning methodologies, treats everyone with respect, and focuses on achieving high levels of understanding.

Mediation: In a collaborative classroom, teachers serve as mediators to adjust the level of information because effective mediation enables students to make connections between new information and what they have already learned and what they are learning in other subjects, teaches them how to deal with difficulties in learning, and enables them to connect learning to their experiences.

Heterogeneity: In a collaborative classroom, heterogeneous groupings of pupils enrich learning in the classroom since the perspectives, experiences, and backgrounds of all pupils are important for enriching learning in the classroom. The nature of the interactions between the teacher and the students in a collaborative classroom is captured by the first two qualities. The third describes the new instructional strategies used by teachers. The fourth discusses how a collaborative classroom is made up. All of the aforementioned elements of collaborative learning are strengthened by the Smart Classroom.

2.2.5 Hands-on activities strategy

Isa learner-centred instructional strategy. It is an extension of the play like nature of the child. It enables the child to be focused because the child uses body and mind in the learning process. Kizilaslan et al., (2020) who worked on improving learning with hands-on activities: science instruction for students with visual impairments pointed out that hands-on activities in form of practical work promote the engagement, interest, and curiosity of learners and as well as develop a range of skills, knowledge, and conceptual understanding.

According to Anderson cited in (Salami, 2014), learning is more influenced by the activities students engage in and less by what teachers do. The highest learning results come from students actively participating in the learning process(Salami, 2014). Children learn when they move and carry out activities and the physical activities help to optimize brain performance (Jensen, 2008). Hands-on activity promotes socio-emotional behaviour in that as learners interact with peer in the learning process, they communicate, thereby have their language development enhanced. Alanamu (2014) recommended that hands-on approach to teaching of science be employed by teachers to promote confidence in the girl child, since it makes learning fun for them, allows them to learn more concepts and that the approach helps bring abstract concepts in science to the observational level of learners. Hands-on activities is the first step to inquiry mode of teaching and learning. This is because as learners manipulate the learning materials their curiosity is aroused thereby prompting them to want to find out more and more.

Basically, man is a product of his genetic predispositions and environmental experiences.

According to Mooij (2013), every child has a specific genetic basis of potential abilities that can be developed by environmental stimulations. These stimulations can be cognitive, social, emotional or motor. This means that the environmental experiences of the child bring out the best in him/her and this why the use of hands-on activities is very essential to learning outcomes. As learner interacts with the learning environment, the thinking process is challenged, and this helps in the wiring of the brain for cognitive development. The manipulation of the learning materials fosters motor development that reflects in physical development. Also, the expressive ability improves because as the learner interacts with the learning environment, they ask questions to clarify issues and discuss their findings. A hands-on activity in science is a specific strategy of instruction, based on activities carried out by pupils. It may be used in conjunction with another instructional strategy. Approaches to Hands-on activity in science include verification/demonstration, discovery, exploration, inquiry and process skills.

For the purpose of supporting direct instruction, a phenomenon may be verified or demonstrated through a hands-on activity. Typically, the phenomenon is first discussed in a lecture or in a textbook, after which the teacher assigns a well-described exercise that allows the students to observe the phenomenon or a particular component of it.

Science students who participate in hands-on activities using the discovery approach are given things to work with but little clear instruction on what to do and what should be discovered.The two objectives of discovery are:first of all, it aids students in independently discovering phenomena, which will help them comprehend and remember them better than if they were shown. Secondly, discovery teaches how science is carried out in practice (Bruner 1960). One of the side effects of discovery is that it not easy for pupils to carry out on their own. There has been a change in the approach to guideddiscovery because of increase in teacher's guidance(Hodson, 1996).Furthermore, some concepts are difficult for students to understand in academic contexts, which limits the implementation of some research(e.g. atomic theory of matter). Another criticism of discovery stems from the misconception that it solely employs inductive reasoning(Hodson, 1996).

Exploratory approach in Hands-on science is very similar to discovery, but more closely linked to verification. Pupils are first given materials to handle with little guidance or expectation. The goal is to make them comfortable with the topic, to stimulate their interest and encourage them to ask questions. Following exploration phase, they receive direct instructions. Unlike discovery, there is no expectation that the pupils discover the underlying concepts, though they may identify issues and questions that can be addressed during direct instruction.

The inquiry approach in hands-on science has two goals, first, the goal of learning specific concepts and the capacity to carry out inquiry on one's own. The other goal involves teaching the student the set of thinking and doing skills plus their overall use in problem solving while addressing a specific topic, often of student choice to increase interest. The teachers' role is to provide support and guidance especially through questioning rather than leadership though this fluctuates with the ability of the pupils.

Inquiry differs from discovery in that it involves both inductive and deductive strategy. It also differs from the process skills approach by its attempt to teach an overall strategy that in-corporates process skills rather than addressing them separately. Pupils do not have to discover all knowledge on their own. Hands-on science is just one technique that can be used in inquiry.

It can be deduced from Piaget's four stages of cognitive development that children's intellectual abilities advance with age. Young children may have to see objects to be able to picture what is said about such object, hence the need for Hands-on activities. Pupils learn more when they engage in hands-on activities. As they manipulate objects, their process skills develop as well as the thinking skills because as they are doing, they are also thinking about the process of getting the task at hand done. The thinking aspect of hands-on activities is essential as Duschl and Gitomer (1997) opines thathands-on activities should not only be doing alone but should engage learners in the form of reasoning that is associated with science value. Experimentation is an integral part of science education which necessitates handling, manipulation, observation and gathering of information. This helps to reduce the abstraction in science.

The outcome of the inquiry-based hands-on science project is not to be known in advance, and the student is to actively participate in planning, carrying out, and analyzing the outcome.In actual practice, inquiry is a challenging and time-consuming strategy that requires a significant deal of ability and expertise from the instructor and is challenging to integrate into a standardized curriculum.The process skill approach attempts to teach individual processes used in science without regard to any specific science topic or discipline. Hands-on science is the primary technique used in teaching those processes that require hands-on activity e.g. measurement. For problem-solving, in-depth subject knowledge is necessary and without enough understanding, it is impossible to tackle problems.

In conclusion, there are various methods for utilizing hands-on science, and a teacher is always free to combine them. The logistics of a policy's implementation must be supported, and teachers must receive proper training.

The American Project 2061 encourages the use of inquiry-based learning.Students' grasp of science conceptual knowledge and science process abilities may improve through hands-on learning. Examining manipulating items can help make abstract knowledge more concrete and understandable. Scientific content knowledge is frequently abstract and difficult. Students can view real-world examples of knowledge and discover how changes in various variants affect things by engaging in hands-on science.

The constructionist theory of Piaget, which holds that information is acquired by interaction with tangible objects, is consistent with the assumption that hands-on activities encourage the acquisition of conceptual knowledge.Many factors affect how well students learn science through hands-on experiences the frequency with which the technique is employed in class and the method. In light of the foregoing, hands-on activities may apply a variety of methodologies, such as inquiry, exploratory, verification discovery, process skill, and others, including the class where they were used.Learning science needs a variety of mental skills, including the ability to organize information into generalizations and employ inductive reasoning.

Science education can be applied in everyday life. All students' world and jobs are directly impacted by the information that science education gives, including information on crop production and preserving good health.Without instruction, it creates a way of thinking for students that relies on inquiry to learn information.

Students use the inquiry approach to answer questions by coming up with their own investigations while being guided by the teacher.

Higher order thinking and problem solving require solid scientific conceptual knowledge, so it is important for science abilities to be founded in scientific achievement. We can then use scientific achievement to suit our own needs or to address societal problems. There was a timethat the emphasis was on knowledge acquisition and content(Teacher's Guide0 NERDC, 2013).This encouraged action and mobilization, but due to current global difficulties like global warming, the emphasis is now on applying scientific achievement to address personal or social problems. It is at this point when scientific investigation is extremely helpful and the use of certain abilities is required. The decision to shift the emphasis to practical application was partly based on the need to adapt the curriculum to the interests of the students in order to boost motivation and make connections between new information and what the students already know.

Curriculum development must take into consideration the following: the learner, teacher, material resources, school environment and teaching strategies, national philosophy and school philosophy. Scientific knowledge change over time through inquiry.

Over time, the study of hands-on science has evolved. Some problems, meanwhile, have not yet found a solution. The lack of research consensus may be at least partially caused by these problems. such problems as;

(1) Factors associated with both achievement and Hands-on science.

(2) A dearth of sizable data sets with individual students that include crucial explanatory factors and each student's performance test results.

(3) A variable association between hands-on science instruction and student achievement according to a student's aptitude.

(4) Numerous facts about hands-on science.

When examining scores, there are several factors that may influence performance that must be taken into account.This issue may also arise with multivariate analyses, particularly with correlational studies like those conducted by NAEP that did not account for any variables.

Several of the factors that previous research has linked to achievement may also be related to the degree of hands-on science. These include SEC (Social Economic Status) prior scientific course participation, the class's overall academic achievement, student aptitude, or previous accomplishment. Using the NAEP and WELS for research: Higher SES students do better academically, according to studies by Jones, Muhlies, Roizen, Weiss, and Weston (1992) discovers the same result using NEL data for eighth- and tenth-grade students.

Accordingly, students' skill in science is influenced by the quantity of science courses they take, regardless of their SES, color, or gender Madigan, (1997). The more science classes a student takes, the more probable it is that they will have Hands-on science. The following (class academic level and individual academic ability) are also linked to both high test scores and higher levels of hands-on activities.

Roizen (1988) specifically asserts that multiple choice tests are unable to capture the content taught through hands-on science, particularly integrated science process skills like hypothesis. Multiple choice testing has to be augmented (and in some cases, supplemented) by alternative types of assessment that encompass a larger variety of knowledge and skills, according to a significant conclusion reached by the critics. Oral presentations, tasks requiring brief or lengthy written responses, and actual performances (such as an exhibition or portfolio of prior work) may all be included in this type of assessment.

Science done by hand makes the abstract more concrete. The providing of real experience to aid in the understanding of abstract concepts is one of the theoretical justifications for hands-on science. It has been said that science is an abstract and difficult subject. Therefore, using hands-on science is very crucial.

As pupils mature, they are able to directly understand abstract ideas (project for level of conjecture development) and require fewer concrete demonstrate (project, 1975; Lawson 1995).

2.2.6 Gender issues in Basic Science education

According to Ambe-Uva et al. (2008), the idea of gender can be defined as the social connotations attached to being male or female, including the development of identities, expectations, behaviour, and power dynamics that result from how men and women interact with one another.Female and male sex roles are perceived differently in Africa, particularly in a traditional Nigerian society, according to (Orji, 2002). For instance, some people still think that women shouldnot work in certain occupations like carpentry, engineering, woodworking, metalworking, and automobile engineering technologies, while others think that nursing and catering are only for women.

In addition, gender was defined by Filgona1i and Sababa (2017) as the set of innate, environmental, mental, and behavioural traits that distinguish male and female members of a group. Because of the variations in their socio-cultural elements, it is crucial to examine gender inequalities in relation to achievement. Some physical science professions such as engineering, arts and crafts, agriculture have been regarded as men's while others such as catering, typing, nursing are regarded as women's.

There are unwritten norms determining what is feminine and what is masculine in African civilization. Consequently, several science-related subjects are viewed as male in most societies. The historical backdrop of education in Nigeria demonstrates how tradition and culture have put women and girls at a disadvantage and limited them to so-called jobs and careers for women, which may be considered as the societal definition of the roles of boys and girls. Parents are not exempt from the gender stereotype either; they assign boys more physically demanding tasks like car washing, mowing the lawn, changing light bulbs, and climbing ladders to fix or remove objects, to name a few. On the other side, the girls are given the responsibility of performing tasks like cooking, cleaning, and dishwashing. In other words, boys are given the more challenging and complex chores, while ladies are supposed to do the simpler and less demanding ones. As a result, girls are frequently viewed as the "weaker sex" in African society. As a result, a typical Nigerian girl from the north attends school with these established prejudices.

Gender equity is currently being stressed all around the world. The educational system in Nigeria has thus attracted a lot of attention due to gender as a component.Gender is defined as the socially constructed differences and relationships between males and females, according to the ABC of Women's Rights and Gender Equality (2000).Gender is not synonymous with "sex" in the document, which only refers to the inherent differences between the two sexes. They remain constant and are universal. Gender describes how males and females behave differently in all spheres of life and in every social setting, including regard to roles, duties, opportunities, and needs.

The Millennium Development Goals (MDGs) state that gender imbalance in education must be significantly decreased or eliminated by 2015, particularly at the primary and secondary levels.Unfortunately, even in 2023, this goal has not been accomplished in certain developing nations, such as Nigeria. As of 2023, Nigeria's UNESCO Institute for Statistics estimates that 69.19 percent of males and 49.69 percent of women are literate, indicating that there is still a gender gap in literacy rates at the post-primary level of schooling. According to Fatokun and Odagboyi (2011), the majority of societies place little value on the contributions that women make to societal advancement. Women are frequently left out of development activities, which prevents them from taking part in them and reaping their benefits. They continued by saying that while some subjects, like home economics and secretarial studies, are branded as feminine, others, like science and mathematics, are branded as male.

In addition, Gin (2011) notes that in the modern context, men and women are classified in a patriarchal world where there are general sets of beliefs that women are inferior to men. As a result, Gin (2011) notes, the power dynamics associated with these ideas and beliefs give men more power, more opportunities, and more conflicts over and above women in society. Women are underrepresented in science, technology, and mathematics, according to (Ezechi and Ogbu,2013;2015; Nwezi, 2020),these are seen as masculine subjects. However,diverse teaching strategies yield diverse results for both males and females, according to studies.If the optimal outcome is to be reached, it is necessary to identify the optimum teaching technique for a particular group of students.There is empirical evidence that shows that females outperformed males in various science learning outcomes, especially in key science process skills before the age of 11. Bassey and Amanso, (2017).

2.2.7 School type

The type of school that parents choose for their children depends on a spectrum of factors.Using information from parents and guardians, NEDS (Nigeria Education Data Survey) (2015) conducts a survey to determine whether students attended private or public schools. The closest school with space available, less expensive school, and better school are the top three considerations while choosing a school. While 78% of parents whose children attend private schools said their decision was based on quality, 65% of parents whose children attend public schools said their choice of school was based on the closest school to where they lived. It can be inferred that study participants who were parents of students in public schools might have preferred better options.

Due to the Federal government's liberalization agenda, private schools are now more prevalent in Nigeria at all educational levels.The majority of parents believed that the quality of education in private elementary schools was higher than that of public schools.NEDS (2015), which demonstrates that students in private schools have greater levels of literacy and understanding than their counterparts in public schools.Furthermore, a recent research by the World Bank titled "Education and Health in Nigeria" cited by Ojukwu (2022) reveals that private schools in Nigeria did better than public schools in Nigeria across all parameters.Private schools stand out for their human resources management, according to a World Bank survey.The World Bank analysis suggests that public elementary schools may not be lacking in human resources as such, but rather in management as a result of insufficient supervision.

Public schools have more professionally qualified teachers than private schools, according to Harry (2016), cited in Aransi (2018). According to Ekundayo (2013), certain factors, including the student-teacher ratio, the instructors' credentials, and the teachers' years of experience, have a significant impact on students' learning outcomes. In terms of two of these factors, primary school teachers can be said to be trained because they underwent pre-service training and many of them have spent several years in the classroom.Therefore, thorough supervision is essential if public schools are to perform as well as private schools.

In 160 public schools in the USA between 2007 and 2011, Carlson and Cowen (2015) conducted a longitudinal study on the relative significance of school neighbourhoods in fostering student achievement in reading and arithmetic. According to the study's findings, students who live in neighborhoods with high socioeconomic level often improve their test scores over the course of a year by around 0.05 standard deviations more than students who live in neighborhoods with median socioeconomic status. The implication of this is that pupils learning outcomes may be influenced by the support they receive from theirs surrounding.

Empirically, there is a contentious debate about whether to send children to public or private schools, and this topic has recently become more important globally (Lauglo, 2010; Day Ashley et al., 2014). The argument over the relative benefits of public versus private education has become more relevant and important as the choice for private school education spreads throughout developing nations like Nigeria and certain African nations (Akaguri, 2013). Ghana shares the opinion of other nations that private schools provide a superior education, a learning atmosphere that is more conducive, greater resources, and better management techniques. Therefore, parental choice indicates that better off parents are more likely to send their kids to privately run schools.

But there are so many unanswered questions when it comes to private vs. public school education quality. Some of these factors interact to affect how well students learn. Prior academic success, the caliber of the teachers at the schools, the demographic makeup of the student body, and the location of the school within the community are a few of the variables. The key is to distinguish the "private school effect" from other potential influences on learning results.

There is general agreement among educational researchers and scholars that factors both inside and outside of schools interact to create achievement gaps among student groups, even though schools are expected to reduce or even eliminate any gaps in student learning outcomes through quality teaching (Creemers and Kyriakides, 2008).According to Creemers and Kyriakides (2008), a child's demographic characteristics, such as sex, age, and place of residence, have varying implications on academic achievement. Additionally, parental traits (genetic endowment, education, employment, and wealth), beliefs, and actions affect a child's skill development, motivation, and achievement (Eccles and Davis-Kean, 2005). Similar factors include the environment around the school and its neighborhood, the importance of education to the general public, and the learning resources accessible at the local level (Carlson & Cowen, 2015). This study will ascertain how school type effects students' accomplishment, science process skills, and attitude to Basic Science after taking into account all school-related variables that may interact with students' skill development and achievement.

Other school context elements, including school kind, location, and conditions, as well as student demographics, have an impact on students' learning (Carlson and Cowen, 2015).The learning resources that are available, such as libraries, children's services, and teacher qualities, vary depending on the type of school (Carlson and Cowen, 2015). Children in schools therefore have diverse skills, attitudes, and behaviours, which may be a result of the various home contexts and educational environments they are exposed to. As a result, a school's makeup can serve as a catalyst for inspiration, aspiration, and in-person encounters that promote learning.Hanushek, Kain, Markman, and Rivkin (2003) claim that peer group interaction can have an impact on a learner's performance and science process abilities, whereby a student both influences and is influenced by peers (i.e., while a single slow learner or disruptive student may hold back an entire class, a small group of high achievers might inspire others to aim high in learning). In summary, the characteristics of the child (i.e., age, gender, prior knowledge) influence his/her learning achievement (Davis-Kean, 2005; Creemers and Kyriakides, 2008). Prior knowledge in particularcan significantly affect pupils' learning achievement. Similarly, school context factors (e.g., school location, public/private) can affect learning outcomes depending on the model used (Carlson and Cowen, 2015).

Finally, it may be claimed that context has a role in how students perform academically in different school types. The debate over how school type affects learning achievement is contentious. According to Jack (2018), each country has a different school type effect on academic attainment. Public schools are thought to compete favourably with private elementary schools if they are competently run.

2.2.8 Basic Science Process Skills (BSPS)

Basic scientific process abilities are a learning result in science and are crucial for other outcomes including attitude and academic success. At all levels of education, science process skills are used to explore, discover and proffer solution to challenges in the world around us.According to Ekon and Eni (2015), acquiring BSPS is the prerequisite for successfully learning fundamental science at the primary level of schooling. Jack (2018) argued that students can study science by using BSPS. It is believed to be one of the major goals of science education in Nigeria.

Despite the centrality of BSPS in science learning, Jack (2018) concludes that most students in Nigerian schools still struggle to acquire these skills. Bassey and Amanso (2017) opines that Nigerian educational system is laden with students who lack basic scientific skills. This also resonates with Bamidele (2016) and Enemaire (2018) that learners are not doing well in the sciences because learners lack manipulative skills, poor expression, wrong observation, and inferences, inability to link theoretical knowledge with actual practical work, lack of familiarity with a common piece of apparatus used in the laboratory, inability to draw logical inference from an observation made on a prescribed test, poor practical exposure.

A collection of generally transferable skills relevant to the science discipline and indicative of what scientists perform are known as science process skills (SPS) (Padilla,1990). Hill (2011) cited in Ekon and Eni (2015) defines SPS as the underlying skills and premises which govern the scientific strategy.According to Bassey and Amanso (2017), SPS acquisition refers to a range of skills that influence how well people learn, remember, comprehend, organize, and utilise verbal and/or nonverbal information. SPS can therefore be defined as the skills used in science to interact with the world around us, to discover, explore and find solution to challenges in our surroundings.

In Nigeria, fifteen SPS have been identified and they can be categorized as basic and integrated skills (Ekon and Eni 2015;Yamtinah et al., 2017;Yuliskurniawati et al., 2019;and Inayah et al. 2020). The basic science process skills that this study is based on are: observing, classifying, measuring, predicting, inferring and communicating.
A lot of research work had been done on science process skills using different teaching strategies. Agoro (2014) studies the effects of reflective teaching strategies on pre-service teachers' achievement in integrated science and science practical skills in Nigeria College of education. Her work shows that Reflective-Reciprocal Teaching and Reflective-Reciprocal Peer Tutoring Strategies enhanced pre-service teachers' achievement in integrated science and Science process skills.

2.2.9 Basic Science Achievement (BSA)

The assumption is that if the Basic Science process skills of learners are inadequate for science learning, then it can be inferred that basic science achievement will also be low, according to Bassey and Amanso (2017) science process skills affect the way pupils acquire, retain, understand, organize or use verbal and/ or non-verbal information. Inayah et al., (2020) believes that science process skills can improve scientific literacy and help learners understand biology concepts easily and correctly.

However, it is believed that the use of the appropriate instructional approach in science may improve learners' academic achievement.

2.2.10 Attitude of pupils to Basic Science

The importance of attitude in science learning cannot be over flogged as it is one of the factors that determine successful learning outcomes. Sofiani, (2017) opines that one of the core purposes of science education is to foster a favorable view of science. Agranovich and Assaraf, (2013) asserts that a student's drive to learn is positively impacted by their attitude toward science, and the attitude they form in elementary school affects their choice of vocation in adulthood.Science is perceived to be a difficult subject and Kortam et al. (2018) argue that students' stimulation and attitude are important for ensuring maximum learning and academic success.

Children by nature are inquisitive and love to explore their world, therefore it can be inferred thatchildren have a positive attitude to science learning at every tender age (Cermik and Fenli-Aktan, 2020). However, studies have shown that children's positive attitude to science decreases with demographic factors such as age and grade level and that learner's attitudes to science are shaped between ages 10-14 (Pell and Jarvis in Agranovich and Assaraf, 2013;Osborne cited in Cermik and Fenli-Aktan, 2020). Their study indicates that pupils' attitude to science decreases with grade level. It can therefore be inferred that the attitude of primary three pupils is more positive than primary five pupils if one is to go by the findings of Osborne. Ananda, et al, (2019) studiesstudents' attitudinal behaviour to science in junior high school after follow science learning used ILD model-assisted science magic.The studyshows that attitude is greatly influenced by the circumstances in the surrounding environment of the child and that teachers' teaching strategy greatly impact pupils' attitude which will invariably affect pupil's interest in the science.

2.3 Empirical review

2.3.1 Teacher–pupil project collaboration and Basic Science process skills

Solving problem in everyday life using science process skills is project-based procedure. Empirically, some researches on teacher pupils' project collaboration have been carried out in the world. These studies have shown that teacher pupils' project collaboration leads to improved pupils learning outcome and revitalized teaching strategies (Johnson and Johnson, 2000; Thomas and Mergendoller, 2000; and Westwood, 2006) they also assert that PBL can develop scientific process skills of pupils. According to Maranan (2017), approaches adopted by the teacher in the classroom in science class can provide opportunity to inculcate science process skills. Gokhale (1995) conducted a study titled "Collaborative Learning enhances Critical Thinking" and found that pupils critical thinking skills improve positively in collaborative learning environment than those working individually.

Yager (2002) and Aldbbus (2016) opines that PBL helps pupils to solve a problem in authentic situations by collaborating with peers. This problem-solving exercise is necessary for project-based learning because to use PBL, a problem is created but the way the problem is collaboratively resolved by the pupil promotes the pupil's problem-solving skills. Jantii (2002), discover that pupils' collaboration on a complex task, help one another to achieve, which needs undivided attention on communicationthat can solve a difficult problem, which cannot be done individually. Team learning is believed to equip pupils for a modern participative workforce (Feichter and Davis, 1991). Duda et al., (2019) investigates the effect of problem-solving knowledge acquisition through practical supported by authentic assessment, problem-based and conventional learning on science process skills of Dayak and Malay students in animal physiology lectures using quasi experimental design with an experimental research design with 3x2 factorial design. Data was collected using a science process skill test to test for significant differences, the learning model influenced students' science process skills.
The study of Hernawati, et al (2018) showsthat project activities have a substantial impact on science process competence at 0.338 with a F value of 4.524 at the 0.05 level of significance.

2.3.2 Teacher–pupil project collaboration and Basic Science achievement

Ayan (2011) discovers no statistically significant differences between the experimental and control group scores in the fifth-grade students' achievement post-test results in theunit of light.Additionally, Kizkapan and Bektas (2017) reveals no statistically significant differences between the achievement test post-test results for the experimental and control groups of students. Muhammad et al. (2016) shows that pupils in Sokoto state, Nigeria who were exposed to problem-based learning at the basic education level performed academically better than those who were taught using project-based learning. Nevertheless, project-based learning students performed better than students who were treated to traditional teaching strategy. Against this backdrop, teacher-pupils' project collaboration will be used as one of the independent variables. Turkmen and Cakici Children's science achievement greatly increased with project-based activities, according to a 2013 investigation into the impact of project-based learning on children's success and attitude in science primary schools in Turkey.

Collaboration, according to Tudge (1992), has a significant impact on student achievement and alters students' capacity for reasoning. According to Solomon (2003), the creation of a more fair learning environment by project-based learning can help students achieve academically. By working together on a task, it allows students to collaborate in a real-world setting and encourages higher order abilities (critical thinking, planning, problem solving, and creativity). Lakkala (2007) adds that students are active agents that share ideas, work together to solve problems, use a variety of information sources, and develop new knowledge.

2.3.3 Teacher –pupils project collaboration and attitude to Basic Science

Teacher–pupils project collaboration promotes learners' positive attitude to science. For instance, Tseng et al. (2013)find that Project Based learning has a positive impact on pupils' attitude and also improve their creativity and encourage inquiry-based learning. PBL has the ability to increase students' achievements in the emotive domain, including attitudes toward chemistry and self-efficacy beliefs, claims (Mataka and Madalisto, 2014). Cakici and Turkmen 2013 shows that Project-based learning does not improve pupils' attitude to scienceChiang et al (2016) believes that in a learning situation, the teacher's guidance of the pupil in proper sequence would be helpful by using a questioning approach.Their research demonstrates that PBL increases students' motivation, which may have a good impact on their attitude.In northern Israel, Kortam et al. (2018) examined how project-based learning influences 7th-grade students' motivation and attitudes about studying biology. The findings indicate an increase in motivation and more favorable attitudes.When the project-based learning approach was applied, the students reported higher levels of enjoyment, curiosity, interest, and cooperation.

Researchers have also shown that working with students from diverse racial or ethnic origins to achieve a shared goal results in improved like and respect between them (Slavin, 1991). According to Johnson and Johnson (1998), teachers who collaborate with students, peers, and value one another will have better psychological health than those who work alone or compete with others. Calore (2018) looked into how project-based learning curricula affects students' attitudes and engagement in scientific classes.According to his research, students' attitudes toward learning science have improved as a result of project-based learning.Eze, et al.'s findings from 2021 showed that students in technical colleges who received Basic electrical instruction using a project-based learning technique scored higher on accomplishment and retention tests than those who received instruction through a traditional teaching strategy.

Results showed that students in technical colleges who were taught Basic electricity using a project-based learning strategy had higher achievement and retention scores than those who were taught using a conventional teaching strategy, when both genders were taken into account.

2.3.4 Hands-on activities and Basic Science process skills

Babajide (2010) focuses on generative and forecast - observe, explain instructional strategies as determinants of secondary school students' accomplishment and practical skills in physics. The study also identified important major influences on students' achievement and practical abilities. Also, Bamidele (2014) investigates the impact of class-wide peer tutoring and peer-led guided inquiry instructional strategies on senior secondary school students' performance and practical chemistry abilities. The results of his research showed that the interventions had a substantial impact on students' performance and practical chemistry skills.

Ehikameanor (2014) investigates how two problem-solving instructional strategies affected students' achievement and science process skills in biology practical. Her research demonstrates that problem-solving instructional strategies improved students' performance in biology practicals, with one strategy having a greater impact on students' science process skills. The main effect of the treatment on students' performance in the biology practical was much greater than that of the control group. Alebiosu (2006) studied how two cooperative learning techniques affected students' acquisition of practical skills in secondary school chemistry. Academic ability and the treatment (student team accomplishment division and Jigsaw 11 Cooperative learning groups) were found to have a significant main effect.

According to Nwagbo and Chukelu (2012) who studied how biology practical activities affected students' learning of science process skills, the practical activity method was superior to the lecture strategy in promoting students' acquisition of science process skills. Chebii et al. (2012) investigated how the science process skills Mastery Learning Approach affected students' acquisition of specific practical skills in school and found that it improved performance in chemistry more than the traditional teaching strategy. The majority of research on science process skills were conducted in secondary schools and focused on a single science subject. However, Marlina and Kanedi (2017) finds that hands-on activities are efficient for enhancing young children's science skills in Srijaya, Indonesia. They focused on this issue while working with limited human resources and facilities in kindergarten.As a result, this study will contribute to filling in the knowledge gap about primary school, which serves as the starting point for formal education.

2.3.5 Hands-on activities and Basic Science achievement

Awolere (2015), works on the effects of experiential and generative strategies on pupils’ academic achievement, attitude and practical skills in biology, his study revealed that Experiential Learning and Generative Learning strategies have a significant main effect on pupils’ achievement scores and practical skills.

Marlina and Kanedi (2017) argues that hands-on activities help children to better understand scientific concepts and critical thinking abilities if exposed to science at an early age. They believe that when children are exposed to science using hands-on activities children will be able to reason scientifically. The studyanalyzed how kindergarten students with limited staff and resources could improve their science skills through hands-on activities. Responsibility for their learning can be achieved when the sensory organs are aroused for understanding and retention to take place.

Practical activities that involve hands-on tasks, as per Akolade (2013) referenced in Awolere (2015), makes the learning task real to the students as opposed to abstract or rote learning. Advantages of hands-on learning activities: it enables children to observe and understand what is happening. It is good for kinesthetic learners who learn by example. Hands-on activities promise to be the best learning strategy for skill acquisition. It enables children to do things by themselves and this helps in independent learning later in life. According to Ohunene and Ozoji (2014), hands-on learning should be promoted since it helps students study science in a more real-world setting and develops critical thinking and exploration, all of which are beneficial for sustainable development.

The disadvantage of hands-on activities is that it lays less emphasis on details and this is why collaboration comes in to bridge the gap.Small-group learning participants combine their efforts when they get together.

2.3.6 Hands-on activities and attitude to basic science

Ananda et al,(2019) believes learning strategy can improve learner's attitude toward science**.** Exploration of the world around the child by using the senses is a scientific attitude. Marlina and Kanedi (2017) opines thatHands-on activities help pupils develop positive attitude towards science. Hands-on activity is pupil-centred, and activity-based and it incorporates many teaching strategies. It allows learners to connect talk with their everyday lives and to reduce the gap between their expectations and real life (Maranan, 2017). Dale (1960) believes that any of the approaches can and should be used, depending on the needs of the learner. He opined that doing the real thing can lead to the retention of the largest amount of information. He believed that the more senses that are used the greater our ability to learn from and remember an event or experience. The only true education is self-education where the learner can discover knowledge by himself /herself with some guidance. He said the sensory organ must be awakened in other for retention and understanding to take place. In doing, several senses are used thereby facilitating understanding and acquisition of skills.In contrast to what is heard, read, or observed, Dale proposes that learning occurs through doing. He propounded the Learning pyramid called Dale’s cone of experience. He believed doing the real thing can lead to the retention of more information. Additionally, he thought that the more senses we use, the better we are able to retain and learn from an experience or an event. The learner taking responsibility for their learning can be achieved when the sensory organs are aroused for understanding and retention to take place.

According to Akolade (2013) cited in Awolere (2015) practical work which involves hands-on activities enables the learning task to be concrete to the pupils as against abstract or rote learning. Hands-on learning benefits include: enabling children to observe and understand what is happening. It is good for kinesthetic learners who learn by example. Hands-on activities promise to be the best learning strategy for skill acquisition. It enables children to do things by themselves and this helps in independent learning later in life.According to Ohunene and Ozoji (2014), hands-on activities should be promoted because they help students learn science in a more relevant and practical way and because they inspire critical thinking and exploration, both of which are beneficial for sustainable development.

The disadvantage of Hands-on activities is that it lays less emphasis on details and this is why collaboration comes in to bridge the gap. When learners in small groups come together, they consolidate their efforts.

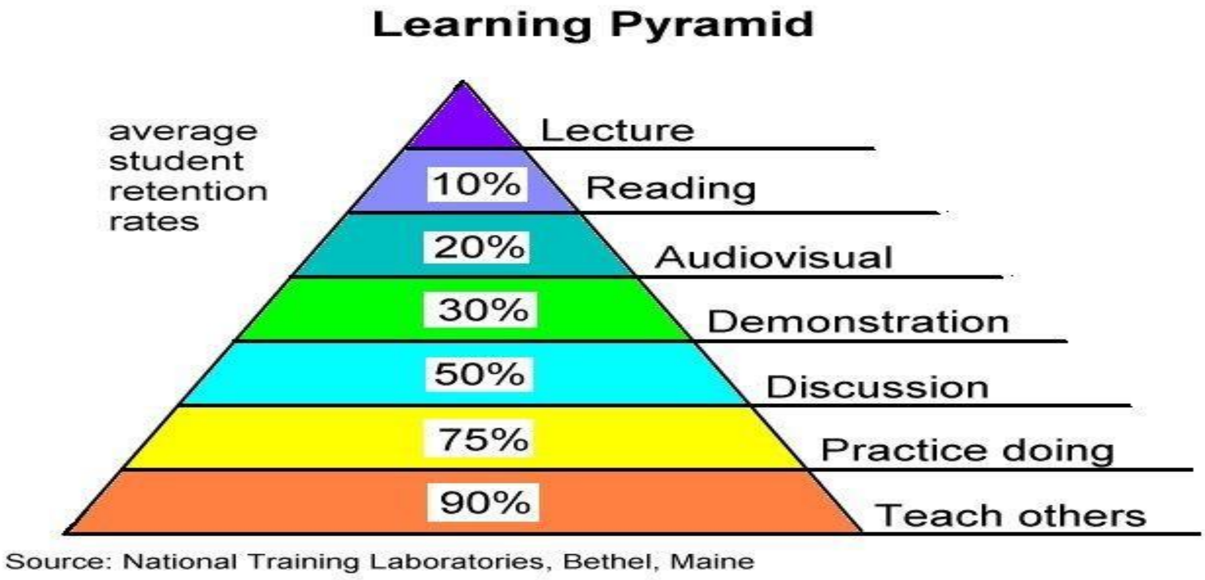

Fig. 2.2: Dale's Learning pyramid

2.3.7 Gender and Basic Science process skills

Another element that has been discovered as influencing student learning results is gender (Kassab, et al. 2005). The study of gender issue is very important to have a balanced study and an unbiased report in science. This is because the human population represented by the two sexes is differently wired. Taylor and Francis (2019) who published gender concept as insight into quality of science knowledge, organizations and practices on behalf of the Institute of materials, minerals and mining investigated the when, why and how biological differences (sex) and or sociocultural factors (gender) influence research result and outcomes. They argue that both males and females should be considered when research is to be carried out on the human population to have a true reflection of what any population stands for. Therefore, this study has taken into consideration the impact of gender on science process skills. Consequently, empirical studies were looked into.

At the basic education level, Ekon and Eni (2015) investigate gender and acquisition of science process skills among junior secondary school students in Calabar municipality: implication for implementation of Universal basic education objectives. According to their research, the majority of pupils gained science process abilities at very low to slightly above average levels, and gender had no discernible impact on this development at the upper basic level of universal basic education.

Jack (2018) investigates the influence of gender and class size on chemistry students' acquisition of science process skills using a descriptive survey design. The study discovered a minor effect of gender on students' learning of chemistry science process abilities. Additionally, it reveals that there was no discernible difference between male and female chemistry students' mean difficulty process skills scores. But according to Afif and Majdi (2015), who were mentioned in Jack 2018, there is a large gender gap in the development of science process skills that favors females. Female students fared much better than male students on the Malaysian-Based Science Process Skills Inventory Development, Validation, and Utilization, according to Tek et al.'s (2012) analysis. Additionally, Yuliskurniawati et al.,(2019) demonstrates that there is a difference between male and female science process capabilities, with females scoring on average 12.06, SD=3.89, compared to males scoring 9.91, SD=4.27.

Dokme and Aydinli (2009) discovered a significant difference with the mean scores of females being higher than those of boys in their investigation of the performance of Turkish primary school students on basic science process abilities. Additionally, their study demonstrates how certain demographic factors affected how much more science process abilities were acquired by female students. According to Bassey and Amanso's (2017) research, male and female science students acquire science process skills in very different ways.There was a significant difference between males and females for computation in favor of males while there was no significant difference observed between males and females in problem-solving skills and making inferences in favor of females.This study demonstrates that gender may have an impact on how children learn science process abilities.Before the age of 11, girls outperform boys in science process skills, according to Abiodun (2006) and Oyebola (2008), both referenced in Bassey and Amanso (2017).However, Yamtinah, et al. (2017) finds that male students had a larger percentage of science process skills than female students when she examined gender disparities in students' attitudes toward science in chemistry using the science process skills indicator.The research listed above suggest that the learning of science process skills by males and females may vary by age and subject.

2.3.8 Gender and Basic Science achievement

According to empirical research, gender is a significant aspect that affects students in study areas like science, business, and the arts in a particular way (Zoghi, Kazemi, and Kalan 2013).The concern over gender in society has drawn the attention of scholars in the field of education. For instance, a study conducted in Lagos State, Nigeria, Fakeye (2011) looks at student characteristics as predictors of performance in English as a second language to investigate the relationship between pupil attributes and English Language achievement. The "Pupils' Attitude to English" (QSAE) and "Pupils' Academic Ability Test" (SAAT) questionnaires were used to collect data. The "Pupils' Attitude to English" (QSAE) and "Pupils' Academic Ability Test" (SAAT) questionnaires were used to collect data. Data was gathered using the "Pupils' Attitude to English" (QSAE) and "Pupils' Academic Ability Test" (SAAT) questionnaires. For the study, a sample of 400 Senior Secondary school students was randomly chosen from five (5) secondary schools. The variables and the students' annual English test results were subjected to a correlational analysis and a t-test. The results showed that there was no statistically significant difference between male and female students' proficiency in the English language. (T-value 0.305, 398 degrees of freedom, p > 05). In numerous other empirical studies on the same topic conducted by various researchers in various locations using various samples and research methods, the same conclusionthat gender has no appreciable impact on students' academic success in English Languagehas been reached (Okoye, 2009; Obadaki, 2011; Babalola and Oyinloye, 2012; Adeyemi and Adeyemi, 2013; Adeyemi, 2014).

But in a related study, Zoghi, Kazemi, and Kalan (2013) uses 100 student: 50 males and 50 females—selected from four distinct classes to investigate the impact of gender on English as a Foreign Language (EFL) at the Iran Language Institute (ILS).The participants were between the ages of 12 and 14.The methods used involved quantitative analysis techniques and made use of pair t-tests, descriptive analysis, and effect size.Male students' overall average (M=11.47) is lower than female students' (M=13.18). Male and female students performed better academically. In this instance, male students' standard deviation was 3.54, while female students' was 3.20.It demonstrates that ladies experienced less score variance than males did. This resulted in a p-value of.000 and a t-value of -3.928, both of which are below the.05 significant level.The findings shows that gender has a substantial impact on the accomplishment test and is somewhat related to learning English as a Foreign Language.Bidin and Jusof (2012) earlier adopts this conclusion.

Results from Eze, et al. (2021) showed that there was no discernible difference between male and female students who were taught basic electricity utilizing(Problem Based Learning Method) PBLM in terms of mean achievement and retention scores. PBLM has the ability to enhance male and female technical college students' academic achievement and retention in the classroom, according to the study's findings.

Gender, perception of learning Physics, and performance in University Physics: A case study from China was the subject of a study by Wei-Zhao in 2012. In the study, the researcher developed and validated an instrument focused on the perception of learning physics, which builds on the Maryland Physics Expectations survey (MPEX). It was administered to first-year university pupils in a Chinese university during the autumn semester of 2011. It was found that female pupils preferred physics learning by relating and by analysis, which were positively correlated to better performance in physics. Male pupils preferred physics learning by rote, which was negatively correlated to performance in university physics. So physics learning perception differences based on gender also exist in China.

The performance of university students in physics was also found to be gender-neutral, with no discernible differences.The results were similar to the studies in Western countries and have pedagogical implications for instructors of university physics and potentially for other science courses.The performance of students in university physics courses did not show any appreciable gender variations in this study. Therefore, it conveyed the following messages to physics educators and researchers: Female pupils performed comparably with their male counterparts; male pupils did not outperform female pupils in the university physics class.

The above findings suggested that pupils performed well in introductory physics depending on the strategy used by the teacher. Therefore, to change the pupils' perception of learning, it must be addressed by the university physics teachers. They can use some strategies such as warming up questions before presenting course material in the class, computer simulations, and laboratory demonstrations to help their pupils to grasp and not just memorize the concepts of physics.

Nwosu and Ibe (2014) works on gender and scientific literacy levels:Both sexes performed significantly worse than average in their acquisition of science literacy at these four levels of nominal, functional, structural, and multidimensional literacy, which has implications for sustainable science and technology education for 21st-century occupations.However, when it comes to the overall development of scientific literacy, male students outperform their female counterparts.The study examined the degree to which male and female students randomly chosen from four co-educational schools in Nigeria's Abia state had achieved scientific literacy at various levels in fundamental science. This study is also a reflection of the poor performance of students in Basic Science as indicated by various studies such as Balarabe (2016) cited in Ekine (2010) and Enemaire (2019).

When comparing the knowledge of male and female social studies instructors, Fasiku (2011) conclusions that male social studies teachers were far more knowledgeable about environmental education than female social studies teachers.Gender issue in science learning is still a very significant factor and many research works had been done and the findings do not show a conclusive agreement on the gender issue. For instance, a study on gender differences and student achievement in Basic science by Ani et al. (2022) found no appreciable gender differences between male and female students in Biu.

Furthermore, Ogunkola and Olatoye (2006) finds no statistically significant difference between males and females in their research of gender disparities in science knowledge among science and non-science senior secondary school students in Nigeria. Gender has a substantial impact on students' interest in elementary science, but not on achievement, according to Ekine (2010).Musa and Samuel (2019) reports that male science and mathematics students achieved significantly better than their female counterparts. According to Berks (2012), the social economic element, particularly in developed countries, may be the reason for the closing gender gap in academic achievement in science.

Although various studies show that there are gender disparities in the science performance of students, there is no conclusive evidence to show the sex that is better in science performance. However, Nwosu and Ibe (2014) suggested the implementation of inquiry/problem-solving-interactive teaching approaches that will enhance the scientific literacy attainment of youth. In order words, project-based learning may enhance science literacy as inquiry and problem-solving approaches are forms of the project-based learning.

2.3.9 Gender and attitude to Basic Science

The attitudes of males and females toward science were not statistically different, according to Cermik and Fenli-Aktan's (2020) investigation into the attitudes of primary school students. Gender was shown to have no effect on students' attitudes in the study by Oba and Lawrence (2014), but there was a modest difference in the students' attitudes in favour of women. Furthermore, Khan and Mohakud (2018) finds no discernible difference in male and female attitudes toward science following the implementation of a project-based learning intervention.

Attitude has both affective and cognitive disposition. According to Awolere (2015), attitude is a mental predisposition toward living and non-living things. The living things are both humans and other animals while the non-living are objects or events. Amusan, (2014) asserts that attitude is concerned with the thinking, acting, and behavior of an individual. Attitude can be referred to as the emotion we develop as a result of our interaction with objects, events, or learning environments that results in the type of behaviour exhibited.Because it influences both the input and the output of the educational system, good disposition is extremely important in the teaching and learning process.

Students who have a good attitude toward science typically perform better on achievement tests, according to research. This can be explained by the principle of effort and reward. An effort rewarded by a high score can motivate the learner to put in more effort. In science education, many factors influence pupils' attitude. According to Adesoji, some of them are- the attitude of the instructor, the method of instruction, parental influence, gender, age, the cognitive style of the students, their career interests, the society perception of science, and science. Peer influence is also a factor.Peer influence plays a very crucial role in attitude to learning. It has been observed that girls are easily influenced by their peers in the learning of science, they tend to believe in the notion that science is a difficult subject and that they do not have the ability for it. This notion can be challenged or changed if the positive influence of peers is harnessed through teacher-pupil project collaboration.

The following empirical studies demonstrate that when a project-based learning strategy is utilized, students exhibit a positive outlook and rank their accumulated effort and experience learning higher than they would when using a traditional learning method. Tseng, Chang, Lou, and Chen (2013) and Kortam et al. (2018) believe that project-based learning does not change pupils' attitude toward the subject matter but that attitude is culture and teachers' knowledge dependent. These results are at odds with one another. As a result, this study will examine how teaching styles affect attitude.

2.3.10 School type and Basic Science process skills

According to a survey the researcher conducted, schools with adequate science resources and qualified teachers tend to draw more students. As more students apply for admission, the best students are typically accepted, which may inevitably have an impact on students' ability to use science process skills.In Calabar, Cross River State, Nigeria, Bassey and Amanso (2017) evaluates the impact of gender and school type on students' science process skills. They found that science students from public schools perform significantly worse than their peers from private schools in the areas of making inferences and computation, with the difference favoring the private school students.This study, therefore, may better influence the science process skills of pupils in public schools and make them at par with their counterparts who are in private schools.

2.3.11 School type and Basic Science achievement

In 160 public schools in the USA from 2007 to 2011, Carlson and Cowen (2015) looked into the relative significance of school communities in determining student achievement in reading and math. In both learning outcomes, it was found that students who lived in neighborhoods that were in the 95th percentile of the income distribution would typically see one-year test score gains that were around 0.05 standard deviations higher than those who lived in the median neighborhood.

In a study by Olasehinde and Olatoye (2014) comparing the science achievement of senior secondary school students in public and private schools in Kastina State, Nigeria, the results revealed a considerable disparity between the science achievement of public and private secondary school students. Compared to public schools, secondary school students in private institutions did much better. Only Physics shows a substantial difference; chemistry and biology did not. This could imply that the observed significant difference is subject-specific.For instance, Aransi (2018) finds no statistically significant differences in students' academic achievement in Economics based on school type when he empirically examined the effects of school type, class classifications, and gender among high school students in Irewole Local Government Area of Osun State, Nigeria.

Public versus private schools' effects on academic achievement have also been studied by Braun, Jenkins, and Grigg (2006), who came to the conclusion that private schools might not be as effective at delivering learning results as is typically believed.For instance, Lubienski and Lubienski (2006) uses hierarchical linear models to compare children' reading and math performance in the public and private spheres in grades 4 and 8.Their data set originated from the 2003 US National Assessment of Educational Progress (NAEP) exams.They came to the conclusion that the demographic differences between students in public and private schools were responsible for the relatively high raw scores of private schools after controlling for student and school-level variables (such as socioeconomic status, race/ethnicity, gender, disability, limited English proficiency, and school location).

In fact, the private school effect vanished and, in many cases, even reversed once the variations were taken into account (Lubienski and Lubienski 2006). Additionally, when socioeconomic background and baseline knowledge as evaluated by the pre-test scores are appropriately adjusted for, the performance advantage of students in private schools disappears, according to Fehrler et al. (2009) analysis of PASEC data for Togo.

Numerous academics have looked into the impact of school neighborhoods on student learning outcomes (Carlson and Cowen, 2015). Effect sizes were 0.28, 0.17, and 0.23 for suburban, rural, and urban schools, respectively, according to a meta-analysis. Additionally, it was discovered that children in the higher socioeconomic bracket performed better primarily because their mothers had better readingskills and more education, as well as because they lived in more affluent neighborhoods, in a study on the family and school neighborhood sources of socioeconomic inequality in child reading and mathematics achievement. Peer influences on achievement have also been the subject of numerous studies. Ewijk and Sleegers (2010) gets an average weighted effect size of 0.32 for peer effects in a meta-analysis of peer effects from 30 research.

Burke and Sass (2011) uses both linear and non-linear-in-mean models to examine the effect of peer ability in the classroom on achievement. Their information was based on a longitudinal survey conducted from 1999 to 2005 that included all Florida public school students in grades 3 through 10. In their linear-in-means models, they discovered minor but statistically significant impacts for peer effects.In their nonlinear models, they found that peer impacts were more prominent, statistically significant, and economically significant. Similar analysis was done on PASEC data (2001/02) for Togo's second and fifth grades by Ferrer et al. (2004).Overall performance is higher for students in private schools, but this performance advantage disappears when socioeconomic background and prior knowledge are sufficiently adjusted for.

Similar to this, Hamilton (2016) compares the science scheme of work in the upper basic secondary education curriculum in Nigeria between public and private schools.The study sought to compare the degree to which privately owned schools (private schools) and government owned schools (public schools) in Yenagoa Local Government of Bayelsa State covered the specified science scheme of work in basic secondary schools.'Integrated Science' was a subject taught in the Basic or Junior Secondary School (JSS) that covered science subjects. Two research questions were posed and addressed, and two hypotheses were presented and put to the test in order to direct the study.There were two private and two public secondary schools among the population.For each chosen school, the inquiry included JSS1, JSS2, and JSS3. The first term through the third term of the academic session (2013/2014) were used to analyze the coverage of the Integrated Science scheme work.A checklist, questionnaire, and personal observation were the main tools utilized to collect the data. The same edition of the curriculum is used by both private and public schools, but their levels of coverage differ. Private schools performed better than public schools, according to a comparison of the two types of schools' scheme of work covered in integrated science. The arrangement of extra lessons, class extensions, and vacation lessons was the reason why the private schools covered their science curriculum. However, it is thought that the teacher and the teaching approach are very important in closing the achievement gap between home and school and may have a substantial impact on students' performance. In order to assess the impact of school type on students' academic progress in basic science, this study will account for school type.

2.3.12 School type and attitude to Basic Science

In several ways, the number of students in a classroom can influence how much is learned (Ehrenberg et al., 2001).The authors claim that the number of students in a classroom can have an impact on how much is taught in several ways.When it comes to science instruction, large courses are more challenging to manage, especially when a child-centered approach is used. In a classroom, for instance, student interactions and social engagement may lead to more disruptive conduct, which may impact the activities the teacher can support.Additionally, it may limit the amount of time the teacher can devote to individualized instruction that addresses each student's unique needs.Additionally, the demographics of the students in a classroom might influence each student's motivation, aspirations, and opportunities for direct contacts and learning (Hanushek et al., 2003).Peer groups can speed up learning in a classroom through questions and answers and participation, but they can also impede learning by engaging in disruptive conduct.

According to empirical evidence, Cermik and Fenli-Aktan (2020) found that school type has statistically significant differences. According to their research, private schools have a more favorable attitude toward science than public schools.

2.4 Appraisal of literature

The primary level of education is where the basis for exploratory, reflective, and inquiry science learning is expected to be established for critical thinking, attitude, problem-solving ability, and life-long learning in science, according to a review of the literature. The primary school level's goal of creating a solid foundation is still unfulfilled since teachers favor the teacher-centered approach over the child-centered approach.

The teacher-centred approach which employs rote, memorization strategy, and regurgitation of facts is not suitable for science.The national policy on education specifically stated that science be taught by the use of explorative, reflective, and discovery modes of instruction. The resultant effect is that pupils are not doing well in the conceptual knowledge and skills acquisition in science which invariably affects pupils' attitude to science. The review also showed that stakeholders in education have tried to find a solution to the poor performance of pupils in science through various research works yet the situation is still the same. Research shows that those who teach science at primary schools are non-science specialists, and pupils are not exposed to adequate activities as a result of teacher training, inadequate science materials, and inappropriate teaching strategies. There is therefore the need to adopt teaching strategies that will enable pupils to master their learning and teachers to also learn in the teaching and learning process.

The literature review has also shown that project-based learning and hands-on activities strategies are globally used to promote academic achievement and science process skills of learners. However, most of the studies carried out are foreign and the local studies were done with pre-service teachers and junior high school pupils with limited studies conducted on primary school pupils.Studies with elementary school students focused largely on the effects of project-based learning on students' motivation and attitudes, whereas studies with secondary students focused more on the influence of hands-on learning on students' academic performance and science process skills. Gender research has not produced convincing results, but school type has a significant impact on students' academic performance and science process abilities.

CHAPTER THREE

METHODOLOGY

This chapter discusses the research strategy that was used. It includes the research design, study variables, participant selection, research tools, instrument validity and reliability, research processes, and statistical tools utilized.

3.1 Research design

Pretest-posttest, control group, and quasi-experimental research design was used in this study.

The Pretest-posttest, Control Group Quasi-Experimental design is represented thus:

O_1 X_1 O_2 ----- E1 ------ Experimental 1(Project collaboration)

O_3 X_2 O_4 ----- E2 - ----- Experimental 2 (Hands-on Activities)

O_5 X_3 O_6 ----- Control ------ Control group (Conventional)

O_1, O_3 and O_5 are the pre-test measures for experiment groups 1, 2, and control while O_2, O_4 and O_6 are the post-test measures for experimental groups 1, 2, and control respectively.

X_1 = Teacher-pupil project collaboration treatment

X_2 = Hands-on activities treatment and

X_3 = Conventional strategy (Control group)

Table 3.1: A 3 x 2 x 2 Factorial Matrix for the Study

Treatments	Gender	Type of School	
		Public School	**Private School**
Experimental group 1	Male	16	13
	Female	9	16
Experimental group 2	Male	13	17
	Female	15	13
Control group	Male	18	10
	Female	6	15

Quasi-experimental research is not fully experimental, it is a design in which treatment group equivalence cannot be guaranteed and individuals cannot be randomly assigned to groups for treatment because of the participants' characteristics. In other words, experimental design is not feasible (Jaiyeoba and Salami, 2006; Obadara, 2007)According to Kerlinger and Lee, cited in Salami (2014), a quasi-experimental design is any experimental design that doesn't meet one or more of the criteria below: (i) manipulating one or more IV(s); (ii) random assignment of the participants into groups and (iii) random assignment of groups to treatment.

Pretest measured the entering behaviour of the learner while the posttest measured the behaviour of the learner after the administration of the treatment. The goal of measuring the entering behaviour was to determine (i) whether the groups' skills, knowledge, and attitudes toward sciences before treatment are nearly the same or significantly different from one another. (ii) to find out about the learning outcomes of the participant before treatment and to be able to compare it with the post outcomes gained or otherwise after treatment. The use of a control group was to justify that the treatment is the cause or otherwise of the observed differences in observation after treatment.

3.2 Variables of the study

Study's variables include:

3.2.1 Independent Variable (IV): This is the instructional strategy manipulated at three levels

I. Teacher-pupilproject collaboration
II. Hands-on activities
III. Conventional teaching Strategy

3.2.2 Moderator Variables (MV): These are human and environmental variables that are capable of influencing the pupils' science learning outcomes. They are:

i. Gender, manipulated at 2 levels - male and female
ii. School type, manipulated at 2 levels-public and private.

3.2.3 Dependent Variables (DV): These are learning outcomes as a result of exposure to science lessons. The three learning outcomes observed in the study are:

1. Basic Science Process Skills which includeObserving, Classifying, Predicting, Measuring, Inferring, Communicating
2. Basic Science Achievement
3. Attitude to Basic Science.

This study adopted a 3x 2 x 2 factorial design which is presented in tabular form as shown on Table 3.1.

Table 3.1 reveals that the independent variable was manipulated at three levels, the first moderator variable, gender was measured at two levels (Male and Female), and school type was measured at two levels (public and private).

Factorial designs are designs with multiple independent/moderator variables. Each independent variable is a factor in the design. This factorial design tested the main effect and the interaction effect, that is,the primary effect of each independent variable, each moderator variable, and the interaction effect when the independent variables were combined. (Ary, et.al, 1979). A main effect represents what would have happened if the experiment was conducted using that single variable alone and ignoring the effect of the moderator variables. The interaction effect is the effect when two or more independent variables combine to produce an effect over and above their main effect (Onuoha, 2009).

3.3 Selection of participants

For the study, three local government areas from the city of Ibadan wererandomly selected. The three LGAs are: Ibadan North, Ibadan South West and Ibadan North West. From each local government area, one public school and one private school were purposively chosen. The schools purposively selected were schools with qualified and professional science teachers and schools that were willing to participate in the research. Primary V was purposively selected because it is believed that the pupils in this class are at the concrete operational stage of cognitive development and are capable of reasoning ability. The class is not preparing for external examination, the pupil's mean age should be between 10– 11 years according to National Policy on

Education. Primary VI was not chosen because the class is preparing for an external examination and there may not be enough time for the research. Primary IV was not chosen because it is the first class in middle-basic education (FRN, 2013).

One arm of Primary V was randomly selected from each school. The primary five classes selected were intact classes comprising both male and female pupils.A total of 161 pupils took part in the study. The participants from the public schools- 25 pupils for experimental 1, 28 pupils for experimental 2while 24 pupils were for control. The participants from private schools- 29 pupils for experimental, 30 pupils for experimental 2 while 25 pupils were for control.

3.4 Selection of topics

The topics for this study were purposively selected to reflect the integrated nature of basic science-biological, and physical. This was done to ensure that the topics were not only biological or physical. Studies have shown that girls do well in the biological sciences than in the physical sciences (Tsabari, et. al. 2008 and Makarova, et.al. 2019). Therefore, the need to have a balance of biological and physical science topics.

3.5 Research instruments

The following research tools were developed, validated, and used to gather data for this study.

A. **Stimulus instruments**

1. Teacher-Pupil Project Collaboration Instructional Guide (TPPC_IG)
2. Hands-on Activities Instructional Guide (HoAIG)
3. Guide for Conventional Instructional Strategy (GCIS)

B. Response instruments

1. Basic Science Process Skills Rating Scale (SPSRS)
2. Basic Science Achievement Test (BSAT)
3. Questionnaire on Pupils' Attitude to Basic Science (QPABS)

3.5.1 Teacher-Pupil Project Collaboration Instructional Guide (TPPC_IG)

This TPPC_IG is a self-designed instructional guide that was used to treat the participants in Experimental Group one.

The guide has the following: General information- (the general information has to do with theme, topic, class, duration, and time), Pre-project assessment, Entry behaviour, Resource materials, Technology tools, Behavioural objectives, and introduction, End of lesson evaluation, End of project evaluation. Under the introduction, we have the lesson activities.

Lesson activities consist of the following:

1. Essential Questions
2. Grouping of pupils
3. Ground rules
4. Project vocabulary
5. Driving questions
6. The task
7. Task activities
8. Activities schedule for the remaining three lessons.
9. End of lesson evaluation.

TPPC_IG consists of four projects. A project was completed in two weeks of four lesson plans. This implies that the treatment lasted eight weeks.

Validation of TPPC_IG

A number of instructors from the University of Ibadan's Early Childhood and Educational Foundations Departmentwho examined the language of the instrument and the practicability of the instrument. TPPC_IG. Also, two experienced primary school teachers were given the guide for their necessary inputs for its usability.

3.5.2 Hands-On Activities Instructional Guide (HoAIG)

This HoAIG, is a self-designed instructional manual, was used to treat the participants of Experimental Group 2. It has the following parts:

General information: Under general information, we have theme, subtheme, Topic, subtopic, class, period, and duration.

Instructional resources: were the teaching aids based on the topic.

Entry behaviour: What the learner is familiar with.

Behavioural objectives: This has three aspects:

1. Skills
2. Cognitive
3. Affective

Class activities:

Step 1: Introduction of the topic

Step 2: Prior knowledge

Step 3: Teacher and learner's activities

Step 4: Summary

Step 5: End of lesson assessment.

Step 6: Reflection

Step 7: Assignment.

The HoAIG consists of 16 lessons that were delivered in eight weeks. This implies that the treatment lasted eight weeks.

Validation of HoAIG

Experts from the University of Ibadan's Early Childhood Education unit criticized the lesson plan. Also, two experienced primary school teachers were given the guide for their input and their criticism was used for the final production of the instrument before use.

3.5.3 Guide for Convectional Instructional Strategy (GCIS)

The participants in the control group were given treatment using this GCIS, which was a self-designed teaching manual. It was a chalk-and-talk guide consisting of six parts:

1. General Information
2. **Specific behavioral objectives:** these are listed in the topic's 9-year Basic Education Curriculum.
3. **Presentation**: this is a step-by-step presentation of the lesson based on the behavioural objectives.The instructor addresses the students while standing in front of them.

4. **Summary:** After treating all the steps, the teacher summarized the lesson.
5. **Evaluation**: Based on the specific behavioural objectives, pupils were asked questions
6. **Assignment**: Pupils were asked to write in their notes and draw necessary diagrams.

GCIS consists of 16 lessons that were delivered two lessons per week. Treatment lasted eight weeks

Validation of GCIS

Three early childhood education specialists from the Department of Early Childhood and Educational Foundations and one expert in science education from the University of Ibadan criticized GCIS. Also, two experienced primary school teachers were given the guide for the necessary input to ensure its usability.

3.5.5 Basic Science Process Skills Rating Scale (BSPS_RS)

The BSPS_RS is a two-section rating scale. The demographic data of the participants is covered in Section A. There are four items in this section which include gender, age, school, and school type.

Section B was designed to rate the participants' basic process science skills acquisition. The rubric has three parts namely performance criteria, rating scale, and indicators. The indicators are the six basic science process skills of Observing, classifying, measuring, inferring, predicting and communicating. It has four performance levels excellent (3), good (2) fair (1) no performance (0). Under each of the performance levels, the performance criteria are stated. An activity basic science process skills worksheet was developed to save time. The activity worksheet has six items for the six basic science process skills for all the topics. Question (1) deals with observation (2) classifying (3) predicting (4) measuring (5) inferring (6) communicating. The topics for the rating scale are:

- Human body: Bones and Joints
- Reproduction in plants
- Acids and Bases

- Heat and Temperature

Validation of BSPS_RS

Experts in the sciences and two primary school teachers with expertise in science education evaluated the instrument's content validity, and the required modifications were made. The rating scale and activity worksheet were administered to 15 pupils from a private school and another 15 pupils from a public school, the schools are outside the research schools.Using inter rater technique, the reliability coefficientof 0.73 was obtained

3.5.6 Basic Science Achievement Test (BSAT)

This instrument is a self-designed instrument to assess students' basic scientific proficiency both before and after treatment.Two sections make up the test: Student demographic data is presented in Section A, and multiple-choice questions drawn from the picture taught using the three interventions are included in Section B of the test. The test items were generated around levels of cognitive domain - remembering, understanding, and applying according to Anderson and Krathwohl (2001) a revised version of Bloom's Taxonomy 1956.The three levels of the cognitive domain are shown in the Table of Specification.

Validation of BSAT

For content validity, 40 items were examined by basic science specialists, two primary school teachers, and some early childhood education lecturers. The instrument was field-tested on pupils outside the study area. Their response was subjected to item analysis to determine the reliability coefficient using Kudar Richardson 20 formula, difficult items were removed and finally, twenty-five items were re-subjected to Kudar Richardson 20 formula, the reliability coefficient obtained is 0.83

Table 3.2: Table of Specification for Basic Science Achievement Test

Content	Remembering	Understanding	Applying	Total
Human bones and joints	13,22	2,	1, 12	5
Reproduction in plants	3,14,19,21	4, 16	11	7
Acids and bases	5, 21	6, 18,20	15, 17	7
Heat and energy	7, 9, 23	8, 24	10	6
Total	11	8	6	25

3.5.7 Questionnaire on Pupils' Attitude to Basic Science (QPABS)

For the purpose of assessing students' attitudes on basic science, the researcher designed the QPABS.Additionally, the instrument has two parts:while Section B is a 30-item scale with a 3-point Likert Scale, Section A measures the participants' demographic data with options ranging from NOT SURE (NS), DISAGREE (D), and AGREE (A). The scoring for positive items was 0 for 'NS' 1 for 'D' and 2 for 'A'. The scoring was reversed for negative items.

Validation of QPABS

Construct validity of QPBS was examined by two science instructors with B.Sc. degrees and two lecturers from Early Childhood department. QPABS was administered to 15 pupils from public and private schools respectively. Ambiguous items were removed. The reliability of the instrument was ascertained using the Cronbach alpha technique and it generated 0.81 as the reliability coefficient.

3.6 Procedure

Permission was taken from SUBEB to conduct research in some primary schools in Oyo state.The researcher visited selected schools with letters of introduction from SUBEB and Early Childhood department.

3.6.1 Experimental I (Teacher-Pupils Project Collaboration TPPC)

First week: Training of Research Assistants (RAs)

Research assistants who took part in the study were given a training programme. The research assistants were primary school teachers who studied science at the pre-service level, science education postgraduate students, and early childhood postgraduate students. The training was done separately for TPPC, hands-on, and conventional strategies. The training familiarized them with the strategies used for Teacher-Pupil Project Collaboration Strategy, Hands-on Activities, and the Convectional Strategy Instructional packages. Two weeks before the training, the researcher met with the Research Assistants (RAs) for TPPC for familiarization. The TPPC_IG was introduced to them and how to use it. The manual was given to RAs to study. After two weeks, the training proper took place and this was done in one week.

First week: Examination of the lesson plan and clarification of issues relating to the use of the lesson plan format. Rehearsal of the teaching strategy and corrections made

Second week: Administration of Pre-test on participants.

Third and fourth weeks: Lessons on the human body: bones and joints – participants were led to organize what they were taught and plan for the project they want to do Production of project and presentation on bones and joints

Fifth and sixth weeks: Lessons on Reproduction in plants. Participants were led to the plan for the project on reproduction in the plant, production of a project on reproduction in plants, and did their presentation.

Seventh and eighth weeks: A lesson on Acids and Bases. Participants were led to organizing their taught and agree on projects on acids and bases presentation on Acids and Bases.

Ninth and tenth weeks: Lesson on Heat and Temperature. Participants were led to organize their taught and plan for what to present and Presentation on Heat and Energy

Eleventh week: Post-Test Administration

Experimental group II

Two weeks before the commencement of training, there was familiarization with the RAs through Hands-on activities and an introduction of the HoAIG to them and how to use it.

First Week: Meeting the research assistants, examination of the lesson plan and clarification of issues relating to the use of the lesson plan format. Rehearsal of the teaching strategy and corrections made. Questions were answered and the lesson plan was put through a practice run, and all required adjustments were made.

Second week: Administration of Pre-test on participants.

Third and fourth Weeks: Lessons on the human body, bones, and joints – participants were given materials to work with.

Fifth and sixth weeks: Lessons on Reproduction in plants. Participants were led to detach the different whorls of the flower to study the different parts. Pupils were given different fruits to work on, they cut the fruits into equal halves and state the parts representing the ovary and ovule of the flower.

Seventh and eighth weeks: Lessons on Acids and Bases. Participants were told to bring different fruits and vegetables to the class. Participants were guided to define acids and bases. They were guided to produce juice from the fruits and vegetables and participants administered blue and red litmus papers to test for acidity and alkalinity.

Ninth and tenth weeks: Lessons on Heat and Temperature. Participants wereled to differentiate between forms of heat such as heat by conduction, convection, and radiation. They were guided on how to use thermometers. They were guided on the scales on the thermometer, unit heat, and temperature. Participants measured the temperature of different liquids at different temperature levels.

Eleventh week: Post-Test Administration.

Control group (Conventional strategy (CoS))

Preliminary meeting with RAs two weeks before research, familiarization, and introduction of CoS manual.

First week: Training of RAs on the manual, knotty issues such as if the time allocated is not enough were clarified. micro teaching took place and questions were asked.

Second week: administration of pre-test

Third and fourth weeks: Lesson on the body: bones and joints

Fifth and sixth weeks: Lesson on reproduction in plants

Seventh and eight weeks: Lesson on acids and bases

Ninth and ten weeks: Lesson on heat and temperature.

Eleventh week: Post-test Administration.

3.6.2 Summary and schedule for the procedure

Research AssistantsTraining–1 week

Pre-test Administration - 1week

Treatment Delivery - 8 weeks

Post-test Observations - 1 week

Total - 11weeks

3.7 Method of data analysis

Both descriptive and inferential statistics were used for the analysis of data collected in this study. Descriptive statistics of frequency count and percentage were used to analyze the demographic data. To test the null hypotheses, inferential statistics from Analysis of Covariance (ANCOVA) were used. To estimate the level of performance between groups and to separate any significant interaction effects, Scheffe's Post-Hoc analysis was conductedat 0.05 level of significance.

CHAPTER FOUR

RESULTS AND DISCUSSION

The analysis done took cognizance of participants with complete data (both pretest and posttest measures). Based on this, the analysis was on the complete data collected from 161 pupils.

Section 4.1: Demographic data analysis

Table 4.1 shows pupils' demography according to treatment groups, type of school and gender. 33.54% of participants are for experimental group one, 36.03% for experimental group two while 30.43% participants for control.

It is significant to mention that 161 students participated in the study. The basic science process skill and achievement data of all the pupils are completed, however only 154 pupils have complete attitude data. The analysis is based on this information.

Table 4.1:Distribution of Pupils According to TreatmentGroups, type of school and Gender

Treatment Groups	Sch Type	Gender		Total	Percentage per school	Percentage per group
		Male	Female			
Expt 1	Private	14	15	29	18%	33.54
	Public	14	11	25	15.5%	
Expt 2	Private	17	13	30	18.6%	36.03
	Public	12	16	28	17.4%	
Control	Private	11	14	25	15.5%	30.43
	Public	17	07	24	14.9%	
Total		85	76	161	100	100

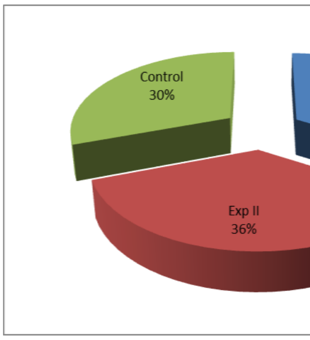

Fig.4.1a **Treatment G**

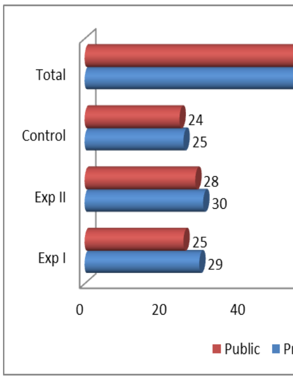

Fig. 4.1c: **Type of**

In Table 4.1, the detailed distributions of the pupils across treatment groups, type ofschool and gender were presented. Figure 4.1a reveals that the pupils in experimental group I (34%) were less than those in experimental group II (36%) while those in the control group (30%) were the least. This implies that there was an unequal number of pupils in the groups.

Figure 4.1b reveals the gender distribution across all the groups. However, it presents that there were more male (52.8%) than female (47.2%) pupils in the study.Again, data demonstrate that the study included a sufficient number of students from both genders.
Figure 4.1c shows the distribution of the participants across the treatmentgroups based on school type. The figure reveals that there were more pupils in private (52.2%) than public (47.8%) schools. This again shows that enough pupils participated from both private and public schools.

Section 4.2: Testing the null hypotheses

Ho1a: There is no significant main effect of treatment on pupils' BSPS

Table 4.2.1a: 3X2X2 ANCOVA on BSPS

Dependent Variable: Basic Science Process Skills - Posttest

Source	TypeIII Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	676.629[a]	12	56.386	11.780	.000	.489
Intercept	220.030	1	220.030	45.969	.000	.237
scproskillPre	47.227	1	47.227	9.867	.002	.062
TreatmentGrp	51.466	2	25.733	5.376	.006	.068
Error	708.402	148	4.787			
Total	13751.000	161				
Corrected Total	1385.031	160				

a. R^2 = .489 (Adjt. R^2 = .447)

Table 4.2.1b: Estimated Marginal Means on BSPS

Treatment Groups	**Mean**	**Std. Error**
Experimental Grp 1	9.632	.306
Experimental Grp 2	8.362	.293
Control	8.445	.348
a. Covariates appearing in the model are evaluated at the following values: Basic Science Process Skills - Pretest = 4.7453.		

Table 4.2.1c: Pairwise Comparison Using Scheffe's Post-hoc Analysis onBSPS

Treatment Groups	Exp. I	Exp. II	Control
Exp. I		*	*
Exp. II	*		
Control	*		

Table 4.2.1a demonstrates that the main effect of treatmenton students' BSPS($F_{(2;148)}$ = 5.38; $p<0.05$; partial $\tilde{\eta}^2 = 0.07$). Therefore, null hypothesis 1a is rejected. Toreveal the magnitude of performance, Table 4.2.1b. shows the EMM scores of the groups. Experimental group I has the highest science process mean score (9.63), followed by those in the control group (8.45) while those in experimental group II have the lowest (8.36). To know the source of the significance, Table 4.2.1c presents Scheffe's post hoc pairwise comparison. The table shows that the significant effect is a result of a significant difference between pupils exposed to Teacher-pupils Project Collaboration (T-PPC) and others (Those exposed to hands-on activities and control). Therefore, it can be inferred that T-PPC enhances science process skills significantly better than hands-on activities and conventional strategies.

The pairwise comparison using Scheffe's Post -hoc Analysis on BSPS in table 4.2.1c reveals that the significant difference exposed by Table 4.2.1a is a result of the significant difference between (1) TPPC versus hands-on activities and (2) TPPC versus conventional (3) there is no significant difference between Hands-on activities and conventional in terms of basic science process skills. Better performance of pupils exposed to TPPC in terms of science process skills is in line with the studies of (Johnson and Johnson 2000; Thomas and Mergendoller, 2000) Duda et al., (2019) on the process skills of pupils.

Ho1b: There is no significant main effect of treatment on pupils' BSA

Table 4.2.2a: 3X2X2 Analysis of Covariance on BSA

Dependent Variable: Basic science achievement - Posttest

Source	TypeIII Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1839.519[a]	12	153.293	14.101	.000	.533
Intercept	1420.255	1	1420.255	130.643	.000	.469
ScachievePre	142.765	1	142.765	13.132	.000	.081
TreatmentGrp	76.969	2	38.484	3.540	.031	.046
Error	1608.953	148	10.871			
Total	27285.000	161				
Corrected Total	3448.472	160				

a. R^2 = .533 (Adjt. R^2 = .496)

Table 4.2.2b: Estimated marginal means onBSA

Treatment Groups	Mean	Std. Error
Experimental Grp 1	12.462[a]	.463
Experimental Grp 2	12.897[a]	.446
Control	11.090[a]	.519
a. Covariates appearing in the model are evaluated at the following values: Basic science achievement - Pretest = 7.4183.		

Table 4.2.2c: Pairwise Comparison Using Scheffe's Post-hoc Analysis on BSA

Treatment Groups	Exp. I	Exp. II	Control
Exp. I			*
Exp. II			
Control	*		

Table 4.2.2a indicates a significant main effect of treatmenton pupils' BSA ($F_{(2;148)}$ = 3.54; $p<0.05$; partial $\tilde{\eta}^2 = 0.05$). Therefore, null hypothesis 1b is rejected. To reveal the magnitude of performance, Table 4.2.2b shows the estimated marginal mean scores of the groups. Experimental group II has the highest BSA mean score (12.88), followed by Experimental group I (12.46) while those in control have the lowest (11.09). To know the source of the significance, Table 4.2.2c presents Scheffe's post hoc pairwise comparison. The table shows that the significant effect is a result of a significant difference between pupils exposed to hands-on activities and those in control. Therefore, it can be inferred those hands-on activities enhanced BSA significantly better than T-PPC and conventional strategies

Ho1c: There is no significant main effect of treatment on pupils' ABS.

Table 4.2.3a: 3X2X2 ANCOVA on ABS

Dependent Variable: Total attitude score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	307.225[a]	12	25.602	1.382	.181	.105
Intercept	4662.555	1	4662.555	251.610	.000	.641
Pretest	7.184	1	7.184	.388	.535	.003
Treatment	19.461	2	9.731	.525	.593	.007
Error	2612.859	141	18.531			
Total	119823.000	154				
Corrected Total	2920.084	153				

a. R^2 = .105 (Adjt. R^2 = .029)

Table 4.2.3b: EMMon ABS

Treatment Groups	**Mean**	**Std. Error**
Exp. I	27.310	.627
Exp. II	28.111	.590
Control	27.391	.684
a. Covariates appearing in the model are evaluated at the following values: Total attitude score = 25.9870.		

Table 4.2.3a indicates no significant main effect of treatment on pupils' ABS ($F_{(2;141)}$ = 0.53; p>0.05; partial $\tilde{\eta}^2$ = 0.01). Therefore, null hypothesis 1c is not rejected. To reveal the magnitude of performance, Table 4.2.3b shows the EMM scores of the groups. Experimental group II has the highest science attitude mean score (28.11), followed by those in the control group (27.39) while those in Experimental group I had the lowest attitude mean score (27.31). The difference among the group is not significant.

$H_0$2a: There is no significant main effect of gender on pupils' BSPS

Table 4.2.4a: 3X2X2 ANCOVA on BSPS with Gender

Dependent Variable: BSPS – Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	676.629[a]	12	56.386	11.780	.000	.489
Intercept	220.030	1	220.030	45.969	.000	.237
scproskillPre	47.227	1	47.227	9.867	.002	.062
TreatmentGrp	51.466	2	25.733	5.376	.006	.068
gender	4.359	1	4.359	.911	.342	.006
Error	708.402	148	4.787			
Total	13751.000	161				
Corrected Total	1385.031	160				

a. R^2 = .489 (Adjt. R^2 = .447)

Table 4.2.4b: EMM scores with Gender on BSPS

Gender	Mean	Std. Error
Male	8.640	.239
Female	8.986	.271

Table 4.2.4a indicates no significant main effect of gender on pupils' sciences processing skills ($F_{(1;148)} = 0.91$; $p>0.05$; partial $\tilde{\eta}^2 = 0.01$). Therefore, null hypothesis 2a is not rejected. In order to reveal magnitude of performance, Table 4.2.4b shows the EMM scores of the sexes. Though, female pupils had higher sciences processing mean score (8.99) than male pupils (8.64), but the difference is not significant.

$H_0$2b: There is no significant main effect of gender on pupils' science achievement

Table 4.2.5a: 3X2X2 ANCOVA on BSA with Gender

Dependent Variable:Basic Science achievement – Posttest

Source	TypeIII Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1839.519[a]	12	153.293	14.101	.000	.533
Intercept	1420.255	1	1420.255	130.643	.000	.469
ScachievePre	142.765	1	142.765	13.132	.000	.081
TreatmentGrp	76.969	2	38.484	3.540	.031	.046
gender	12.344	1	12.344	1.135	.288	.008
Error	1608.953	148	10.871			
Total	27285.000	161				
Corrected Total	3448.472	160				

a. R^2 = .533 (Adjt. R^2 = .496)

Table 4.2.5b: EMM with Gender on BSA

Gender	**Mean**	**Std. Error**
Male	12.434	0.361
Female	11.854	.408

Table 4.2.5a indicates no significant main effect of gender on pupils' BSA ($F_{(1;148)}$ = 1.14; p>0.05; partial $\tilde{\eta}^2$= 0.01). Therefore, null hypothesis 2b is not rejected. In order to reveal magnitude of performance, Table 4.2.5b shows the EMM scores of the sexes. Though, male pupils had higher sciences achievement mean score (12.43) than female pupils (11.85), but the difference is not significant.

$H_0$2c: There is no significant main effect of gender on pupils'ABS.

Table 4.2.6a: 3X2X2 ANCOVA on ABS with Gender

Dependent Variable: Total attitude score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	307.225[a]	12	25.602	1.382	.181	.105
Intercept	4662.555	1	4662.555	251.610	.000	.641
Pretest	7.184	1	7.184	.388	.535	.003
Treatment	19.461	2	9.731	.525	.593	.007
gender	83.540	1	83.540	4.508	.035	.031
Error	2612.859	141	18.531			
Total	119823.000	154				
Corrected Total	2920.084	153				

a. R^2 = .105 (Adjt. R^2 = .029)

Table 4.2.6b: EMM on Gender on ABS

Gender	**Mean**	**Std. Error**
Male	28.370	.490
Female	26.838	.530

Table 4.2.6a indicates a significant main effect of gender on pupils' attitude to sciences ($F_{(1;141)} = 4.51$; $p<0.05$; partial $\tilde{\eta}^2 = 0.03$). Therefore, null hypothesis 2c is rejected. To reveal the magnitude of performance, Table 4.2.6b shows the EMM scores of the sexes. Male pupils had a higher attitude to sciences mean score (28.37) than female pupils (26.84) and the difference is significant.

$H_0$3a: There is no significant main effect of type of school on pupils' BSPS.

Table 4.2.7a:3X2X2 ANCOVA on BSPS with Gender and School type

Dependent Variable: Basic Science Process Skills - Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	676.629[a]	12	56.386	11.780	.000	.489
Intercept	220.030	1	220.030	45.969	.000	.237
scproskillPre	47.227	1	47.227	9.867	.002	.062
TreatmentGrp	51.466	2	25.733	5.376	.006	.068
gender	4.359	1	4.359	.911	.342	.006
typeSchool	189.799	1	189.799	39.653	.000	.211
Error	708.402	148	4.787			
Total	13751.000	161				
Corrected Total	1385.031	160				
Corrected Total	1385.031	160				

a. R^2 = .489 (Adjt. R^2 = .447)

Table 4.2.7b: EMM with type ofSchool on BSPS

School type	**Mean**	**Std. Error**
Private	9.99	.248
Public	7.633	.272

Table 4.2.7a indicates a significant main effect of type ofschool on pupils' BSPS ($F_{(1;148)}$ = 39.65; $p<0.05$; partial $\tilde{\eta}^2$ = 0.21). Therefore, null hypothesis 3a is rejected. To reveal the magnitude of performance, Table 4.2.7b shows the EMM scores of the type of school. Pupils in private schools had higher science process skills mean score (9.99) than pupils in public schools (7.63) and the difference is significant.

$H_0$3b: There is no significant main effect of type of school on pupils' BSA

Table 4.2.8a: 3X2X2 ANCOVA on BSA with Gender and school type

Dependent Variable: Science achievement - Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1839.519[a]	12	153.293	14.101	.000	.533
Intercept	1420.255	1	1420.255	130.643	.000	.469
scachievePre	142.765	1	142.765	13.132	.000	.081
TreatmentGrp	76.969	2	38.484	3.540	.031	.046
gender	12.344	1	12.344	1.135	.288	.008
typeSchool	457.078	1	457.078	42.044	.000	.221
Error	1608.953	148	10.871			
Total	27285.000	161				
Corrected Total	3448.472	160				

a. R^2 = .533 (Adjt. R^2 = .496)

Table 4.2.8b: EMM with school type onBSA

School type	Mean	Std. Error
Private	14.104	.390
Public	10.183	.423

Table 4.2.8a indicates is a significant main effect of school type on pupils' BSA ($F_{(1;148)}$ = 42.04; $p<0.05$; partial $\tilde{\eta}^2$ = 0.22). The null hypothesis 3b is rejected. In order to reveal magnitude of performance, Table 4.2.8b shows the EMM scores of the type of school. Participants in private schools had higher BSA mean score (14.10) than pupils in public school (10.18) and the difference is significant.

$H_0$3c: There is no significant main effect of type of school on pupils' ABS

Table 4.2.9a: 3X2X2 ANCOVA on ABS with Gender and schooltype

Dependent Variable: Total attitude score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	307.225[a]	12	25.602	1.382	.181	.105
Intercept	4662.555	1	4662.555	251.610	.000	.641
Pretest	7.184	1	7.184	.388	.535	.003
Treatment	19.461	2	9.731	.525	.593	.007
gender	83.540	1	83.540	4.508	.035	.031
typeschool	16.953	1	16.953	.915	.340	.006
Error	2612.859	141	18.531			
Total	119823.000	154				
Corrected Total	2920.084	153				

a. R^2 = .105 (Adjt. R^2 = .029)

Table 4.2.9b: EMM with School Typeon ABS

School type	**Mean**	**Std. Error**
Private	27.258	.478
Public	27.950	.542

Table 4.2.9a shows that there is no significant main effect of type of school on pupils' ABS ($F_{(1;141)}$ = 0.92; p>0.05; partial $\tilde{\eta}^2$ = 0.01). Therefore, null hypothesis 3c is not rejected. To reveal the magnitude of performance, Table 4.2.9b shows the EMM scores of the type of school. Though pupils in public schools had a higher ABS mean score (27.95) than pupils in private schools (27.26) the difference is not significant.

$H_0$4a: There is no significant interaction effect of trtm and gender on pupils' BSPS.

Table 4.2.10a: 3X2X2 ANCOVA on BSPS with Gender, type ofschool and 2-Way Interactions

Dependent Variable: Basic Science Process Skills - Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	676.629[a]	12	56.386	11.780	.000	.489
Intercept	220.030	1	220.030	45.969	.000	.237
scproskillPre	47.227	1	47.227	9.867	.002	.062
TreatmentGrp	51.466	2	25.733	5.376	.006	.068
gender	4.359	1	4.359	.911	.342	.006
typeSchool	189.799	1	189.799	39.653	.000	.211
TreatmentGrp * sex	32.987	2	16.494	3.446	.034	.044
TreatmentGrp * typeSchool	110.989	2	55.495	11.594	.000	.135
sex * typeSchool	.067	1	.067	.014	.906	.000
Error	708.402	148	4.787			
Total	13751.000	161				
Corrected Total	1385.031	160				

a. R^2 = .489 (Adjt. R^2 = .447)

Table 4.2.10b: EMMwith Interaction between Treatmentand Gender on BSPS

	Male	**Female**
Exp. I	9.333	9.931
Exp. II	8.815	7.908
Control	7.773	9.118

Table 4.2.10c: EMM with Interaction between Treatmentand type of school on BSPS

	Private	**Public**
Exp. I	9.544	9.721
Exp. II	10.058	6.665
Control	10.378	6.513

Table 4.2.10d: EMM with Interaction between Gender and type of school on BSPS

	Private	**Public**
Male	9.799	7.482
Female	10.187	7.784

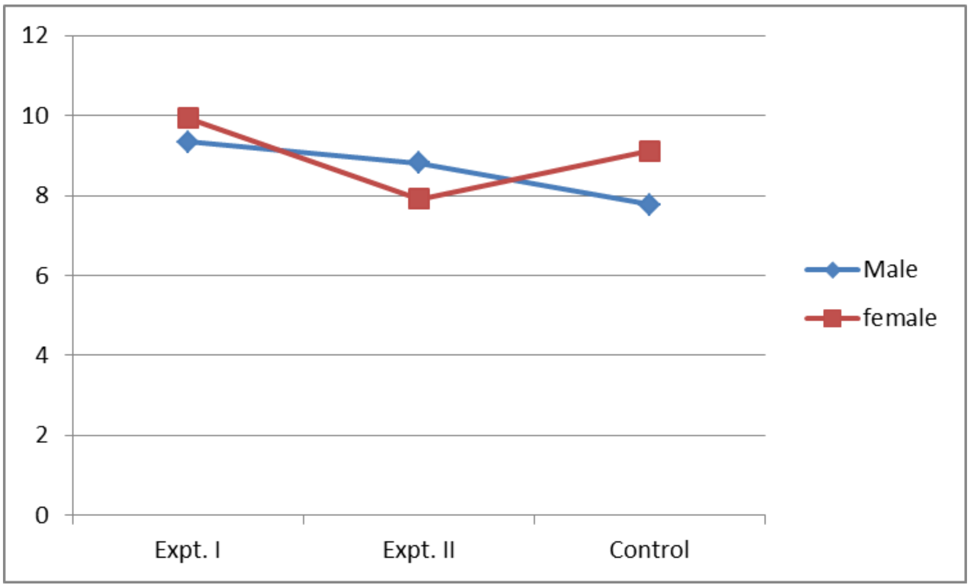

Fig. 4.2: Interaction Effect of Treatment and Gender on BSPS

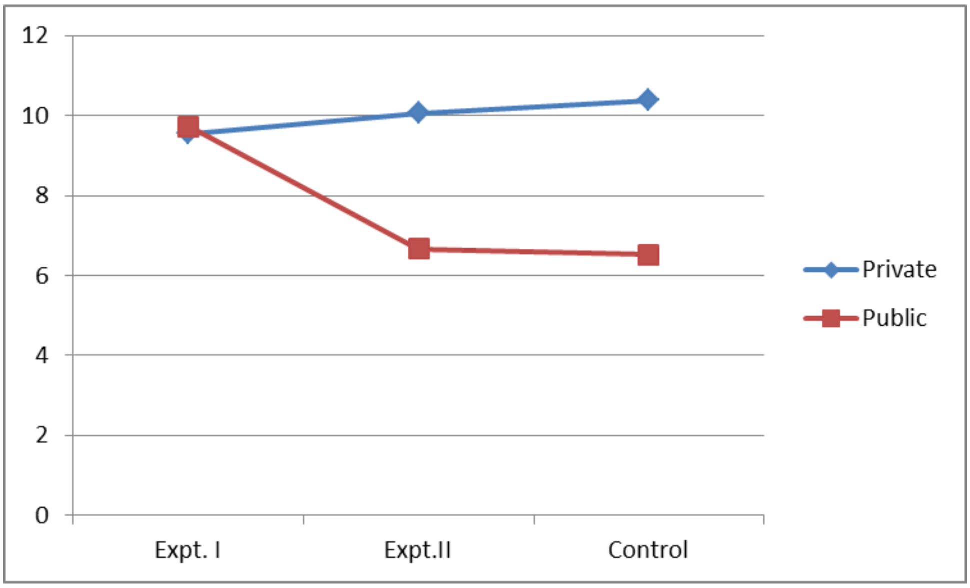

Fig.4.3:Interaction Effect of Treatmentandschooltype on BSPS

Table 4.2.10a shows that there is a significant interaction effect of treatment and gender on pupils' BSPS ($F_{(2;148)} = 3.45$; $p<0.05$; partial $\tilde{\eta}^2 = 0.04$). Therefore, null hypothesis 4a is rejected. To reveal the magnitude of performance, Table 4.2.10b shows the EMM scores across treatment and gender. Female pupils in experimental group I had a higher process skill mean score (9.93 against 9.33); Male pupils in experimental group II had a higher mean score (8.82 against 7.91) while female pupils in the control group had a higher mean score (9.12 against 7.77). The interaction effect is disordinal and it is significant (See Figure 4.2).

$H_0$4b: There is no significant interaction effect of treatment and gender on pupils' BSA.

Table 4.2.11a:3X2X2 ANCOVA on BSA with Gender, type of school and 2-Way Interactions

Dependent Variable: Basic Science achievement - Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1839.519[a]	12	153.293	14.101	.000	.533
Intercept	1420.255	1	1420.255	130.643	.000	.469
scachievePre	142.765	1	142.765	13.132	.000	.081
TreatmentGrp	76.969	2	38.484	3.540	.031	.046
gender	12.344	1	12.344	1.135	.288	.008
typeSchool	457.078	1	457.078	42.044	.000	.221
TreatmentGrp * gender	44.686	2	22.343	2.055	.132	.027
TreatmentGrp * typeSchool	486.844	2	243.422	22.391	.000	.232
gender * typeSchool	8.226	1	8.226	.757	.386	.005
Error	1608.953	148	10.871			
Total	27285.000	161				
Corrected Total	3448.472	160				

a. R Squared = .533 (Adjusted R Squared = .496)

Table 4.2.11b: EMM with Interaction between Treatment and Gender on BSA

	Male	**Female**
Exp. I	12.236	12.689
Exp. II	13.888	11.870
Control	11.178	11.003

Table 4.2.11c: EMMInteraction between Treatmentand School type on BSA

	Private	Public
Exp. I	12.978	11.946
Exp. II	17.408	8.350
Control	11.926	10.255

Table 4.2.11d: EMM with Interaction between Gender and School type on BSA

	Private	Public
Male	14.631	10.237
Female	13.577	10.130

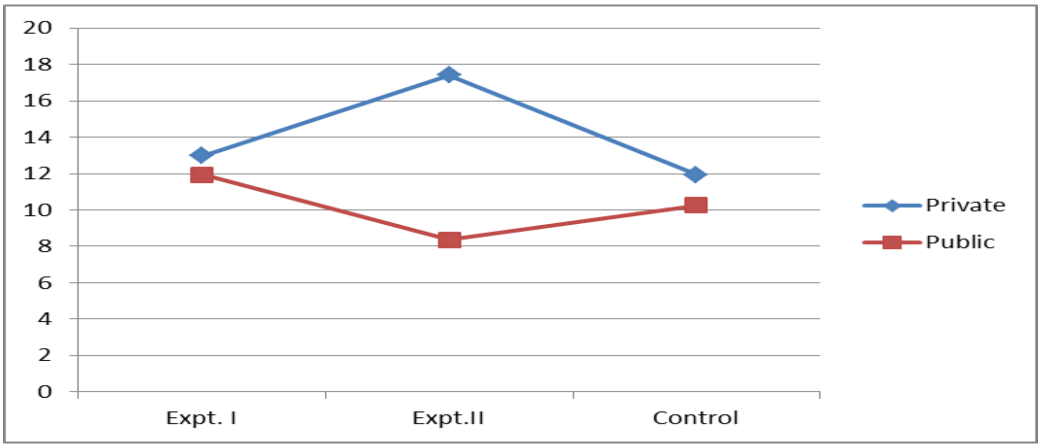

Fig. 4.4: Interaction Effect of Treatment and School type on BSA

Table 4.2.11a shows that there is no significant interaction effect of treatment and gender on pupils' BSA ($F_{(2;148)}$ = 2.06; $p>0.05$; partial $\tilde{\eta}^2$ = 0.03). Therefore, null hypothesis 4b is not rejected. In order to reveal magnitude of performance, Table 4.2.11b shows the EMM scores across treatment and gender. Though, female pupils in experimental group I had higher achievement mean score (12.69 against 12.23); Male pupils in experimental group II had the higher mean score (13.89 against 11.87) while male pupils in control group had higher mean score (11.18 against 11.00). The interaction effect is disordinal but not significant.

$H_0$4c: There is no significant interaction effect of treatmentand gender on pupils' ABS.

Table 4.2.12a: 3X2X2 ANCOVA on ABS with Gender, type of school and 2-Way Interactions

Dependent Variable: Total attitude score

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	307.225[a]	12	25.602	1.382	.181	.105
Intercept	4662.555	1	4662.555	251.610	.000	.641
Pretest	7.184	1	7.184	.388	.535	.003
Treatment	19.461	2	9.731	.525	.593	.007
gender	83.540	1	83.540	4.508	.035	.031
typeschool	16.953	1	16.953	.915	.340	.006
Treatment * gender	78.450	2	39.225	2.117	.124	.029
Treatment * typeschool	5.491	2	2.746	.148	.862	.002
gender * typeschool	10.752	1	10.752	.580	.447	.004
Error	2612.859	141	18.531			
Total	119823.000	154				
Corrected Total	2920.084	153				

a. R^2 = .105 (Adjt.R^2= .029)

Table 4.2.12b: EMM with Interaction between Treatmentand Gender onABS

	Male	**Female**	
Exp. I	29.093	25.527	
Exp. II	28.277	27.946	
Control	27.741	27.040	

Table 4.2.12c: EMM with Interaction between Treatment and School typeon ABS

	Private	**Public**
Exp. I	26.807	27.813
Exp. II	27.628	28.595
Control	27.339	27.443

Table 4.2.12d: EMM with Interaction between Gender and School type onABS

	Private	**Public**
Male	28.300	28.441
Female	26.215	27.460

Table 4.2.12a shows that there is no significant interaction effect of treatmentand gender on pupils' attitude to science ($F_{(2;141)}$ = 2.12; p>0.05; partial $\tilde{\eta}^2$ = 0.03). Therefore, null hypothesis 4c is not rejected. To reveal the magnitude of performance, Table 4.2.11b shows the EMM scores across treatment and gender. Though, male pupils in experimental group I had a higher attitude mean score (29.09 against 25.53); Male pupils in experimental group II had a higher mean score (28.28 against 27.95) while male pupils in the control group had a higher mean score (27.74 against 27.04). The interaction effect is ordinal but not significant.

$H_0$5a: There is no significant interaction effect of treatment and school type on pupils' BSPS.

Table 4.2.10a shows that there is a significant interaction effect of treatment and school type on pupils' science process skill ($F_{(2;148)}$ = 11.59; p<0.05; partial $\tilde{\eta}^2$ = 0.14). Therefore, null hypothesis 5a is rejected. To reveal the magnitude of performance, Table 4.2.10c shows the estimated marginal mean scores across treatment and school types. Public pupils in experimental group I had a higher process skill mean score (9.72 against 9.54); Private pupils in experimental group II had a higher mean score (10.06 against 6.67) while Private pupils in the control group had a higher mean score (10.38 against 6.51). The interaction effect is disordinal and significant (See Figure 4.3 on page 103).

$H_0$5b: There is no significant interaction effect of treatment and school type on pupils' science achievement.

Table 4.2.11a shows that there is a significant interaction effect of treatment and school type on pupils' science achievement ($F_{(2;148)}$ = 22.39; p<0.05; partial $\tilde{\eta}^2$ = 0.23). Therefore, null hypothesis 5b is rejected. To reveal the magnitude of performance, Table 4.2.11c shows the estimated marginal mean scores across treatment and school types. Private pupils in experimental group I had a higher achievement mean score (12.98 against 11.95); Private pupils in experimental group II also had a higher mean score (17.41 against 8.35) Also, private pupils in the control group had a higher mean score (11.93 against 10.26). The interaction effect is ordinal and significant.

$H_0$5c: There is no significant interaction effect of treatment and school type on pupils' ABS.

Table 4.2.12a shows that there is no significant interaction effect of treatment and school type on pupils' attitude to science ($F_{(1;141)} = 0.15$; $p>0.05$; partial $\tilde{\eta}^2 = 0.00$). Therefore, null hypothesis 5c is not rejected. To reveal the magnitude of performance, Table 4.2.11b shows the EMM scores across treatment and type of school. Though public pupils in experimental group I had a higher attitude mean score (27.81 against 26.81); public pupils in experimental group II had a higher mean score (28.60 against 27.63), and public pupils in the control group had a higher mean score (27.44 against 27.34). The interaction effect is ordinal but not significant.

$H_0$6a: There is no significant interaction effect of gender and school type on pupils' BSPS.

Table 4.2.10a shows that there is no significant interaction effect of gender and type of school on pupils' science process skill ($F_{(1;148)} = 0.01$; $p>0.05$; partial $\tilde{\eta}^2 = 0.00$). Therefore, null hypothesis 6a is not rejected. To reveal the magnitude of performance, Table 4.2.10d shows the EMM scores across gender and school type. Though male pupils in private schools had a higher process skill mean score (9.80 against 7.48), and female pupils in private schools had a higher mean score (10.19 against 7.78). Though, the interaction effect is ordinal but not significant.

$H_0$6b: There is no significant interaction effect of gender and type of school on pupils' BSA.

Table 4.2.11a shows that there is no significant interaction effect of gender and school type on pupils' BSA ($F_{(1;148)} = 0.76$; $p>0.05$; partial $\tilde{\eta}^2 = 0.01$). Therefore, null hypothesis 6b is not rejected. To reveal the magnitude of performance, Table 4.2.11d shows the EMM scores across gender and type of school. Though male pupils in private schools had a higher process skill mean score (14.63 against 10.24), and female pupils in private schools had a higher mean score (13.58 against 10.13). Though, the interaction effect is ordinal but not significant.

$H_0$6c: There is no significant interaction effect of gender and type of school on pupils' attitudes to science.

Table 4.2.12a shows that there is no significant interaction effect of gender and school type on pupils' attitude to science ($F_{(1;141)} = 0.58$; $p>0.05$; partial $\tilde{\eta}^2 = 0.00$). Therefore, null hypothesis 6c is not rejected. To reveal the magnitude of performance, Table 4.2.12d shows the estimated marginal mean scores across gender and type of school. Though male pupils in public schools had a higher attitude mean score (28.44 against 28.30), and female pupils in public schools had a higher mean score (27.46 against 26.22). Though, the interaction effect is ordinal but not significant.

$H_0$7a: There is no significant interaction effect of treatment, gender, and type of school on pupils'BSPS.

Table 4.2.13:3X2X2 ANCOVA on BSPS with 3-Way Interactions

Dependent Variable: Science Process Skills - Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	676.629[a]	12	56.386	11.780	.000	.489
Intercept	220.030	1	220.030	45.969	.000	.237
scproskillPre	47.227	1	47.227	9.867	.002	.062
TreatmentGrp	51.466	2	25.733	5.376	.006	.068
gender	4.359	1	4.359	.911	.342	.006
typeSchool	189.799	1	189.799	39.653	.000	.211
TreatmentGrp * gender	32.987	2	16.494	3.446	.034	.044
TreatmentGrp * typeSchool	110989	2	55.495	11.594	.000	.135
gender* typeSchool	.067	1	.067	.014	.906	.000
TreatmentGrp * gender* typeSchool	26.325	2	13.162	2.750	.067	.036
Error	708.402	148	4.787			
Total	13751.000	161				
Corrected Total	1385.031	160				

a. R^2 = .489 (Adjt. R^2= .447)

Table 4.2.13a shows that there is no significant interaction effect of treatment, gender, and type of school on pupils' BSPS ($F_{(2;148)}$ = 2.75; p>0.05; partial $\tilde{\eta}^2$ = 0.04). Therefore, null hypothesis 7a is not rejected.

$H_0$7b: There is no significant interaction effect of treatment, gender, and type of school on pupils'BSA

Table 4.2.14: 3X2X2 ANCOVA on BSA with 3-Way Interactions

Dependent Variable: Science achievement - Posttest

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	1839.519[a]	12	153.293	14.101	.000	.533
Intercept	1420.255	1	1420.255	130.643	.000	.469
scachievePre	142.765	1	142.765	13.132	.000	.081
TreatmentGrp	76.969	2	38.484	3.540	.031	.046
gender	12.344	1	12.344	1.135	.288	.008
typeSchool	457.078	1	457.078	42.044	.000	.221
TreatmentGrp * gender	44.686	2	22.343	2.055	.132	.027
TreatmentGrp * typeSchool	486.844	2	243.422	22.391	.000	.232
gender * typeSchool	8.226	1	8.226	.757	.386	.005
TreatmentGrp * gender * typeSchool	48.579	2	24.289	2.234	.111	.029
Error	1608.953	148	10.871			
Total	27285.000	161				
Corrected Total	3448.472	160				

a. R^2 = .533 (Adjt. R^2 = .496)

Table 4.2.14 shows that there is no significant interaction effect of treatment, genderand type of school on pupils' BSA ($F_{(2;148)}$ = 2.23; $p>0.05$; partial $\tilde{\eta}^2$ = 0.03). Therefore, null hypothesis 7b is not rejected.

$H_0$7c: There is no significant interaction effect of treatment, gender, and type of school on pupils' ABS.

Table 4.2.15: 3X2X2 ANCOVA on ABS with 3-Way Interactions

Dependent Variable: Total attitude score

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	307.225[a]	12	25.602	1.382	.181	.105
Intercept	4662.555	1	4662.555	251.610	.000	.641
Pretest	7.184	1	7.184	.388	.535	.003
Treatment	19.461	2	9.731	.525	.593	.007
gender	83.540	1	83.540	4.508	.035	.031
typeschool	16.953	1	16.953	.915	.340	.006
Treatment * gender	78.450	2	39.225	2.117	.124	.029
Treatment * typeschool	5.491	2	2.746	.148	.862	.002
gender * typeschool	10.752	1	10.752	.580	.447	.004
Treatment * gender* typeschool	33.071	2	16.536	.892	.412	.012
Error	2612.859	141	18.531			
Total	119823.000	154				
Corrected Total	2920.084	153				

a. R^2 = .105 (Adjt. R^2= .029)

Table 4.2.15 shows that there is no significant interaction effect of treatment, gender, and school type on pupils' attitude to science ($F_{(2;141)} = 0.89$; $p>0.05$; partial $\tilde{\eta}^2 = 0.01$). Therefore, null hypothesis 7c is not rejected.

4.3: Discussion of findings

4.3.1 Effect of treatmenton learning outcomes

4.3.1.1 Effect of treatmenton BSPS

The findings of this research revealed that treatment had a significant effect on BSPS. The main effect was a result of the significant difference between pupils' post-test scores of students exposed to TPPC and hands-on activities. The difference between the posttest BSPS score of students exposed to TPPC and control also accounted for the significant main effect of treatment. This point to the superiority of TPPC in improving pupils' process skills. The superiority of TPPC may be explained by the fact that students have a sense of ownership and contribution. Children had a choice in the selection of materials, planning, and execution of the projects based on the curriculum concepts. All of these assisted in their critical thinking, reasoning, problem-solving skills, and their creativity. Take for instance the project on the skeletal system, some pupils used mud, another set used clay, and some used paper mash. The freedom given and the responsibility of personal learning enhanced their observation, measurement, classification, and inferring skills. Moreover, there was a class presentation at the end of the project which enhanced pupils' communication skills. Acquiring science knowledge for problem-solving in the 21st century, requires the use of skills that will support pupils' knowledge of natural phenomena around them. TPPC allowed pupils not only to collaborate with their teacher but also with their peers. This significantly promoted skills that ordinarily cannot be acquired in teacher-centred classrooms. This is in line with Lev Vygotsky's social learning theory that children learn from a more knowledgeable adult or peer who may assist a child to move to a higher level of cognitive development than he/she can achieve alone. The findings of this study are corroborated by Hernawati et al. (2018) that project-based learning helps to fill the gap between the theoretical and real-world in science learning. Skill acquisition is very germane at the primary school level as it enhances the pupils' learning process. Research supports the notion that when one increases students' science process skills their academic achievement will also increase. If BSPS is the tool that pupils use to investigate the world around them and to construct science concepts then with prolonged usage of project-based learning, pupils' achievement in science will improve. This study also revealed that pupils exposed to conventional strategy had higher basic science process skills than pupils exposed to hands-on activities. What may account for the higher science process skills of pupils exposed to convectional strategy is the fact that the control group had higher science process skills as their baseline. Pupils in the conventional group may have been exposed to learner-centred strategy than the hands-on activities group before the treatment in previous years and this may account for higher mean scores in science process skills than the group for hands-on activities.

4.3.1.2 Effect of treatmenton BSA

The treatment had a significant effect on basic science achievement. The main effect was a result of the significant difference between the pupils' posttest scores of students exposed to TPPC and control. This point to the importance of Hands-on activities in improving the science achievement of pupils. The superiority of Hands-on activities on science achievement could be explained by the fact that science activities in the classroom guided by the teacher allowed pupils to interact with concrete objects. The manipulation of these concrete objects helped children to reconstruct their prior knowledge with the opportunity of increasing their science vocabulary and knowledge and this may explain the reason for higher science achievement than project-based strategy or conventional teaching strategy. This is in line with Piaget' theory of cognitive development that children are able to construct knowledge when they engage with the learning environment. Piaget further pointed out that children are able to reconstruct misconception through the process of assimilation and accommodation.

Another reason for the higher mean scores for hands-on activities may be attributed to the fact that project-based learning is new to the participants of this study and demand more time to execute than hands-on activities that took place in the classroom under the guidance of the teacher. The challenge has been that project-based learning takes a lot of time. Two weeks for each project was a short time for the pupils to execute the project and master the curriculum content. Primary school curricula are jam-packed with many subjects with very little time for practice and collaboration between peers and this may account for the higher mean score for the hands-on activities' strategy. Hands-on activities were carried out within the stipulated time for basic science in the classroom under the supervision of the teacher. Whereas pupils exposed to teacher-pupil project collaboration had to create time to execute their project and find a solution to the driving question outside the time allocated for science in school. The collaborative effort is a must in TPPC strategy as pupils will have to plan, put their plan into action and find necessary materials for project execution. Moreover, TPPC is a progressive work that necessitates continual reflection and development. Furthermore, most of the pupils are in the concrete operational stage of cognitive development and their reasoning may be inductive. Inductive in the sense that they reason on what they see rather than on abstract thinking. Inductive reasoning may not relate to the project development and curriculum content and this may explain the higher scores for Hands-on activities. The average age of pupils who took part in the study was 11 years, which means pupils are at the concrete operational stage of development according to Jean Piaget's development, they are capable of inductive reasoning but not capable of deductive reasoning. However, the strategy helped in the development of their knowledge. Pupils exposed to Hands-on activities had a better effect than TPPC is in line with Akintemi, (2019) which shows that formal sciencing activities had a better effect than informal sciencing and conventional science approaches. On the contrary, Ayan 2011 and Kizkapan and Bektas, 2017 found no significant difference between the experimental group that used the project and the control group score which was obtained from their achievement test post-test performance.

4.3.1.3 Effect of treatment on ABS

The treatment had no significant effect on pupils' attitudes to basic science. Table 4.2.3a is a reflection of this. This finding of treatment not having a significant effect on pupils' attitude to basic science may be explained by the fact that attitude takes a long time to form. The eight weeks for the administration of the treatment is not enough to develop a positive attitude to basic science.Primary five, pupils' attitudes to science learning may have been formed. At this stage, pupils regard science as an abstract subject which is consequent on the teaching strategy adopted by the teacher which literature reveals is the teacher-centred approach. Research shows that primary pupils' attitude to science learning decreases with age and class and by age eleven, pupils' attitude to science would have been formed.

4.3.2 Effect of gender on learning outcomes

4.3.2.1 Effect of gender on BSPS

This study shows no significant main effect of gender on pupils'basic sciences process skills as reflected in Table 4.2.4a. The treatment allowed male and female pupils to engage in the learning process and to use their skills both in project construction and hands-on activities. This may explain why gender had no significant difference in the science process skills of the two sexes. This finding corroborates the findings of Ekon and Eni (2015), and Jack (2018) that there is no significant main effect of gender on pupils' science process skills. However, it differs from Dokme and Aydinli (2009), Bassey and Amanso (2017) and Yuliskurniawati et al. 2019, which reveal a statistically significant difference in gender in respect of science process skills.

4.3.2.2 Effect of gender onBSA

This study shows no significant main effect of gender on pupils'BSA. This is reflected in table 4.2.5a. Learner-centred teaching strategies benefit both sexes in terms of science achievement. This finding is in line with (Ogunkola and Olatoye 2006;Fakeye 2011; Akintemi,2019; Eze et.al. 2021; Ani et al. 2022). However, Ekine, (2010) found a significant difference in the effect of gender on achievement. Factors responsible for the decrease in the differences between the two sexes' academic achievement in developed countries may also be true of developing nations like Nigeria where parents in the south-west of the country now give equal opportunity to males and females to go to school and children are also given the same environmental conditions to develop their science knowledge. More women are educated and are taking up career in the sciences and this may be a source of encouragement to girl child. Also, the advocacy for the girl child's education (Umoh and Atakpa 2014) may be another reason for no significant difference in the performance of both sexes in science achievement.

4.3.2.3 Effect of gender on ABS

This investigation indicates a significant main effect of gender on pupils' attitudes to basic science. Male pupils had a higher attitude to sciences mean score than female pupils and the difference is significant.

Table 4.2.6a shows that there is a significant main effect of gender on pupils' attitude to sciences. Table 4.2.6b shows the estimated marginal mean scores of the sexes. Male pupils had a higher attitude to sciences mean score (28.37) than female pupils (26.84) and the difference is significant. The significant difference between the mean scores of males and females attitude to basic science could be explained by the fact that environmental issues such as the societal view that science is a masculine subject, curriculum biases, media support for males in respect of science learning, curriculum gender bias and more parental support for the male child in terms of science learning may have contributed to the significant difference in attitude of male and female in this study Megalokonomou, (2021). However, this finding aligns with Tenzin et.al. (2017) that says boys have a more positive attitude toward science learning than girls.

4.3.3 Effect of schooltype

4.3.3.1 Effect ofschooltype on BSPS

This study indicates a significant interaction effect of treatment and school type on pupils' basic science process skills. Table 4.2.10c shows the estimated marginal mean scores across treatment and school types. Pupils in public school in experimental group I had a higher process skill mean score (9.72 against 9.54); Private pupils in experimental group II had a higher mean score (10.06 against 6.67) while Private pupils in the control group had a higher mean score (10.38 against 6.51). The interaction effect is disordinal and significant (See Figure 4.3 on page 103). The importance of science process skills in science learning cannot be overemphasized as it promotes the development of scientific knowledge that may translate to a positive science attitude. Considering a public school has a higher mean score than a private school that has many factors such as a science-friendly environment is commendable. The public school in Teacher pupil project collaboration had higher mean scores than their private school counterpart, this shows that the strategy employed by the teacher will go a long way to boast pupils' learning potential as shown by this study, Teacher pupil project collaboration should be explored by the classroom teacher as it promotes pupils' learning outcomes. Teacher-pupils project collaboration utilises 21st-century skills such as critical thinking, collaboration, communication, and problem-solving and this may explain public schools' better performance in science process skills.

Pupils in private schools had higher science process skills mean score (9.99) than pupils in public schools (7.63) and the difference is significant. This result is in accordance with the findings of Bassey and Amanso (2017) that there is a significant difference in the effect of school type on science process skills. Considering the learning environment, and home involvement, these two factors are key in science process skills development in science (Tenzin et al. 2019) and in the education of pupils from both private and public schools. It can be inferred that learning environment, pupil interest, and teaching strategy are major factors that influence the science process skills of pupils in basic science at primary school. Public schools can compete favorably with their peer from private schools if the factors mentioned are properly taken care of. In advanced countries that have well-developed public schools, their public schools sometimes perform better than private schools. Lubienski and Lubienski (2006) after controlling for student and school-level variables (i.e., socioeconomic status, race/ethnicity, gender, disability, limited English proficiency, and school location), concluded that the demographic differences between pupils in public and private schools accounted for the relatively high raw scores of private schools.

4.3.3.2 Effect of school type on BSA

The study indicates a significant interaction effect of treatment and school type on learners' BSA. The interaction effect is ordinal and significant. All the private schools in the three groups had higher mean scores than their public-school counterparts. This is not unexpected as the private schools had everything in their favour. Strike action does not affect them, most of them even organize after-school lessons to ensure that the curriculum is covered every term. Investigation reveals a joint examination of all private schools in the same local government. All these factors enhance quality education in some of the private schools. This may explain the reason for the higher mean scores of the private schools than their public-school colleagues. In Nigeria, the gap between private schools owned by individuals and public schools owned by the government is very wide in many ways. For instance, public schools are not adequately equipped with material resources to teach science as should be done, pupils are taught by non-science teachers, the level of supervision is low, and the commitment of teachers is very low because teachers are not adequately motivated (Osokoya,2013; Aina et. al., 2015). Considering all the factors in favour of private schools that gave private an advantage over their public counterpart, the performance of public schools in terms of achievement is very encouraging when TPPC was administered. Therefore, teachers and education planners should adopt a teaching strategy that can reduce the gap between private and public schools' science process skills as shown by TPPC. TPPC has been able to bridge the gap between private and public schools in the area of science achievement. It can be observed that TPPC has almost the same effect on both private and public schools.

4.3.3.3 Effect of school type on ABS

Shows that there is no significant interaction effect of treatment and school type on pupils' attitude to basic science. Table 4.2.11b shows the estimated marginal mean scores across treatment and school types. Though public pupils in experimental group I had a higher attitude mean score (27.81 against 26.81); public pupils in experimental group II had a higher mean score (28.60 against 27.63), and public pupils in the control group had a higher mean score (27.44 against 27.34). The interaction effect is ordinal but not significant. The interaction effect is ordinal in the sense that both treatment and control introduced concrete materials that pupils in public schools saw for the first time which aroused their interest in science, this may explain a higher mean score recorded for science attitude by the public schools. Tenzin (2019) argued that students take an active part in science when provided with hands-on experiences and learning than lecture strategy and that the classroom learning environment is a strong factor in determining and predicting student attitude towards science.

4.3.4. Interaction effect of treatmentand gender on learning outcomes

4.3.4.1 Interaction effect of treatments and gender on BSPS

This study showed that there was a significant interaction effect of treatment and gender on pupils' basic science process skills and the interaction effect is disordinal. It is disordinal in the sense that in the TPPC group, the females have the higher mean score, in the HoA, males have the higher mean scores while in the conventional group, females have the higher mean score. It can be observed that the interaction effect of gender on science process skills is dependent on the strategy used. Therefore, the interaction effect is disordinal it is significant.

This means that the effectiveness of treatment on pupils' science process skills was influenced by gender. The interaction effect of treatment and gender on science process skills is in favour of females in the control group, followed by females in TPPC. This implies that females and males should be adequately catered for in learning science. All teaching strategies should be equally considered when planning primary science. The prior knowledge of females could be seen to be higher than males which they maintained to the posttest stage. The role of the curriculum planner and implement or is to adopt strategy/strategies that promote science process skills in both male and female pupils to enhance their science learning outcomes Ekon and ENI, (2015). This can be done by using TPPC strategy that brought the mean scores of both males and females in science process skills to almost the same level, unlike male and female scores in hands-on and conventional strategies. Project apart from bridging the gap between males and females in science process skills also improves their science achievement.

4.3.4.2 Interaction effect of treatment and gender onBSA

There is no significant interaction effect of treatment and gender on pupils' basic science achievement. Table 4.2.11b shows a wider margin between the male and female scores in HoA than in TPPC and conventional groups. The margin is in favour of males. Better achievement of males in Hands-on activities could be based on the premise that hands-on activities in the class took place in class and pupils could have mastered skills within the limited period of the study. However, one can see a promising trend in project-based strategy as the female and male mean scores are almost at par. This implies that the learning environment should encourage teaching strategies that will bridge the gap between males and females. Moreover, males and females in project-based performed better than females in hands-on strategy. Furthermore, project-based and hands-on activities are child-centred approaches that had better performance influence on pupils than the conventional approach. Considering the time for the execution of the project in a Project-based approach, more time is needed to be able to assess the impact of TPPC on pupils' achievement in basic science. TPPC is a more complex teaching approach than a hands-on approach but the benefits of TPPC far outweigh Hands-on Aldabbus, (2018). TPPC involves reflection, creativity, critical thinking, problem-solving, and communication. These skills have the potential to promote learners' achievement in basic science and full benefits may not be achieved within eight weeks of treatment.

4.3.4.3 Interaction effect of treatment and gender on ABS

There is no significant interaction effect of treatment and gender on pupils' attitude to basic science. There is no 2-way interaction between treatment and gender on pupils' attitude to science. This means the effectiveness of treatment on pupils' attitudes is not influenced by gender. The interaction effect is ordinal but not significant. The teacher as the facilitator of knowledge should deliberately challenge the female pupils to develop their potential in science by pairing them with male pupils who can assist in areas where females have difficulty. Research has shown that male gravitates towards the physical sciences while female pupils tend towards life science Steegh et.al, (2019). stakeholders in education should do all they can to encourage female pupils to be interested in science. Moreover, this study reveals males have a higher mean score in achievement while females have a higher mean score in science process skills. These different abilities can be harnessed by the science teacher to improve both male and female attitudes to science. It is very important to promote a positive attitude in pupils at the primary school level because research shows that learners' attitude to science decreases with age and grade(Pell and Jarvis in Agranovich and Assaraf, 2013;Osborne cited in Cermik and Fenli-Aktan, 2020).

4.3.5 Interaction effect of treatment andschooltype

4.3.5.1 Interaction effect of treatment and school type on basic science process skills shows that there is a significant interaction effect of treatment and school type on pupils' basic science process skills. Table 4.2.10c shows the estimated marginal mean scores across treatment and school types. Public pupils in experimental group I had a higher process skill mean score (9.72 against 9.54); Private pupils in experimental group II had a higher mean score (10.06 against 6.67) while Private pupils in the control group had a higher mean score (10.38 against 6.51). The interaction effect is disordinal and significant. The importance of basic science process skills in science learning cannot be overemphasized as it promotes the development of scientific knowledge that may translate to a positive science attitude. Considering a public school has a higher mean score than a private school that has many factors such as a science-friendly environment is commendable. The public school in teacher pupil project collaboration had higher mean scores than their private school counterpart, this shows that the strategy employed by the teacher will go a long way to boost pupils' learning potential as shown by this study, Teacher pupil project collaboration should be explored by the classroom teacher as it promotes pupils' learning outcomes Chiang and Lee (2016). The strategy also utilizes 21st-century skills such as critical thinking, collaboration, communication, and problem-solving and this may explain public schools' better performance in science process skills.

4.3.5.2 Interaction effect of treatment and school typeon basic science achievement shows that there is a significant interaction effect of treatment and school type on pupils' science achievement. Therefore, null hypothesis 5b is rejected. To reveal the magnitude of performance, Table 4.2.11c shows the estimated marginal mean scores across treatment and school types. Private pupils in experimental group I had a higher achievement mean score (12.98 against 11.95); Private pupils in experimental group II also had a higher mean score (17.41 against 8.35) Also, private pupils in the control group had a higher mean score (11.93 against 10.26). The interaction effect is ordinal and significant. All the private schools in the three groups had higher mean scores than their public counterparts. This is not unexpected as the private schools had everything in their favour. Strike action does not affect them, most of them even organize after-school lessons to ensure that the curriculum is covered every term. Investigation reveals a joint examination of all private school in the same local government. All these factors enhance quality education in some of the private schools. This may explain the reason for the higher mean scores of the private schools than their public colleagues. In Nigeria, the gap between private schools owned by individuals and public schools owned by the government is very wide in many ways. For instance, public schools are not adequately equipped with material resources to teach science as should be done, pupils are taught by non-science teachers, the level of supervision is low, and the commitment of teachers is very low because teachers are not adequately motivated (Osokoya,2013; Aina et. al.2015). Considering all the factors in favour of private schools that gave private an advantage over their public counterpart, the performance of the public school in terms of achievement is very encouraging when TPPC was administered. Therefore, teachers and education planners should adopt a teaching strategy that can reduce the gap between private and public schools' science process skills as shown by TPPC. TPPC has been able to bridge the gap between private and public schools in the area of science achievement. It can be observed that TPPC has almost the same effect on both private and public schools. Since education aims to balance the differences between the two schools in the area of science learning outcomes, it behooves stakeholder in education to adopt a strategy that favours the promotion of science process skills in the two schools.

4.3.5.3 Interaction effect of treatment and school type on Attitude to basic scienceshows that there is no significant interaction effect of treatment and school type on pupils' attitude to science. This means the combined effect of school type and treatment had no effect on attitude to basic science. This study shows that treatment had no effect on attitude to basic science and the combined effect of treatment and school type also did not have effect on basic science attitude, this may imply that attitude formed may take a long time to change. This study is contrary (Ananda, et. al. 2019, Tenzin, et. al. 2019). Although many other facts come to play when it comes to attitude to basic science. However, the prolong use of treatment may have a significant effect on pupils' attitude to basic science.

4.3.6 Interaction effect of gender and schooltype

This study showed no significant interaction of gender and school type on basic science process skills, basicscience achievement, and attitude to basic science. This means that the combined effect of gender and school type had no effect on the treatment and this implies that treatment was able to improve pupils'basic science process skills and basic science achievementin primary school science (Chiang and Lee, 2016; Hernawati, et. al. 2018; Mulyeni, et.al. 2019; Duda et. al 2019).

4.3.7 Interaction effect of treatment, gender, and schooltype

This study showed no significant interaction effect of treatment, gender, and school type on basic science process skills, basic science achievement, and attitude of pupils to basic science. This implies that the 3-way interaction of treatment, gender, and school type had no effect on treatment. This means that the two treatment of teacher-pupil project collaboration, hands-on activities are effective in developing pupils'basic science process skills, and basic science achievement (Chiang and Lee, 2016; Hernawati, et. al. 2018; Mulyeni, et.al. 2019; Duda et. al 2019).

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

This chapter presents the summary, conclusion, recommendations, contribution to knowledge, limitations to the study and suggestions for further studies.

5.1 Summary

This study examined the impact of Teacher-pupil Project Collaboration, Hands-on Activities and Pupils' Learning Outcomes in Basic Science in the Ibadan Metropolis. The moderating effects of gender and school type were studied. Seven hypotheses were formulated and tested at 0.05 level of significance.Jean Piaget's Cognitive Development and Lev Vygotsky's Sociocultural theories served as the framework, while the pretest-posttest control group quasi-experimental design with a 3x2x2 factorial matrix was adopted. Three Local Government Areas (LGAs) were randomly selected from the Ibadan metropolis. One public and one private school with qualified and professional science teachers were purposively selected from each LGA. The schools were randomly assigned to TPPC (54), HoA (58) and conventional (49) groups. The instruments used were Basic Science Process Skills Rating Scale (0.73), Basic Science Achievement Test (0.83), Questionnaire on Pupils' Attitude to Basic Science (0.81) and instructional guides. The treatment lasted 11 weeks. The data were analysed using descriptive statistics and inferential statistics of Analysis of covariance and Scheffe's Post-hoc test at 0.05 level of significance.

The findings show a significant main effect of treatment on pupils' BSPS and BSA. TPPCenhanced basic science process skills significantly better than hands-on activities and conventional strategies.Hands-on activities enhanced basic science achievement significantly better than TPPC and conventional strategies. Treatment has no significant main effect on pupils' attitude to basic science. Gender has no significant main effect on pupils' BSPS and BSA but has a significant effect on pupils' attitudes to basic science with male pupils. There is a significant interaction effect of treatment and gender on pupils' basic science process skills and the interaction effect is disordinal. But no significant interaction effect of treatment and gender on pupils' basic science achievement and pupils' attitudes tobasic science.There is a significant interaction effect of treatment and school type on pupils' basic science process skills and pupils' basic science achievement but no significant interaction effect of treatment and school type on pupils' attitudes to basic science.Males have a higher attitude to basic sciencethan female pupils and the difference is significant. School type has a significant main effect on pupils' BSPS and BSA. Pupils in private schools had higher basic science process skills mean scores than pupils in public schools.Pupils in private schoolhad higher basic science achievement mean scores than pupils in public schools and the difference is significant.School type has nosignificant main effect on pupils' ABS.

There is no significant two-way interactions effects of gender andschool type on pupils'basic science process skill, basic science achievement, and attitude to basic science.There is nosignificant three-way interaction effects of treatment, gender, and type of school on pupils' basic science process skills, basic science achievement, and attitude to basic science.

5.2 Conclusion

Based on the findings of this study, it can be concluded that both TPPC and hands-on activities had better effects on basic science learning outcomes at the primary level of education than the conventional strategy. Pupils' engagement by manipulation of objects and problem-solving approaches enhanced better retention of facts. Hands-on activities improved basic science achievement while TPPC improved basic science process skills therefore the two strategies can be integrated to achieve learning goals.

Gender is not a barrier to basic science learning. Both sexes can equally learn basic science by using teaching strategies that encourage pupils' engagement, experimentation, discovery, problem-solving, creativity, communication, and critical thinking skills. Prior knowledge is very critical in learning outcomes, this is because pupils build on their experience.

School type is a critical issue when it comes to science learning. Quality education is encompassing as many factors come to play in learning. But the school environment most times can compensate for the shortfall in the home front and this is why the strategies employed by the teacher and teacher's attitude go a long way to mar or promote quality learning at the primary school. Science learning can be expensive and time demanding but an experienced teacher can navigate some of the challenges. The situation in public schools can be redeemed if teachers are more committed, consistent, and go the extra mile.

5.3 Recommendations

Based on the findings of this study, the following recommendations are made:

1. Findings of this study show that project-based and hands-on activities strategies can be used to develop the Basic Science process skills of pupils and can also be used to bridge the gap in achievement and Basic science process skills of public and private schools. It is therefore recommended that these two strategies be used at the foundational level to enhanceBasic Science performance.
2. This study has shown the attitude of male pupils toward Basic Science to be higher than that of females. It is therefore recommended that female pupils be encouraged to develop a more positive attitude to Basic Science by making the curriculum to be gender friendly and by advocating that what a male can do, the female can do the same
3. This study has shown that school type is significant in basic science learning outcomes, therefore, stakeholders should ensure that public primary schools are brought to the same standard as private schools which are of good quality. This can be done by ensuring that the school environment in terms of the provision of material resources, use of these materials by teachers, and thorough supervision of teaching activities.
4. Though project-based and hands-on activities have slight but no significant effects on pupils' attitudes, effects must be made to get parents, teachers, and all stakeholders in education to intentionally encourage pupils who have science potential and interest in science by promoting and organizing inter-

school science debate, science exhibitions of artifacts and appropriate reward be given to deserving pupils.

5. More emphasis should be placed on Basic Science process skills that emphasize problem-solving than science knowledge. This will promote science learning as it should be learned.
6. Science exhibitions should be encouraged at the primary school level. This may promote the interest of pupils in science and thereby enhance positive attitude.
7. Primary school teachers who teach science should gain more experience on how to improvise simple science material from waste items. As earlier mentioned, science materials are expensive, therefore some of the materials may be improvised by using waste materials.
8. Curriculum planning and implementation should go together, therefore, supervision is a must to ensure that learner-centred and activity-based learning strategies are used in the teaching of science. Science is a dynamic subject, therefore, there is a need to incorporate many strategies and this can be done by using a project-based learning strategy.
9. The Basic Science curriculum, teaching strategies, and teaching styles should be learner-centred and gender friendly.
10. There should be training and retraining of science teachers at the primary school level to ensure they are conversant with learner-centred teaching strategies and teaching should be thoroughly supervised.
11. Teacher training programme should incorporate a project-based learning strategy into their curriculum.

5.4 Contributions to knowledge

This study has contributed to knowledge in the following ways:

1. This study has shown that project-based and hands-on activities learning strategies though not very pronounced in primary school, can be used to develop the Basic Science process skills of male and female pupils and can also help to bridge the gap between male and female achievement and Basic Science process skills of public and private school pupils.

2. The study has shown how project-based lessons and hands-on lesson plans can be organized and implemented. Simple project-based and hands-on lesson plans have been produced to guide primary school teachers who may like to adopt the strategies in teaching Basic Science at the primary school level.
3. It has been shown that hands-on activities can be successfully implemented in the classroom by improvisation.
4. This study has shown the need to connect classroom activities to society.
5. Science activities at the primary school can be used to address community challenges.
6. Also, the study has shown that primary school pupils can collaborate to develop science artifacts.

5.5 Limitations to the study

The study determined the impact of project-based collaboration, hands-on activities on pupils' learning outcomes in basic science. During the study, some of the challenges encountered were:

1. Time was a major issue in project development in the experimental group. One of the schools had her inter-house sports competition during the study. This affected the time for one of the projects.
2. Flowers were not readily available during the study because the study was carried out in the dry season.
3. It was tough getting some private primary schools to be involved in the study because of the centralized examination
4 Attendance of pupils in public school was not consistent. Some of the pupils were off and on school.

5.6 Suggestion for further studies

Based on the observation during investigation, the following suggestions are made:

This study can be carried out in all local government areas in Oyo state. This will ensure that schools in urban and rural areas are involved in the study and lead to more generalization of the study. Pupils in rural also have their native intelligence and their exposure to the strategies might develop their interest in science. This can be done by getting a grant from both government and private organizations.

A longitudinal study may be used to carry out the treatment. This might involve long time training of teachers and using the strategies in six years of primary education. At the end of this period, teachers would have mastered the strategies, and pupils would have gotten used to the strategies. With all these in place, it will be easy to deduce if the project-based learning and hands-on activities promote basic science achievement, basic science process skills, and attitude to basic science.

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APPENDIX I

TEACHER- PUPIL PROJECT COLLABORATION INSTRUCTIONAL GUIDE

(TPPC _IG)

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An instructional guide for teachers to deliver Teacher-Pupil Project Collaboration Method

Being Experimental Group1 of a Doctoral Research

Introduction

The holistic development of the child, basic science knowledge and skills acquisition are shaped by 21st century skills which are child centred approaches such as collaboration, inquiry and discovery to mention a few. This therefore, necessitates the development of a teaching strategy that will encourage pupils to discover science conceptual knowledge, skills and positive attitude to basic science through the use of authentic questions. This therefore birth Teacher-Pupil project collaboration instructional strategy and the production of this instructional guide-Teacher-Pupil Project Collaboration

This Instructional Guide is learner centred and inquiry -based. It fosters learner's choice, team work and exploration by pupils to find solution to authentic (authentic means projects that meet real need outside the classroom or have direct impact on learners) questions in real world using project strategy to drive the curriculum content. The project is presented to a large audience and the project may be in form of artifact or otherwise. Learners explore to gather information from a variety of sources to answer an authentic question. The teacher serves as facilitator of knowledge as opposed to the traditional way of teaching basic science in which the teacher is the authority of knowledge. This guide helps to connect what is taught in class to real world where knowledge acquired in the class room is applied to issues outside the classroom for knowledge retention by pupils.

This guide has created the lesson plans for all the topics covered in this study. Each project will last two weeks of four lessons.The four lessons are as stated below:Learners are given the project vocabulary which they will use in their project execution.

The first lesson starts with pre-project assessment, entry behaviour, resource materials, technology tools, behavioural objectives and introduction. Pupils are supplied with technology tools which are on -line resources to help them with the project. They are also free to source for information from other areas. Under introduction are the following: essential questions, class grouping, ground rules, project vocabulary, driving questions, the task, task activities, and activity schedule. After introduction the lesson is summarized and end of lesson evaluation is carried out.

The second lesson is progress on project one. It consists of introduction as listed in lesson one, groups presentation of project ideas and plan, observation, question and answers and teacher facilitation.

Lesson 3: introduction, pupils' presentation of project plans and ideas, teacher's facilitation and end of lesson evaluation.

Lesson 4. group presentation of project, teacher's facilitation and finally, end of project evaluation.

It is hoped that this guide will help teachers to teach basic science as inquiry-based subject and will promote the critical thinking skills of learners. Critical thinking is key to a successful academic endeavour, labour market and self -development. The aim of this guide is to encourage learners to think and master their own learning.

Goals of this guide:

Learning behavior expected from learners are to:

- State major bones and joints in human and be able to present projects on it and explain how to prevent bone injury.
- Demonstrate the parts of the flowers that form fruit and present a project on how our knowledge of plant reproduction can be used to produce more food for a community.
- Find out the acidity and alkalinity of common fruits and liquid used in the home and how their knowledge of acids and bases can help to increase soil acidity and alkalinity.

- Use common thermometers to measure temperature of different liquid.

Course Content:

The topics are copied from Primary school basic science curriculum by Nigeria Educational Research Council Development (NERCD)

The topics that will be treated or taught during this study are:

1. Human body, bones and joint.
2. Reproduction in plants.
3. Acids, Bases and salts
4. Heat and Temperature

Weekly Activities Week 1:

Training of research assistants and administration of pre-test

Weeks 2 and 3:

Project 1

Identification of major bones in the body and their names and identification of major joints and functions.

The driving question on human bones and joint are: (1.)Howdo we preventbone injury? (2) How do bones, joints and muscles bring about movement in human?

Weeks 4and 5:

Project 2

Identification of parts of flower concerned with pollination and fertilization

Drawing and labelling of parts of a flower and differences between pollination and fertilization.

-The driving questions are:How does pollination benefit humanity? What part of the flower form the different part of a fruit?How can we produce more fruit for human consumption?

Weeks 6 and7:

Project 3

Definition of acids, bases and salts with examples, physical properties of acids, bases and salts. Differences between acids, bases and salts, uses of acids and bases.
-Driving question:How does our knowledge of acids and bases help in agriculture and engineering? How can improve soil acidity or alkalinity?

Weeks 8 and 9:

Project 4

Definition of temperature and identification of commonly used temperature scales.
Differences between heat and temperature, identification of units and symbols of temperature, use of thermometer to measure the temperature of objects accurately.
The driving question- How can earth temperature impact global warming?

Week 10:

Administration of post-test.

TEACHER -PUPIL PROJECT COLLABORATION LESSON PLAN FORMAT

General Information

Theme: …………………… **Sub- theme**: …………………………..

Class: ……………………… **Topic**: ………… **Sub- topic**: ………..

Time: ……………………… **Duration**: …………………………..…

Pre-project Assessment: ……………………

Entry Behaviour: ………………………….

Resource materials: ……………………….

Technology tools: ………………………….

Behavioural Objectives: …………………..

Introduction: ………………………………

Lesson Activities:

1.Essential questions.

2.Grouping of pupils.

3. Ground rules.

4. Project vocabulary.

5. Driving question.

6. The task.

7. Task activities.

8. Activity schedule for the remaining three lessons.

End of Lesson Evaluation……………………………

End of Project Evaluation……………………………

LESSON PLAN ONE

2nd and 3rd weeks- Project 1 (human bones and joints)

ThemeBasic science.

Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic**:**	Human bones and joints
Sub-topic**:**	Structure and function of human bones and joints
Duration:	2 weeks

Pre-project assessment

The teacher asks pupils the following questions and let them know that the right answers will be made known during the lesson. They are to write the answers in their notes. The questions are:

1. What do bones do for us? Possible answers – protect, support our body, allow us to move.
2. How many bones are in the body? Possible answers- 206
3. Where is the longest bone found in the body?- femur
4. What is a joint?- where two or bones meet
5. Name three joints in human body- ball and socket joint, kneel joint, suture joint etc

Entry behaviour: Pupils have seen bones before and they have bones in their bodies.

Resource Materials:

Model of human skeleton, chart of human skeleton, bones of another mammal, pictures, clay, labels, pencil, paper, eraser.

Technology tools:

- Teach with technology: The skeletal system Online Activities- Pinterest www. Pinterest.com > pin
- Human Body | STEM www.stem.org. uk > resource> hum
- Free!v- Human skeleton Resource Pack (teacher made) -Twinkl www. Twinkl.com>resource>t-

Behavioural objectives:

At the end of this project, the pupils should be able to

- i Identify major bones in the body.
- ii Name the major bones of the of the body- femur, humerus, skull, and vertebral column
- iii Identify the major joints in the body
- iv State the functions of bones and joints

Introduction: The teacher introduces the topic- human bones. Pupils are encouraged to say what they know about bones.

The teacher displays different bones and model of human skeleton. The teacher then asks the following essential questions.

Lesson Activities

A. Essential Questions

1. What are the structures in humanbody responsible for movement?

2. How do these structures bring about movement?

3. What happens if these structures are injured?

4. How can we prevent bone injury?

5. Why is human skeleton different from rat's skeleton?

B. Breaking of class into small groups:

Pupils are asked to pick numbers 1-5. All pupils who picked 1s will form a group, likewise all 2s, 3s, 4s. A group leader is selected by each group.

C. Ground Rules:

The following rules are to be adhered to by all group members

1. All group members are given responsibility that must be delivered at specified time.

2. All group members take responsibility for sourcing for material

3. All members work together as one to carry out group activities

4. All group members should be able to communicate the procedure for the project

D. Project -Vocabulary

Skeleton, Ulna, Fibula, Ligament, Pelvis, Radius, Scapula, Sternum, Tendon, Tibia, muscle, Joint, Long bone, Short -bone, Vertebrae, Skull, Clavicle, Femur
Humerus, Phalanges, Fibula, Ligament, Pelvis, Radius, Scapula, Sternum, Tendon, Tibia.

E. Driving Question:

How can we prevent bone injury?

F. The task: Modelling human skeleton.

- Pupils should make a model of human skeleton with any material of choice – it may be clay, paper mash or plasticine. How can we prevent bone injury?
- Create a poster showing the importance of wearing safety gear to protect the skeletal system and write a persuasive letter why safety is important on our roads.
- Write an informal picture book about the skeletal system including important vocabulary facts and functions of the skeletal system.
  May develop a game on skeletal system.

Group selects task by balloting. Projects under the task are written on pieces of paper, the papers are passed around for groups to pick. The picked project will be executed by each group.

G.Task Activities:

1.Brainstorming and planning of project material under the following:

- material to be supplied
- when and where to meet for project

-activity plan for

a) Lesson 2- The plan for the execution of the project and materials collected will be explained by each group

b) Lesson 3- progress report on project will be discussed and difficulty stated

c) Final class presentation of project.

Summary:

The teacher summaries the lesson thus:

Each group will work on a project of choice using the project vocabulary to present a project at the end of two weeks. Each group will give update on the project at every lesson. the summative assessment will be done in the fourth lesson.

End of lesson Evaluation

At the end of the lesson, the teacher asks the following questions:

1. What are the essential steps in carrying out the project?
2. What are the materials needed for the project?

LESSON PLAN 2

PROGRESS ON PROJECT 1

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Human bones and joints
Sub-topic:	Structure and function of human bones and joints
Duration:	45 min

Pre- project assessment

As in lesson 1

Entry Behaviour: As in lesson 1

Resource materials

As in lesson 1

Technology tools:

- Teach with technology: The skeletal system Online Activities- Pinterest www. Pinterest.com > pin
- Human Body | STEM www.stem.org. uk > resource> hum
- Free!v- Human skeleton Resource Pack (teacher made) -Twinkl www. Twinkl.com>resource>t- **Behavioural objectives:**

As in lesson 1

Introduction:

The teacher reminds the class of the topic for project- Humans bones and joints. Today there will be presentation of the draft of the project.

Lesson activities

Group one presentation.

At the end of this lesson, pupils should be able to:

i. The group presents on the material collected and how far they have gone in their project execution.The general plan is shared with the class.

ii. Observation, questions and answer session for the group

iii. Teacher's suggestions for the group

B. Group two presentation

i. The group presents on the material collected and how far they have gone in their project execution. The general plan is shared with the class.

ii. Observation, questions and answer session for the group

iii. Teacher's suggestions for the group

C. Group three presentation

i. The group presents on the material collected and how far they have gone in their project execution. The general plan is shared with the class.

ii. Observation, questions and answer session for the group

iii. Teacher's suggestions for the group

D. Group four presentation

i. The group presents on the material collected and how far they have gone in their project execution. The general plan is shared with the class.

ii. Observation, questions and answer session for the group

iii. Teacher's suggestions for the group

End of Lesson Evaluation:

The teacher asks pupils the following questions

1. Can the material available execute the project?
2. Will the time available be enough to execute the project?

There is a reflection on the project by each group. If the work done covers the vocabulary listed then the group can proceed with their project. necessary correction is made, the group can then move to the next level of the work.

Summary:

The lesson is summarized thus- The purpose of the lesson is to design a project on human bones and joints. The project will reflect the project vocabulary and the driving questions.

Pupils will work in team to gather material for use and the project will be delivered in two weeks.

End of lesson Evaluation:

The teacher evaluates based on presentation

LESSON PLAN 3

PROGRESS ON PROJECT 1

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Human bones and joints
Sub-topic:	Structure and function of human bones and joints
Duration:	60 Mins

Pre-project assessment

As in lesson 1

Entry Behaviour:

As in lesson 1

Resource materials

As in lesson 1

Technology tools:

As in lesson 1

Behavioural objectives:

As in lesson 1

Lesson activities

A.Group one additional presentation

i.The group presents further on the second lesson. The group explains how to prevent bone injury

ii. Observation, questions and answer session for the group

iii. Teacher's suggestions for the group

B. Group two additional presentation

a. The group presents further on the second lesson. The group explains how to prevent bone injury.
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

C. Group three additional presentation

a. The group presents further on the second lesson. The group explains how to prevent bone injury
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

D. Group four additional presentation

a. The group presents further on the second lesson. The group explains how to prevent bone injury
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

Summary:

The lesson is summarized by highlighting the points addressed by different groups.

End of Lesson Evaluation:

The teacher asks pupils the following questions

1. How do we prevent bone injury?
2. How can a broken bone be corrected?

LESSON PLAN 4

PROGRESS ON PROJECT 1

Date:

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Human bones and joints
Sub-topic:	Structure and function of human bones and joints
Duration:	45 mins

Pre--project assessment

As in lesson 1

Entry behaviour:

As in lesson 1

Resource materials

As in lesson 1

Technology tools:

As in lesson 1

Behavioural objectives:

As in lesson 1

Lesson activities

A. Group one presentation on the project. Questions, answer and observation
B. Group two presentation on the project Questions, answer and observation
C. Group three presentation on the project Questions, answer and observation
D. Group four presentation on the project Questions, answer and observation

Summary:

The lesson is summarized thus:

Bone is the hard white substance in the body. The long and short bones are the bones of the legs and hands. Other major bones are the ribcage, back- bone and skull.

End of project Evaluation:

Class comes together and answer the following questions:

- What are the major bones in human body?
- Where are these major bones found?
- Mention five joints in the body and where found.
- State four functions of bone
- What is the function of joint in human body?

WEEKS 4-5

PROJECT 2

LESSON PLAN 1

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Reproduction in plants
Sub-topic:	parts of the flower
Duration:	45 mins

Pre-project assessment

- What is flower?
- What are the parts of a flower?
- What is pollination and fertilization?
- What are the agents of pollination?
- How does a plant produce fruit?

Entry Behaviour: Pupils have seen flowers and fruits before.

Resource materials

Insect and wind pollinated flowers, fruits at different stages of development, charts, pencil, eraser, drawing books.

Technology tools:

1. Basic parts of a flower digital directed drawing in interest. www.pinterest.com>pin.
2. What is a flower? Answers – Twink 1 Teaching Wiki www.twinkl.com.ng>teaching-wiki
3. Parts of a plant/labeling rest. Twinkl.co.uk
4. What is flower? Answers – twinkl.co.uk
5. What is pollination? Fs.fed.us
6. Plant and flower activities avasflowers.net.

Behavioural objectives:

At the end of this lesson, the pupils should be able to:

- Identify the parts of a flower
- Explain the types of pollination and explain the agents of pollution
- Enumerate the features of insect pollinated flower
- Enumerate features of wind pollinated flower.
- Draw and label the parts of a flower
- State the differences between pollination and fertilization in a flowering plant.

Introduction: The teacher introduces the topic- Reproduction in plants as an introduction to the project.

Lesson activities:

Pupils are encouraged to look at a flower and state the major parts of the flower.

Agent of pollination is defined and pupils are encouraged to state five agents of pollination.

Production of whole flower using plastersine and other materials

A.Essential Questions

- What are the differences between insect and wind pollination flowers?
- What are the agents of pollination in flowers?
- What are the characteristics of insect and wind pollinated flowers that make them suitable for their function?
- How are flowers pollinated and fertilized?

B. Breaking of class into small groups:

Pupils are asked to pick number 1-5. All ones will form a group, likewise all 2s, 3s, 4s and 5s.

C. Ground Rules:

All group members are given responsibility that must be delivered at specified time.

All members work together as one to carry out group activities.

All group members take responsibility for sourcing for material

All group members should be able to communicate the procedure for the project

D. Project Vocabulary

- Flower whorl, Petal, Sepal, Stigma, Style, Gynoecium, Androecium, Pollination
- Fertilization in wind pollinated flower, Insect pollinated flower, Agents of pollination
- Zygote, Ovule, Ovary, Calyx, Corolla, Stamens, Anther, Carpels, Pollen grains ‘style

E. Driving Question:

How can our knowledge of flower increase food production?

F. The task:

- Modelling of flower using plaster sine or clay or any other material.
- Production of photo album of flower, parts, pollination and fertilization.
- Presentation on how to use knowledge of flowers to solve everyday problem i.e. beautification of environment.

Task is chosen by balloting. The tasks are written on sheets of paper for group to choose group project.

G. Task Activities:

Group members come together to brainstorm and plan the project.

H.Activity schedule:

a.Brainstorming and planning of project material under the following:

- material to be supplied
- when and where to meet for project

-activity plan and the finished project.

Summary:

The teacher summaries the lesson thus:

Each group will work on a project of choice using the project vocabulary to present a project at the end of two weeks. Each group will give update on the project at every lesson. The summative assessment will be done in the fourth lesson.

End of lesson Evaluation:

At the end of the lesson, the teacher asks the following questions:

1. On group basis, pupil signifies when they would meet.
2. The materials they will use for their project.

LESSON PLAN 2

PROGRESS ON PROJECT 2

Date:

Theme:	Basic Science
Sub-theme:	Living and Non – living things
Class:	Primary 5
Topic:	Reproduction in plants
Sub-topic:	Parts of a flower
Duration:	45 mins

Pre-project assessment

As in lesson 1

Entry Behaviour:

As in lesson 1

Resource materials

As in lesson 1

Technology tools:

1. Basic parts of a flower digital directed drawing in interest. www.pinterest.com>pin.
2. What is a flower? Answers – Twink 1 Teaching Wiki www.twinkl.com.ng>teaching-wiki
3. Parts of a plant/labeling rest. Twinkl.co.uk
4. What is flower? Answers – twinkl.co.uk
5. What is pollination? Fs.fed.us
6. Plant and flower activities avasflowers.net.

Behavioural objectives:

As in lesson 1

Introduction:

The teacher reminds the class of the topic for project- Reproduction in plants

Lesson activities:

i. Group one additional presentation.
ii. The group presents further on the second lesson.
iii. The group explains how to prevent bone injury.
iv. Observation, questions and answer session for the group.
v. Teacher's suggestions for the group.

B.Group two additional presentation

a. The group presents further on the second lesson.
b. The group explains how to reproduction in plants to produce more food.
c. Observation, questions and answer session for the group.
d. Teacher's suggestions for the group.

C.Group three additional presentation

a. The group presents further on the second lesson.
b. The group explains how to reproduction in plants to produce more food.
c. Observation, questions and answer session for the group.
d. Teacher's suggestions for the group.

D.Group four additional presentation

a. The group presents further on the second lesson. The group explains how to reproduction in plants to produce more food
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

Summary:

End of lesson Evaluation:

The teacher asks pupils the following questions

a. How do we prevent bone injury?
b. How can a broken bone be corrected?

LESSON PLAN 3

PROGRESS ON PROJECT 2

Date:	
Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Reproduction in plants
Sub-topic:	Parts of the flower.
Duration:	45 mins

Pre-project assessment

As in lesson 1

Entry Behaviour:

As in lesson 1

Resource material

As in lesson 1

Technology tools:

As in lesson 1

Behavioral objectives:

As in lesson

Introduction:

The teacher reminds the class of the topic of the project that is on-going and the lesson activities.

Lesson activities:

A. Group one additional presentation

a. The group presents further on the second lesson. The group explains how reproduction in plants produce more food

b. Observation, questions and answer session for the group

c. Teacher's suggestions for the group

B. Group two additional presentation

a. The group presents further on the second lesson. The group explains how reproduction in plants produce more food.
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

C. Group three additional presentation

a. The group presents further on the second lesson. The group explains how reproduction in plants produce more food
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

D. Group four additional presentation

a. The group presents further on the second lesson. The group explains how reproduction in plants produce more food
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group.

Summary:

End of the lesson Evaluation:

LESSON 4

PROGRESS ON PROJECT 2

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Reproduction in plants
Sub-topic:	Parts of the flower.
Duration:	45 mins

Pre- lesson assessment

As in lesson 1

Entry Behaviour:

As in lesson 1

Resource materials

As in lesson 1

Technology tools:

As in lesson 1

Behavioural objectives:

As in lesson 1

Lesson activities

A. Group one presentation on the project. Questions, answer and observation

B. Group two presentation on the project Questions, answer and observation

C. Group three presentation on the project Questions, answer and observation

D. Group four presentation on the project

Questions, answer and observation

Summary:

- Class comes together as one and each group does its presentation.
- Class and teacher give feedback to the groups and necessary correction is done.

End of project Evaluation:

The teacher asks the following questions.

- What are the major parts of a flower?
- What is pollination?
- Mention 4 agents of pollination
- After fertilization in flower what is the object produced? - State 4 differences between insect and wind pollinated flower - State two differences between pollination and fertilization.

WEEKS 6 and 7.

PROJECT 3

Acids, Base and Salts

Lesson plan 1

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Acids and bases
Sub-topic:	
Duration:	45 mins

Pre-project assessment

The teacher asks pupils the following questions and pupils are informed that the right answers will be made known during the lesson. They are to write the answers in their notes.

- What are acids?
- What are bases?
- Where are acids and bases found?

Entry Behaviour: Pupils have tasted lime, lemon or unripe fruits that gives stringent taste

Resource materials

Charts, lemon, lime, wood ash, liquid soap, some vegetables, red and blue litmus papers.

Test- tubes, source of heat, text -tube holder and water.

Technology tools:

1) http:ed.ted.com/lessons/the- strengths and weaknesses –of-acids-and-base.
2) Teaching children about acids and bases| Acids vs. Bases Experiments for Kids https://scienceexplorers.com>teachi....

Behavioural objectives:

At the end of this lesson, the pupils should be able to:

- To define acid and bases
- To list some examples of acids and bases
- To state some physical properties of acids and bases
- To identify the types of acid and bases.
- To differentiate between acids and bases by using litmus paper.
- To find out the uses of acids and bases in the community.

Introduction: The teacher introduces the topic- Acids and Bases

Every substance in the universe is made up of hundreds and thousands of tiny atoms, molecules and ions. When a large number of those are hydrogen ions, the substance is acidic.
When a large number of these are hydroxide ions, then the substance is base

pH scale measures the degree of acidity or alkalinity. There are 14 different possible point values on the scale and each represents a possible level of acidity or baseness. O is the most acidic. pH level of 7 – 14 is basic, 14 is the most basic. If a substance has a pH of 7 – it is neutral and it means it has equal amount of hydrogen ions and hydroxide ions.
Indicators are substances that can measure if a substance is acidic or basic. – e. g litmus and turmeric are great natural indicators. Red cabbage is a great natural indicator. Where we find acid and base in nature acids and bases are all around us in daily life e.g. plant leaves, stems, roots, flowers, fruit, soda, milk. Acid in stomach help with digestion our pancreas is basic. Basic substances contain lots of hydroxide. These are different type of molecule with a small electrical charge. In foods, this mean they will taste more bitter an example of base is baking soda.

Acid and base are important in living things because most enzymes can do their job only at a certain level of acidity. Cells secrete acids and bases to maintain the proper

PH for enzymes to work for example every time you digest foods, acids and bases are at work in your digestive system.

Car battery: was strong sulphuric and chemical reactions between the acid and lead plants in the battery help make electricity to start the car. Most dairy products are acid forming food e.g. cow's milk, meat, poultry, fish and most grains. Most fruits and vegetables are alkaline forming lemon is acidic before digestion but contains alkaline – forming products once broken down in the body.

Lesson activities:

Essential Question

A. Grouping of pupils:

Pupils are asked to pick numbers 1-5. All ones will form a group, likewise all 2s, 3s, 4s and 5s.

B. Ground Rules:

The following rule are to be adhered to by all group members

All group members are given responsibility that must be delivered at specified time.

All group members take responsibility for sourcing for material

All members work together as one to carry out group activities

All group members should be able to communicate the procedure for the project

C. Project Vocabulary

- Acids
- Bases
- Salts
- Litmus paper
- Properties of acids
- Properties of bases
- Hydrochloric acid (Hcl) }

- Trioxonitrate (v) acid ($HN0_3$) }Strong acid
- Tetraoxosulphate (vi) acid (H_2S0_4) }
- Methanoic acid (HC00H) }weak acid
- Ethanol acid (CH_2C00H) }from lemon
- Sodium Hydroxide (Na0H) }lime tangerine
- Potassium Hydroxide (K0H) } strong bases
- Calcium hydroxide }weak base
- Sodium hydrogen tetraoxosulphate (vi) $NaHS0_4$
- Sodium trioxosulphate (iv) Na_2C0 - Basic salt
- Calcium chloride, sodium chloride - New salt

E. Driving Question:

How can we increase soil acidity or alkalinity?

F. The task:

- Making of paper indicators from red cabbage
- Pupils should gather ten fruits and determine which is alkaline or acidic

G.Task Activities:

Group members come together to brainstorm and plan the project.

H.Activity schedule:

Brainstorming and planning of project material under the following:

- material to be supplied
- when and where to meet for project -activity plan

Summary:

The teacher summaries the lesson thus:

Each group will work on a project of choice using the project vocabulary to present a project at the end of two weeks. Each group will give update on the project at every lesson. The summative assessment will be done in the fourth lesson.

End of lesson Evaluation

At the end of the lesson, the teacher asks the following questions:

1. What are the essential steps in carrying out a project?
2. What are the materials needed for the project?

LESSON PLAN 2
PROGRESS ON PROJECT 3

Date:	
Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Acids and bases
Sub-topic:	
Time:	
Duration:	45 mins

Pre-project assessment

As in lesson 1

Entry Behaviour:

As in lesson 1

Resource materials

As in lesson 1

Technology tools:

As in lesson 1

Behavioural objectives:

As in lesson 1

Introduction:

The teacher reminds the class of the topic for project **Lesson activities**.

A.Group one additional presentation

a. The group presents further on the second lesson. The group explains how to improve soil acidy and alkalinity.

b. Observation, questions and answer session for the group

c. Teacher's suggestions for the group

B. Group two additional presentation

a. The group presents further on the second lesson. The group explains how to improve soil acidy and alkalinity.
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

C. Group three additional presentation

a. The group presents further on the second lesson. The group explains how to improve soil acidy and alkalinity.
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

D. Group four additional presentation

a. The group presents further on the second lesson. The group explains how to improve soil acidy and alkalinity.
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

Summary:

The teacher summaries the lesson thus:

The essence of this lesson is to do a project based on acids, bases and salt

End of lesson Evaluation:

The teacher asks pupils the following questions

1. How can we do a project on acids, bases and salt?
2. What are the materials needed to carry out this project?

LESSON PLAN 3

PROGRESS ON PROJECT 3

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Acids and bases
Sub-topic:	
Time:	
Duration:	45 mins

Pre-project assessment

As in lesson 1

Entry Behaviour:

As in lesson 1

Resource materials

As in lesson 1

Technology tools:

As in lesson 1

Behavioural objectives:

As in lesson 1

Lesson activities:

A. Group one additional presentation

a. The group presents further on the second lesson. The group explains how to improve soil acidity.

b. Observation, questions and answer session for the group

c. Teacher's suggestions for the group

B. Group two additional presentation

a. The group presents further on the second lesson. The group explains how to improve soil acidity.

b. Observation, questions and answer session for the group

c. Teacher's suggestions for the group

C. Group three additional presentation

a. The group presents further on the second lesson. The group explains how to improve soil acidity.

b. Observation, questions and answer session for the group

c. Teacher's suggestions for the group

D. Group four additional presentation

a. The group presents further on the second lesson. The group explains how to improve soil acidity.

b. Observation, questions and answer session for the group

c. Teacher's suggestions for the group.

Summary:

End of the lesson Evaluation:

The teacher asks the pupils the following questions:

List three sources of acids

Define bases.

LESSON 4

PROGRESS ON PROJECT 3

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Acids and Bases
Sub-topic:	
Duration:	45 mins

Pre- lesson assessment

As for lesson 1

Entry Behaviour:

As for lesson 1

Instructional Resources

As for lesson 1

Technology tools:

As for lesson 1

Behavioural objectives:

As for lesson 1

Lesson activities:

A. Group one presentation on the project. Questions, answer and observation

B. Group two presentation on the project

Questions, answer and observation

C. Group three presentation on the project. Questions, answer and observation

D. Group four presentation on the project.

Questions, answer and observation.

Summary:

- Class comes together as one and each group does its presentation.
- Class and teacher give feedback to the groups and necessary correction is done.

End of project Evaluation:

The teacher asks the following questions.

1. Define acids and bases.
2. Give two examples each of acids and base.
3. State two physical properties of acids.
4. Mention two properties of bases.
5. Mention two strong acids and two strong bases.
6. State two differences between acids and bases

WEEKS 8-9

PROJECT 4

LESSON PLAN 1

Date:

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Heat and Temperature.
Sub-topic:	
Duration:	45 mins

Pre-project assessment

Ask pupils the following questions and let them know that the right answers will be made - What is heat?

- What is temperature?
- What is the relationship between heat and temperature?
- Mention the instrument for measuring temperature.

Entry Behaviour:

Pupils have handled hot and cold-water bottles

Resource materials:

Charts, containers, boiling water, ice-cubes, thermometers, source of heat.

Technology tools:

The Heat is on! www.teachstarter.co,>blog grade lesson eliciting student ideas: What is heat? Betterlesson.com> eliciting.

Behavioural objectives:

At the end of the lessons, pupils should be able:

- To define temperature
- Differentiate between heat and temperature

- Measure temperature using different types of thermometers -Identify and write the units and symbols of temperature.
- Use the thermometer to measure the temperature of objects accurately -Identify commonly used temperature scales.
- List the uses of thermometer.

Introduction: The teacher introduces the topic- Heat and temperature.

Heat is the transfer of energy between objects that are at different temperature. Energy is always transferred from an object with higher temperature to an object with a lower temperature. Temperature is a direct measure of the average kinetic energy of the particles in a substance. Energy is the ability of a system to do.

Higher heat is equivalent to higher temperature. Temperature is measured in Celsius (^{0}C) or Kelvin (k) or Fahrenheit (^{0}F). Heat is measured in calories or joules.

All matters contain heat energy. Heat is neither created nor destroyed. Types of heat:

Convention – transfer of heat through the air.

Conduction – heat through a material

Radiation – heat from hot object to surrounding.

Temperature is the measure of heat in the body. Other scales used to measure the temperature are Celsius or Fahrenheit (^{0}F). Heat is the total energy of the motion of the molecules inside the object or particles, whereas temperature is merely a measure of this energy. The relationship between heat and temperature- the more heat an object has the higher the temperature. The temperature of different materials are listed below:

- Boiling point – 100^oc
- Everyday temperature - 37^0c
- Room temperature - 20^0c
- Freezing point - 0^oc
- Sweater keep you well insulated from cold weather -Metal conduct heat from stove or cooker to cook.

- **Lesson activities**

Essential Questions

- What is the relationship between heat and temperature?
- How do we measure the temperature of a substance?
- What make temperature measurable?

A. Breaking of class into small groups:

Pupils are asked to pick number 1-5. All ones will form a group, likewise all 2s, 3s, 4s and 5s

B. Ground Rules:

The following rule are to be adhered to by all group members

All group members are given responsibility that must be delivered at specified time.

All group members take responsibility for sourcing for material

All members work together as one to carry out group activities

All group members should be able to communicate the procedure for the project

Project-Vocabulary

- Heat, Temperature, Thermometer, Kelvin, Celsius, Fahrenheit, Mercury,
- Clinical thermometer, Maximum and minimum thermometer, Centigrade

C. Driving Question:

How does the heat generated on earth affect global warming?

D. The task:

-Modelling mercury/ liquid in glass thermometer.

- Modelling clinical/digital thermometer.
- Modelling infrared thermometer.

- Modelling minimum and maximum thermometer.

Production of a simple thermometer.

E. Task Activities:

Group members come together to brainstorm and plan the project.

F. Activity schedule:

a. Choosing of project work.

b. Brainstorming and planning of project material under the following:

- material to be supplied
- when and where to meet for project -activity plan

Summary:

End of lesson Evaluation:

1. What is heat?

2. What is temperature?

LESSON PLAN 2

PROGRESS ON PROJECT 4

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Heat and Temperature.
Sub-topic:	Structure and function of human bones and joints
Duration:	45 mins

Pre- lesson assessment

As in lesson 1

Entry Behaviour:

As in lesson 1

Resource materials.

As in lesson 1 **Technology tools:**
http:ed.ted.com/lessons/the- strengths and weaknesses –of-acids-and-base.

Teaching children about acids and bases| Acids vs. Bases Experiments for Kids https://scienceexplorers.com>teachi....

Behavioural objectives:

As in lesson 1

Introduction:

The teacher reminds the class of the topic for project- Heat and temperature.

Lesson activities:

A. Group one additional presentation

a. The group presents further on the second lesson. The group explains how to reduce global warming.
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

B. Group two additional presentation

a. The group presents further on the second lesson. The group explains how to reduce global warming.
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

C. Group three additional presentation

a. The group presents further on the second lesson. The group explains how to reduce global warming
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group

D. Group four additional presentation

a. The group presents further on the second lesson. The group The group explains how to reduce global warming
b. Observation, questions and answer session for the group
c. Teacher's suggestions for the group.

Summary:

End of the lesson Evaluation:

The teacher asks the pupils the following questions:

1. What is the difference between heat and temperature?
2. Mention three ways by which heat is transferred?

LESSON PLAN 3

PROGRESS ON PROJECT 4

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Heat and temperature.
Sub-topic:	
Duration:	45 mins

Pre- lesson assessment

As in lesson 1

Entry Behaviour:

As in lesson 1

Resource materials

As in lesson 1

Technology tools:

As in lesson 1

Behavioural objectives:

As in lesson 1

Lesson activities:

a. Group one additional presentation.
b. The group presents further on the second lesson. The group explains how to reduce global warming.
c. Observation, questions and answer session for the group.
d. Teacher's suggestions for the group.
e. Group two additional presentation.

a. The group presents further on the second lesson. The group explains how to reduce global warming.

b. Observation, questions and answer session for the group.

c. Teacher's suggestions for the group

d. Group three additional presentation

e. The group presents further on the second lesson. The group explains how to reduce global warming.

f. Observation, questions and answer session for the group

g. Teacher's suggestions for the group

h. Group four additional presentation

i. The group presents further on the second lesson. The group explains how to reduce global warming

j. Observation, questions and answer session for the group

k. Teacher's suggestions for the group.

Summary:

End of the lesson Evaluation:

The teacher asks the pupils the following questions:

i. Mention two instruments for measuring temperature

ii. Mention three types of thermometers

LESSON 4

PROGRESS ON PROJECT 4

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Heat and Temperature.
Sub-topic:	
Duration:	45 mins

Technology tools:

As in lesson 1

Pre- lesson assessment

As in lesson 1

Entry Behaviour:

As in lesson 1

Resource materials

As in lesson 1

Behavioural objectives:

As in lesson 1

Lesson activities:

A. Group one presentation on the project. Questions, answer and observation
B. Group two presentation on the project

Questions, answer and observation

C. Group three presentation on the project Questions, answer and observation
D. Group four presentation on the project

Questions, answer and observation

Summary:

- Class comes together as one and each group does its presentation.
- Class and teacher give feedback to the groups and necessary correction is done.

End of project Evaluation:

The teacher asks the following questions.

1. What is temperature?
2. Give two differences between heat and temperature.
3. What are the units and symbols of temperature?
4. State two types of thermometers.

APPENDIX II

HANDS-ON ACTIVITIES INSTRUCTIONAL GUIDE (HoAIG)

For

Basic science in primary schools

By

Olagbaju Adenike Bosede

Under the supervision of

Dr. Ishola Akindele Salami

An instructional guide for teachers to deliver Hands- On Activities

Being Experimental Group 11 of a Doctoral Research

Introduction to Hands-on Activities Instructional Guide

Children construct knowledge by engaging with the world around them. This engagement promotes the development of positive learning outcomes. Hands-on activity strategy is an experiential teaching strategy. It is a hands-on, minds-on learning approach. The teacher scaffolds knowledge by guiding pupils in the conduct of the activities to achieve the behavioral objectives.

In this approach, the instructor supports learners to carry out the activities to achieve the behavioural objectives during class lessons. After pupils might have gone through the activities for the behavioral objectives, the teacher summaries the topic. Formative assessment is carried out to find out the weakness of pupils. The weak areas are addressed.

The teacher reflects on the learning process and if satisfied with the learning outcomes, the class moves to the next topic.

This hands-on instructional guide consists of sixteen lesson plans. There are eight weeks for teaching and since we have two lessons in a week, it therefore implies a total of sixteen lessons for the eight weeks. The first four lesson plans are on human bones and joints the next four lesson plans on reproduction in plants, another four for acids, bases and salts while the last four lesson plans are for heat and energy.

A lesson plan consists of the following: General information, pre-assessment, behavioural objectives, activities, formative assessment, reflection, and assignment. I hope this guide will assist science teachers in the teaching and learning process.

WEEKLY ACTIVITIES

Week 1:

Training of research assistants

Week 2

administration of pre-test

Week 3:

Identification and name of major bonesin the body and functions

Week 4:

Identification of human joints and functions.

Week 5:

Identification of parts of a flower, diagrams and label of parts of a flower. Pollination in plants- agents of pollination and features of insect and wind pollinated flowers.

Week 6:

Fertilization in plants, parts of a flower involved in pollination and fertilization, process and stages of development in plants. Differences between pollination and fertilization.

Week 7:

Definition of acids and bases, some examples of acids and bases, physical properties of acids and bases

Week 8:

Identification of acids and bases, differentiation between acids and bases, uses of acids and bases.

Week 9:

Definition of temperature, differences between heat and temperature. Identification and writing of the unit and symbol of temperature.

Week 10: List and uses of thermometer, use of thermometer to measure the temperature of objects accurately.

Week 11:

The post-test.

HANDS-ON ACTIVITIES LESSON PLAN FORMAT

General Information

Theme: ……………………..…… **Sub- theme**: ……………….………

Topic……………………..….. **Subtopic**………………………….

Class: ………………………**Period**: … ……..**Duration**: …………………

Instructional Resources: ……………………………………………………..

Entry Behaviour:………………………………………………………………….

Behavioural Objectives: ……………………………………………………………

1. Skills………………………………………………………………………..
2. Cognitive……………………………………………………………………
3. Affective…………………………………………………………………….

Class Activities: ……………………………………………………………………

1. Introduction:……………………………………………………………….
2. Prior knowledge……………………………………………………………
3. Teacher and Learners' Activities:…………………………………………….
4. Summary:…………………………………………………………………..
5. End of lesson Assessment :…………………………………………………
6. Reflection:…………………………………………………………………..
7. Assignment:…………………………………………………………………

3rd week

Lesson Plan 1

Theme: Basic Science

Sub-Theme: Living Things and non-living things.

Topic: Human Body: Bones and Joints

Sub-Topic: Human bones

Class: Primary 5

Period:

Duration:

Instructional Resources: Model of human skeleton, charts, pictures, human skeleton cut and stick, pictures of bones of other animals.

1.Entry Behaviour:

Learner have seen bones of different animals before and they have bones in their body.

Behavioural objectives:

At the end of the lesson, pupils should be able to develop the following: A.Skills: observing, classifying, inferring - touch the major bones of human skeleton.

- Cut and stick the name of major bones and match with the bones. B.Cognitive:
- Mention the five the major bones.
- State where the major bones are found in the body. C.Affective:
- Be able to work in group to achieve the goal of the lesson.

Class Activities

Step	Teacher's Activities	Pupils' Activities
Step 1	The teacher familiarizes him/herself with the class	Pupils introduce themselves
Step 2	The teacher introduces the lesson and assesses pupils' previous knowledge, they are asked to identify the skeletal systems of human being and rat	1.Pupils pay attention to teacher's instruction. 2.Pupilsrespondtoprevious knowledge questions by naming the skeletal systems and they state

		the reasons for their answers 3. Also listen to any correction made by the teacher (if any)
Step 3	The teacher gives each pupil the photocopy of human skeleton cut and stick. The teacher asks pupils to fill the cut and stick photocopy as shown on pages 143. The teacher then shows the filled human skeleton.	1.Pupils assists in the distribution of the worksheet. 2. Pupils fill the human skeleton cut and stick 3. Pupils exchange their photocopy with another pupil who marks their work when the teacher show the model. 4. Pupils do the marking of their colleagues' work
Step 4	1.The teacher asks pupils to write against each feature where they are found in the body. For instance, the skull is found in the head etc 2. Teacher moves around to assess the pupils work	1.Pupils share thesecond worksheet. Write against each feature where they are found in the body. 2. Pupils present their work for teacher to assess.

Summary

The teacher guides pupils to summarize the lesson thus:

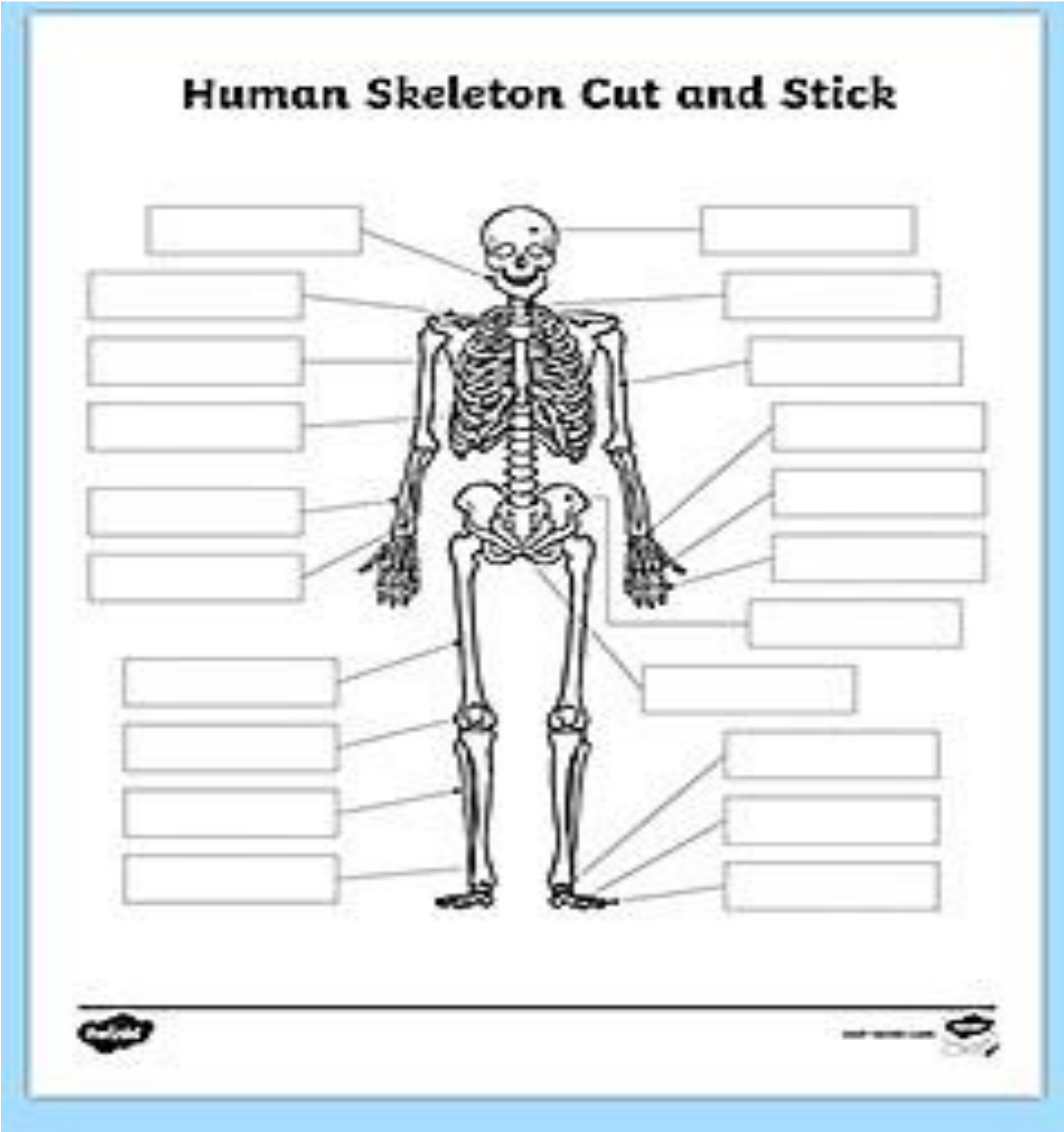
- Bone are hard, white substances found in the bodies of some animals
- The major bones are: bone of the head called skull, the rib cage, backbone called vertebrae, bones of the hand- humerus, ulna and radius bones of the legs- femur, tibia and fibula, bones of the wrist- carpals, metacarpal, bones of the feet- tarsals, metatarsals and phalanges

End of Lesson Assessment: The teacher asks the pupils the following questions

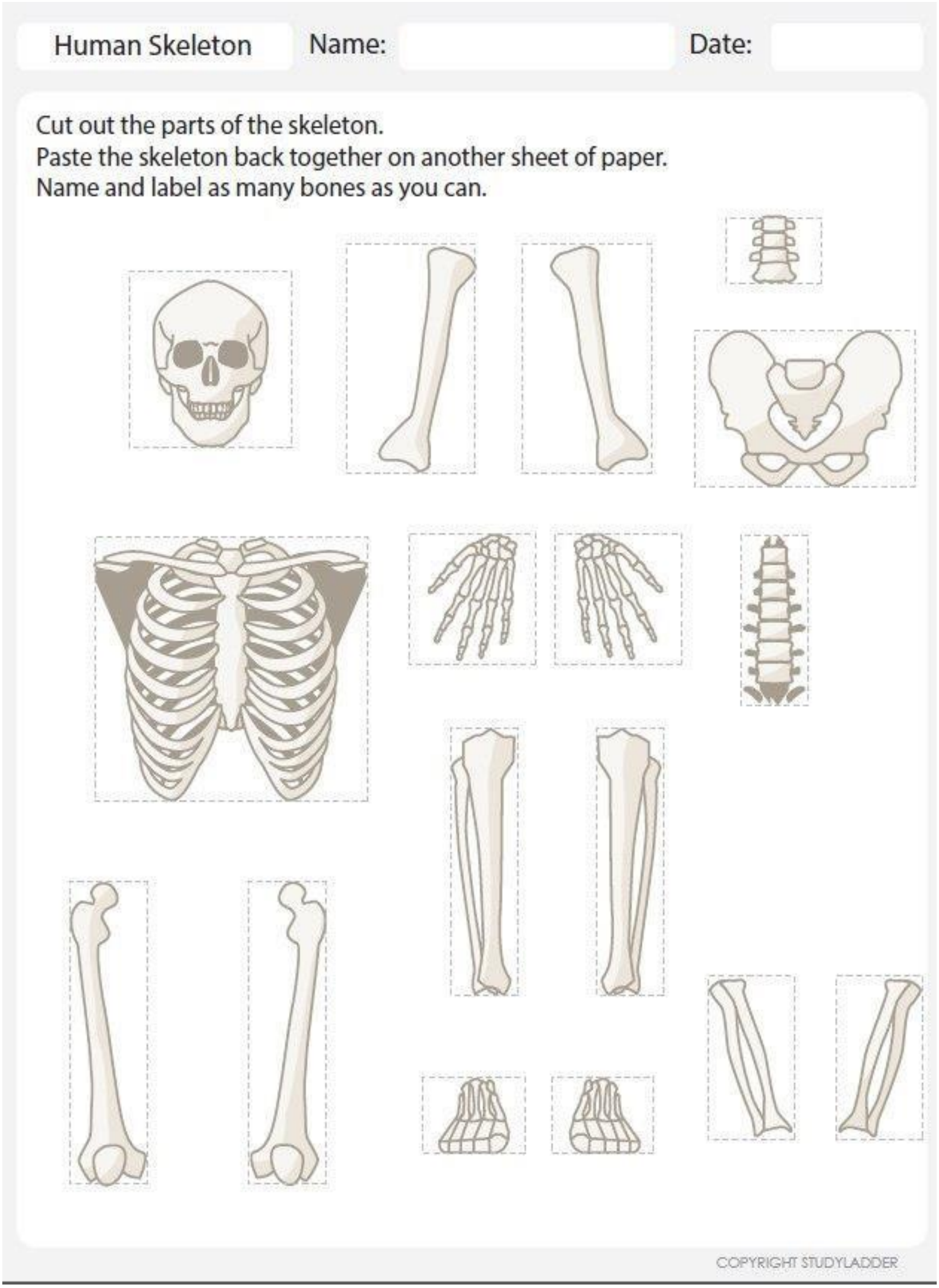
1. What is a bone?
2. Skeletal system is made up of --------------- ----------------- --------------- -------------- and------------
3. The teacher picks up different bone parts and pupils are asked to name them.

Reflection: The teacher reflects on the lesson and learners' response, revisits the difficult areas then move to the next sub-topic.

Assignment: The pupils are to draw the diagram of the human skeleton using circle and lines to represent the different parts.



Human skeleton cut and stick



Human skeleton cut and paste 1

LESSON PLAN 2

Theme:	Basic Science
Sub-Theme:	Living Things and non-livings.
Topic:	Human Body: Bones and Joints.
Sub-Topic:	Human bones
Class:	Primary 5

Period:

Duration:

Instructional Resources: Model of human skeleton, charts, pictures, human skeleton cut and stick, pictures of bones of other animals

4.Entry Behaviour:

Learner are familiar with types of bones in human body

Behavioural objectives:

At the end of the lesson, pupils should be able to:

Skills:

- Cut and assemble parts of human skeleton
- **Cognitive:**
- State three functions of bone.

Affective:

- Be able to work together in group to assemble bone parts

Class Activities

Step 1	The teacher introduces the lesson and asks pupils to write one or two organs that may be found in the labelled features of the human bone and the teacher move around to guide the pupils.	1.Pupils listen to the introduction. 2.Write name of organ against the skeleton. 3. Pupils seek assistance when/where the need arises
Step 2	The teacher group pupils. A group consists of 5-6 pupils. The teacher asks each group to cut and assemble the human skeleton on page 144.	A. Pupils go into 5-man or 6-man groups. B. Each group works as a team to produce a model of human skeleton as reflected in the chart or modelwith proportional dimensions.
		C. Pupils call the attention of the teacher to their work and make correction where necessary.
Step 3	The teacher asks pupils to look at the model of human skeleton and identify the long bones and the short bones in a tabular form and suggest four functions of the bone	a. Individual pupils draw a table with the heading long and short bones. b. The long and short bones are identified and written under appropriate column. c. They also try to state the four functions of human bone in their note-book. d.Any pupil who cannot remember the function seeks assistance from the teacher.
Step 4	The teacher guide pupils to state functions of human bones	A. Pupils compare the functions given by the teacher with theirs. B. Pupils write all the functions of human bones in their notebook

Summary

- Bones with tendon, ligament and muscle bring about movement in animals - Bones do different works in the bodies of some animals.

- Bones are of different types. Some are long while some are short. Bones with tendon, ligament and muscle bring about movement in animals Bones do different works in the bodies of some animals.

Bones are of different types. Some are long while some are short.

End of lesson assessment:

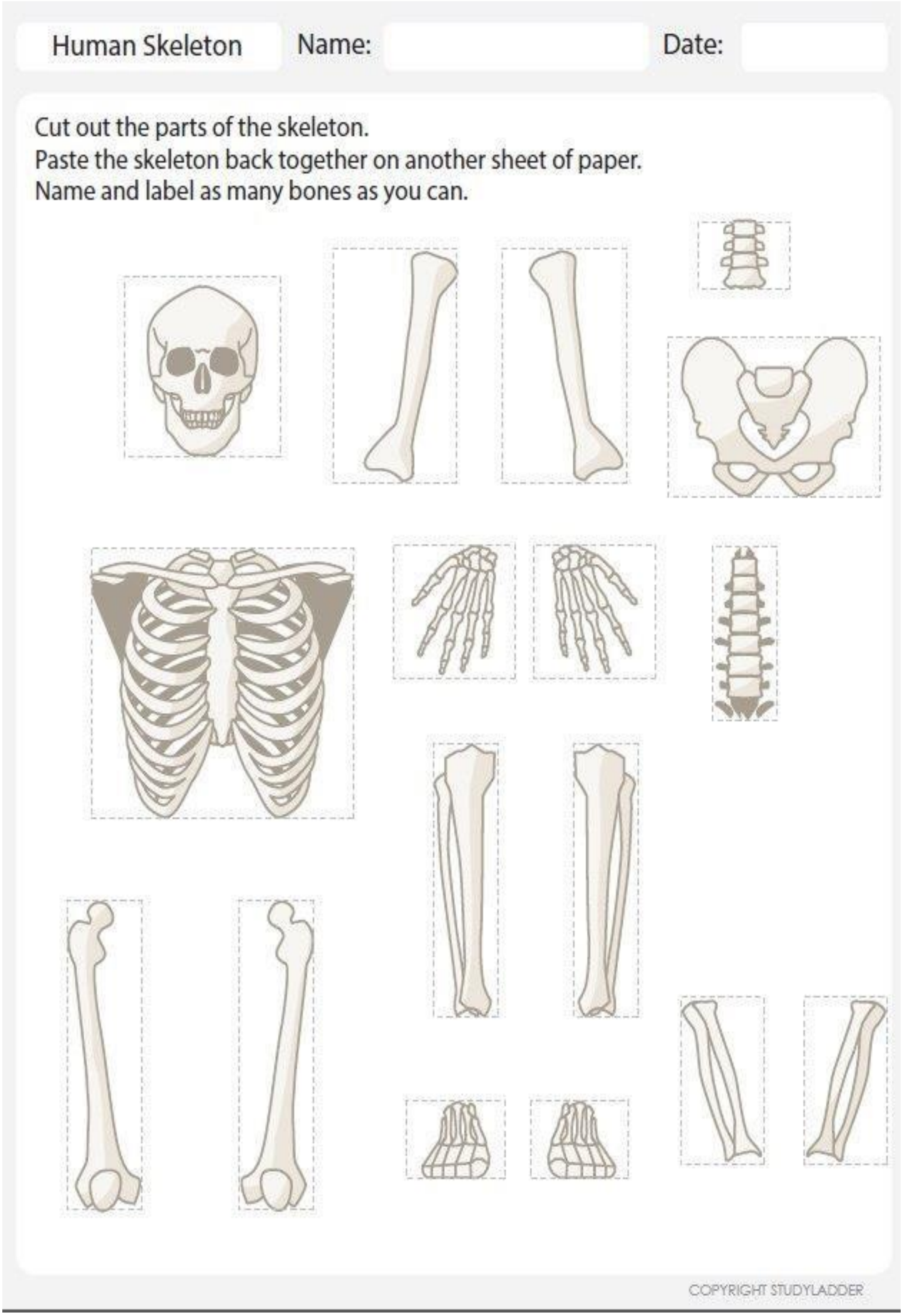
1. Bones of the backbone are called what?
2. Long bones of the body are called what?

3.The vertebra column can be grouped as ____________ ______________ ________________ -

4.State three functions of human bones

Reflection: The teacher reflects on the lesson and learners' response, revisits the difficult areas then move to the next sub-topic.

Assignment: The pupils are to draw the diagram of the human skeleton using circle and lines to represent the different parts.



Human skeleton cut and paste 2

4TH WEEK

LESSON PLAN THREE

Theme:	Basic Science
Sub-Theme:	Living Things and non-living things.
Topic:	Human Body: Bones and Joints
Sub-Topic:	Joints
Class:	Primary 5

Period:

Duration:

Instructional Resources: Model of human skeleton, charts, pictures, human skeleton cut and stick, pictures of bones of other animals **Entry Behaviour:**

Pupils have joint in their body **Behavioural objectives:**

At the end of this lesson, pupils should be able to:

Skills:

i. Identify the major joints in the body for example joints of the elbow, shoulder, knee, skull, trunk.
ii. Differentiate between elbow and shoulder joints

Cognitive:

i.State the functions of human joints.

Affective:

i.Work with others to identify types of joints.

Class Activities

Step	Teacher's Activities	Learners' Activities
Step 1	The teacher introduces the lesson and asks the pupils to touch where two or more bones meet on the human skeleton or charts and write the location and number of bones in their basic science note.	a) Pupils touch where bones meet in the body. b) Pupils locate where bones meet on the skeletal system. c) Pupils number the bones at each joint in their basic science note.
Step 2	The teacher asks the pupils to cut the different	a) Pupils cut the cut and stick
	bones from page 147 and place the bones on each other to show different joints such as elbow joint, shoulder joint, knee joint.	skeleton in pieces b) Pupils put the pieces together to reflect each joint c) for instance, pupils put the humerus to join the clavicle and scapular to show the ball and socket joint d) Pupils asks for the assistance of the teacher to clarify issues
Step 3	The teacher asks the pupils to bend the different joints backward and forward Pupils and record their observations.	a) Pupils bend the different joints backward and forward. b) Pupils record their observations in their notebook. c)Pupils identify the direction of each joint d) Pupils name the joint based on direction of movement.

Summary:

The teacher summaries the lesson thus**:**

- A joint is a place where two or more bones meet
- Major joints in the body are: ball and socket joint, hinge, elbow. Knee, suture, gliding joint.

End of lesson assessment: the teacher guides the pupils to discuss the following questions

1. What is a joint?
2. Mention three types of joints in the body of man.
3. In what direction can the elbow joint move?
4. In what direction can the shoulder joint move?

Reflection: Based on learners' response, the teacher reviews the teaching strategy, the teacher tackles the difficult area and then move to the next level.

Assignment

Pupils are to write in their note the number of bones at the following:

ii. Ball and socket joints of shoulder and hip

iii. Hinge joints of elbow and knee

iv. Gliding joints of wrist and ankle

Learners are given a set of bones to identify and assembly the bones at elbow and shoulder joint

3RD WEEK

LESSON PLAN FOUR

Theme: Basic Science

Sub-Theme: Living Things

Topic: Human Body: Bones and Joints

Sub-Topic: Joints and functions

Class: Primary 5

Period:

Duration:

Instructional Resources: Model of human skeleton, charts, pictures, human skeleton cut and stick, pictures of bones of other animals.

5.Entry Behaviour:

Pupils have seen the model of human skeleton and the bones arrangement.

Behavioural objectives:

At the end of this lesson, pupils should be able to:

Skills:

-Cut and place the joints on each other – differentiate between elbow joint and knee joint

Cognition:

-State the functions of joint.

Affective:

The pupil is able to work in a group.

Class Activities

Step 1	The teacher introduces the lesson and asks the pupils to write down the number of bones joined at the: elbow, shoulder, hip, hand and feet	a) Pupils write the number of bones against the name of the joint. b) Pupils identify the bones at the elbow and knee joints
		c) Pupils ask for assistance if needed
Step 2	Teacher asks pupils to move their arm to 90 degrees and the leg too to 90 degrees. pupil should write in their basic science note what is responsible for the movement.	a) Pupils move their arm and leg in clockwise and anticlockwise direction b) Pupils list joint that can move in clockwise and anticlockwise
Step 3	Teacher guides pupils to move every part of the body. Not all joints are movable. Pupil should look at the model of human skeletal system and list those joints that are movable and those that are not movable.	a) Pupils' list movable joint and immovable joint. b) Pupils write the names of joints that are movable and those that are not moveable. c) Pupils ask for assistance when needed.
Step 4	The teacher guides pupils to state the functions of joint	a) Pupils state the major bones b) Pupils state the function of the major bone such as skull, rib-cage, legs and hands, backbone (vertebral column) c) Pupils get feedback from the teacher.

Summary

The teacher summaries the lesson thus:

Joint is a place where two or more bones meet

Joint can be movable or immovable. An example of immovable joint is the joint of the skull others are movable e.g knee joint, hip joint, shoulder joint. joint may be named as to the degree of movement e.g. hinge joint can move backward only not forward. Shoulder joint can move 360 degrees

- Bones with tendon, ligament and muscle bring about movement in animals - Bones do different works in the bodies of some animals.
- Bones are of different types. Some are long, some are short.
- Bones are for movement, protection and production of some useful substances in the body and support.
- Pupils are to state the part of the skeletal system for movement, protection, and production of red blood and support.

End of lesson assessment:

The teacher guides the pupils to discuss the following questions:

1. What is a joint?
2. Name two types of joint.
3. Give two examples of moveable joint and one example of immovable joint.
4. List four functions of joint.

Pupils are to write in their note the number of bones at the following:

i. Ball and socket joints of shoulder and hip
ii. Hinge joints of elbow and knee
iii. Gliding joints of wrist and ankle

Learners are given a set of bones to identify.

Reflection: Based on learners' response, the teacher reviews the teaching strategy, the teacher tackles difficult issues.

Assignment

4TH WEEK

LESSON PLAN FIVE

Theme:	Basic Science
Sub-Theme:	Living Things and non- living things
Topic:	Reproduction in plants
Sub-Topic:	Parts of the flower
Class:	Primary 5

Period:

Duration:

Instructional Resources:

Different flowers with diverse features, pictures of insect pollinated flowers (For example- insect pollinated and wind pollinated flowers), hand lens, drawing book, pencil, eraser blade and ruler.

Entry Behaviour:

Pupils have seen flowers before. #

Behavioural objectives:

At the end of this lesson, pupils should be able to:

Skills:

1. Ability to detach the four floral whorls
2. Ability to group the four floral whorls Cognitive:

1.mention the four floral whorls of an insect pollinated flower.

2. what are the male and female parts of the flower?

Affective:

Ability to work as a team.

Class Activities

Step	Teacher's Activities	Learners' Activities
Step 1	The teacher introduces the lesson asks pupils to collect ten different flowers. The teacher guides learners to state the importance of the flower.	a) Pupils collect ten different flowers. b) Pupils state the importance of flower. c) Pupils compare the different flowers
Step 2	Teacher asks pupils to detach every part of an insect pollinated flower	a) Pupils detach every part of the flower b) Write down the names of different parts of the flower. c) Pupils rearrange the separated parts as they have removed them from the whorl. d) Pupils write their observation in their drawing book.
Step 3	The teacher guides the pupils to identify the 4 main parts of the flower	a) Pupils identify the four main parts of the flower. b) Pupils write the number the four main parts of a flower such as the number of calyx, corolla, androecium and gynoecium

Summary:

The teacher summaries the lesson thus:

A flower is the reproductive part of the plant.

Most flower have both male and female reproductive organs on the same flower.

Flowering plant may have four floral parts called calyx, corolla, androecium and gynoecium. The calyx is made up of sepals, corolla is made up of petals, the androecium is made up of the male reproductive part which are stamens. A stamen has a stalk called filament. On the filament is the anther. The gynoecium consists of carpels. A carpel has ovary, style and stigma.

End of lesson assessment:

The teacher asks the following questions

1.Identify four main parts of the flower.

2.Name the parts of the male and female parts.

Reflection:

The teacher reflects on the lesson, misconceptions are corrected.

Assignment: pupils are to bring an insect pollinated and wind pollinated flowers to the class and in a tabular form differentiates between insect pollinated flower and wind pollinated flower.

4^{TH} WEEK

LESSON PLAN SIX

Theme:	Basic Science
Sub-Theme:	Living Things and non- living things
Topic:	Reproduction in plants (continued)
Sub-Topic:	The flower.
Class:	Primary 5

Period:

Duration:

Instructional Resources:

Different flowers with diverse features, pictures of insect pollinated flowers (For example- insect pollinated and wind pollinated flowers), hand lens, drawing book, pencil, eraser blade and ruler.

Entry Behaviour:

Pupils have seen flower before.

Behavioural objectives:

At the end of this lesson, pupils should be able to:

Skills:

Draw and label parts of a flower.

Cognitive:

State the position of the floral whorl in the flower.

Affective:

Pupils are able to assist in detaching and grouping of flower parts.

Class Activities

Step 1	The teacher does a brief introduction and asks pupils to detach all the floral whorls. Pupils are to draw the female organ of the flower	a) Pupils detach all the floral whorls b) Pupils draw the female organ of the flower and label. c) Pupils draw the diagram of a petal
Step 2	The teacher guides pupils to cut longitudinally through the flower. The teacher asks pupils to draw the longitudinal part to 10cm in their basic science note and label the parts seen.	a) Pupils use the hand lens to look at the cut surface of a flower. b) Pupils write in science note their observation. c) Pupils draw and label the parts seen.

Summary:

End of the lesson assessment:

The teacher asks the following questions

State the number of (a) petals (b) sepals (c) stamens (d) carpels in insect pollinated flower.

Reflection:

The teacher reflects on the lesson and if satisfied with the level of learning, he then moves to the next topic.

Assignment: pupils are to bring an insect pollinated and wind pollinated flowers to the class and in a tabular form differentiates between insect pollinated flower and wind pollinated flower.

5^{TH} WEEK

LESSON PLAN 7

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Reproduction in plants
Sub-topic:	
Time:	
Duration:	45 mins

Instructional Resources:

Different flowers with diverse features, pictures of insect pollinated flowers (For example- insect pollinated and wind pollinated flowers), hand lens, drawing book, pencil, eraser blade and ruler.

Entry Behaviour:

Pupils have seen bees on insect before.

Behavioural objectives:

At the end of the lesson, the pupils should be able to:

Skills:

Identify insect and wind pollinated flowers.

Cognitive:

1. Explain types of pollination
2. Enumerate the features of insect pollinated and wind pollinated flowers.
3. Explain agents of pollination.

Affective:

Learners are able to complete the sorting of insect and wind pollinated flowers.

Class Activities

Step	Teacher's Activities	Learners' Activities
Step 1	The teacher introduces the lesson and guides pupils to define pollination. It is defined as the transfer of pollen grains from the anther of the style to the stigma of the flower. The teacher asks pupils to explain pollination in their own words. Teacher asks pupils to pollen grains on stigma	a) Pupils explain in their own words the meaning of pollination b) Pupils press pollen grain from the anther put some on the sigma of hibiscus flower c) Pupils get feedback from teacher.
Step 2	Teacher asks pupils to classify the tenflowers collected form home as wind or insect pollinated flowers and write in their basic science note the differences between insect pollinated and wind pollinated flowers. The teacher uses the stated differences to explain types of pollination and features of flower that promotes pollination.	a) Pupils examine insect pollinatedflower and note all the features. b) Pupils examine wind pollinated flower. c) Pupils state the feature of insect and wind pollinated flowers Pupils examine features of wind and insect pollinated flowers that suit them to the type of pollination.
Step 3	Teacher asks pupils to mention 4 agents of pollination.	a) Pupils mention the agent of pollination of five of the flowers collected b) Pupils give reasons for the agent mentioned above. c) Pupils get feed-back from the teacher

Summary:

The teacher summaries the lesson thus:

Pollination is transfer of pollen grains from the anther to the stigma of the flower.

Pollination can be self or cross.

It can be insect or wind pollinated flower.

Agent of pollination are: insect, wind, animals or water.

Feature of insect pollinated flowers are- brightly coloured petals and/ or sepals, presence of nectar.
Features of wind pollinated flowers are – light and small pollen grains, dull coloured petal and / sepals.

End of the lesson assessment:

1.Mention types of pollination.

2. State four agents of pollination.

3. Mention the features of the flower that promote pollination.

Reflection:

Assignment
Pupils are to collect fruits formed by one insect pollinated flower and wind pollinated flower and state their differences.

5TH WEEK

LESSON PLAN EIGHT

Theme:

Sub-Theme: Living Things and non-living things

Topic: Reproduction in plants

Sub-Topic: Pollination and Fertilization

Class: Primary 5

Period:

Duration:

Instructional Resources:

Reference books:

1.Basic Science and Technology for Primary Schools book 5 Nelson by Igwe et al

Entry Behaviour:

Behavioural objectives:

At the end of the lesson, pupils should be able to:

Skills:

Cut a flower into two equal halves

Cognitive:

1) Identify the stages of development in a plant.
2) State the differences between pollination and fertilization.

Affective:

Work with team to complete class task.

Class Activities

Step	Teacher's Activities	Learners' Activities
Step 1	The teacher guides learners to cut a longitudinal section of the flower that has dropped it's petal and sepal to show fertilization. The teacher asks pupils to draw the longitudinal section of insect pollinated flower.	a) Pupils use blade to cut an insect pollinated flower. b) Pupils examine the cut section of the flower. c) Pupils draw the longitudinal section of a flower that has dropped its petals and sepals.
Step 2	The teacher guides the pupils to describe what happens to the floral whorl after fertilization	a) Pupils states the features of the petals after fertilization. b) Pupils states the features of the ovary after fertilization.
Step 3	The teacher asks pupils to state the differences between pollination and fertilization.	Pupils state the differences between pollination and fertilization.
Step 4	The teacher guides the pupils to identify fruits formed after fertilization. Pupils are to gather fruits from both insect pollinated and wind pollinated flowers.	a) Pupils gather fruits from insect and wind pollinated flowers. b) Pupils compare the fruits of insect and win pollinated flowers.

Summary:

The teacher summaries the lesson thus:

End of lesson assessment:

What is pollination?

The term fertilization is……..?

State two differences between pollination and fertilization

Based on Learners response to questions, difficult areas of the topic are revisited**.**

Reflection:

The teacher reflects on the lesson in order to make necessary adjustment.

Assignment

Pupils are to collect fruits formed by one insect pollinated flower and wind pollinated flower and state their differences.

Assignment: pupils are to bring an insect pollinated and wind pollinated flowers

6TH WEEK

LESSON PLAN 9

Theme:	Basic science
Sub-Theme:	Living Thing and non -living things
Topic:	Acids, Bases and Salts
Sub-Topic:	Acids
Class:	Primary 5
Period:	
Duration:	

Instructional Materials

Lime, lemon, liquid soap, wood ash, tomato, vegetable juice, rice water, red and blue litmus, containers and text tubes.

Entry Behaviour: Learners are familiar with the taste of lime, unripe orange and ripe orange.

Behavioural Objectives

At the end of the lesson the pupils should be able to:

Skills:

Extract juice from some fruits Carry out acids and alkaline test

Cognitive:

i. Define acids

ii. Define bases

iii. List some examples of acids and bases.

Affective:

Show positive interest in the experiment

Class Activities

Step	Teachers Activities	Learners Activities
Step 1	The teacher asks pupils to make a list of the items provided and make predictions of the items (lime, lemon wood ash, tomato liquid soap, rice water, vegetable juice) if they are acidic or basic	a) Pupils list in their basic science note the items provided b) Pupils predict if they are acidic or basic
Step 2	The teacher asks learners to make juices of all the material provided – the lime, lemon, tomatoes, vegetable juice, wood ash liquid, liquid soap. Juice or liquid of each is to be divided into two separate text tubes labelled A and B. The teacher guides in carrying out the experiment	a) Pupils collect the juice or liquid of the items provided b) Pupils put each liquid in two separate text tubes. Text tube A and B. c) Pupils observe the teacher as the experiment is carried out.
Step 3	Teacher asks learner to dip red litmus paper in solution A and blue litmus paper in solution B and record their observation in their note book.	a) Pupils dip red litmus in solutions A and record their observation b) Pupils dip blue litmus in solutions A and record their observation c) Pupils dip red litmus in solution B and record their observation. d) Pupils and dip blue litmus in solution B and record their observation.

Summary: The teacher guides the whole class to state the characteristics of acids as:

i. Acids are corrosive, i.e. they can burn the skin and clothes

ii. They are sour to taste (they are not to taste acid)

iii. They turn moist blue litmus paper red

iv. They combine with bases to form salt and water only.

End of lesson assessment:

i. The teacher asks the following questions

ii. What are acids? iii. What are bases? iv. List some examples of acids and bases.

Reflection:

The teacher reflects on the lesson and if satisfied with pupils understanding moves to the next topic.

Assignment:

Pupils are to extract the juice of some fruits and test them with both red and blue litmus papers.

6^{TH} WEEK

LESSON PLAN 10

Theme: Basic Science

Sub-Theme: Living Thing and non-living things

Topic: Acid, Bases and Salts

Sub-Topic: Bases

Class: Primary 5

Period:

Duration:

Instructional Materials

Lime, lemon, liquid soap, wood ash, tomato, vegetable juice, rice water, red and blue litmus, containers and text tubes.

Entry Behaviour: Learners are familiar with the taste of lime, unripe orange and ripe orange

Behaviour Objectives:

At the end of the lesson pupils should be able to:

Skills:

To infer the acidity and alkalinity of different liquid.

Cognitive:

i. State some physical properties of acids and bases.

Affective:

Test all the liquid provided

Class Activities

Step 1	Teacher introduces the lesson and merges the class as one. Each group discusses the experiment and their observation.	a) Pupils go over the experiment solution Aand B in lesson 9. b) Pupils are to state the characteristics of solution A. Pupil state the characteristics of solution B c) Pupils infer the characteristics of solution A or B that makes it acidic or alkaline. d) Pupils get help from the teacher to ensure they are on the right track.
Step 2	Teacher asks learner to draw conclusion from what they observed from the experiment carried out. This is done on the premise that acidic substance turns blue litmus paper red while bases turn red litmus paper blue.	a) In tabular form pupils write the five characteristics of acids b) pupils write the characteristics of bases.
Step 3	Based on the experiment, the teacher guides pupils to state the physical properties of acids and bases	a) Pupils write the physical properties of acids and bases b) pupils receive guidance from the teacher to write all the properties of acids and bases.

Summary*:* The teacher guides the whole class to state the characteristics of bases as:

Characteristics of bases

i. Bases have bitter taste (do not taste they are corrosive) (they burn when they touch the skin)

ii. they turn moist red litmus paper blue

iii. they combine with acids to form salts and water (iv.)they are slippery when they are touched.

End of lesson assessment:

The teacher guides the pupils to answer the following questions:

- What is a base?
- Mention three differences between acids and base.

Assignment: pupils are to bring an insect pollinated and wind pollinated flowers to the class and in a tabular form differentiates between insect pollinated flower and wind pollinated flower

7^{TH} WEEK LESSON PLAN 11

Theme: Basic Science

Sub-Theme: Living Things and non- living things

Topic: Acid, Bases and Salts

Sub-Topic: Salts

Class: Primary 5

Period:

Duration:

Instructional Materials

Lime, lemon, liquid soap, wood ash, tomato, vegetable juice, rice water, red and blue litmus, containers and text tubes, water, table salt, some solution of acids and bases, paper, pencil, eraser, solution of some food items, litmus papers

Entry Behaviour: Learners are familiar with the taste of lime, unripe orange and ripe orange.

Behavioural objectives: At the end of the lesson the pupils should be able to

Skills:

Demonstrate how to test for acids and bases.

Cognitive:

i. Identify the type of acids and bases

ii. State the strong and weak bases.

iii. State bases, acids and neutral salts.

Affective:

Give a short presentation on acids and bases.

Class Activities

Step	Teacher's Activities	Learner's Activities
Step 1	The teacher introduces the lesson and guides the pupils to review their knowledge on acids and bases by asking pupils to state two characteristics of acids and bases and source.	a) Pupils write two characteristics of acids and bases b) Pupils writes the sources of some of the acids and bases in nature.
Step 2	The teacher drops some strong solution of hydrochloric acid, (HCl), trioxonitrate (V) acid (HNO_3) and tetraosxosulphate (VI) acid (H_2SO_4) on paper and asks pupils to put their observation on paper. The two solutions are also added to litmus papers. pupils are asked to compare the effects of the two solutions on litmus papers	a)Pupils write their observation in their basic science notes. b) Pupils state the weak acids and strong acids based on their observation. c) Pupils get feedback from the teacher
Step 3	The teacher asks pupils to list weak and strong acids and weak and strong bases in their environment.	a) Pupils found out substances in the environment that have weak or strong acid or bases b) Pupils test some liquid with litmus paper to ascertain if they are strong acids or alkaline.

Summary: The teacher guides the pupils to summarize the lesson thus:

Depending on the strength of acids and bases, they are classified as:

Acidic: hydrochloric acid, (HCl), trioxonitrate (V) acid (HNO_3) and tetraosxosulphate (VI) acid (H_2SO_4)
Basic: Sodium Hydroxide, Potassium Hydroxide.

Neutral:

End of lesson assessment:

The teacher guides the pupils to answer the following questions

i. Mention two strong bases

ii. List two weak bases

iii. State two strong acids iv. State one strong acid

v.Salts can be grouped as ………………., …………………… and ……………….

vi.Mention one neutral salt.

Reflection:

Assignment: n a tabular form state three uses of acid, bases and salts

.

7TH WEEK

LESSON PLAN 12

Theme:	Basic Science
Sub-Theme:	Living Thing and non- living things.
Topic:	Acid, Bases and Salts
Sub-Topic:	Acids and Bases
Class:	Primary 5

Period:

Duration:

Instructional Materials

Lime, lemon, liquid soap, wood ash, tomato, vegetable juice, rice water, red and blue litmus, containers and text tubes.

Entry Behaviour: Learners are familiar with the taste of lime, unripe orange and ripe orange.

Behavioural objectives:

At the end of the lesson the pupils should be able to

Skills:

Compare and contrast acids, bases and salts.

Cognitive:

Differentiate between acids and bases**.**

Affective:

Find out materials in the environment that acidic or alkaline.

Class Activities

Step 1	The teacher introduces the lesson and guides the pupils to identify weak and strong acids and bases as. The strong acids are Strong acids: Hydrochloric acids (HCl) Methanoic (HC00H) Methanoic acid Trioxonitrate (V) acid (HNO_3) Ethamoic acid (H_3C00H) Tetraoxosulphate (VI) acid (H_2S0_4). The strong bases as Sodium Hydroxide, Potassium Hydroxide. While the weak base is Calcium Hydroxide	a)Pupils listen to the teacher as he/she introduces the lesson. b) Pupils dip blue and red litmus paper in given solutions c) Pupils compare and state the differences between acid and bases. d) Pupils get feedback from the teacher.
	The salts are: acidic salt- Sodium hydrogen tetraoxosulphate – $NaHS0_4$. Basic salt- Sodium trioxocarbonate (IV) – NO_2C0_3 Neutral Salt - Calcium Chloride CaCl2, Sodium Chloride (NaCl)	
Step 2	The teacher asks pupils to dip litmus papers in different solutions of weak and strong acids and they are to compare the colour of the litmus papers. The same for the weak and strong bases. The teacher asks pupils to find out five uses of acids and bases in agriculture and engineering	a)Pupils write five uses of acids in agriculture and engineering. b) Pupils write five uses of bases in the environment

Summary: The teacher summaries the lesson thus

End of lesson assessment:

Mention two strong acids

Mention three weak bases

Reflection:

The teacher reflects on the lesson based on pupils’ answer, if satisfied then the class moves to the next topic.

Assignment:

8^{TH} WEEK

LESSON PLAN 13

Date:

Theme: Basic Science

Sub-theme: Living and Non -Living Things

Topic: Heat and Temperature

Sub-topic:

Class: Primary 5

Duration: 40 minutes

Entry Bahaviour: Learners are familiar with change in temperature.

Instructional materials: charts showing various types of thermometers, different thermometers, boiling water, containers, source of heat, small bucket of iced block, text tubes and different liquids.

Behavioural objectives: At the end of the lesson, the pupils will be able to:

Skills:

To carry out experiment on heat

Cognitive:

i. Define temperature ii.Define heat iii.Differentiate between heat and temperature.

Affective:

To find out high body temperature in cold weather.

Class Activities

Step	Teacher's Activities	Learners' Activities
Step 1	The teacher guides the pupils to recall their prior knowledge on heat and temperature by asking the following questions. What is heat? - Heat is a form of energy How can a body be heated? The teacher asks pupils to put some pebbles in a small container with a lid and shake it vigorously.	a) Pupils define heat and temperature. b) Pupils put some pebbles in a small container with a lid and shake it vigorously. c) Pupils touch the pebbles after shaking and record their observation in their note. d) Pupils feel the temperature of a container with hot water and another
		with iced block. e) Pupils record their observations in their note. They give explanation for the differences in temperature f) Pupils leave the container of hot water exposed for 45minutes.The iced block container should be left for 45minutes. g) Pupils write their observation after 45mins.
Step 2	The teacher guides the pupils to define temperature based on their observation. Temperature is the degree of hotness or coldness of a body. That the temperature of a body is usually changed by addition or loss of heat.	a) Pupils use their hand to feel the degree of hotness of a beaker containing water on fire b) Pupils use a thermometer to measure the degree of hotness of the liquid every 2minutes c) Pupils compare the temperature when hand is used to feel the temperature and when thermometer is used. d) Pupils record their answer in their note.

Summary:

The teacher guides the pupils to summaries the lesson thus:

- Temperature is the degree of hotness or coolness of a body.
- temperature can be measures by using thermometer
- Heat is a form of energy
- While temperature is degree of hotness or coolness of a body.
- The teacher guides learners to state the differences between heat and temperature as:

Heat	Temperature
A form of energy	Degree of hotness or coldness
Measured in joules	Measured in Celsius (^oC) or Fahrenheit (^oF) or Kelvin (K)
Flows from a hotter body to a colder one when placed in contact	Determines directions in which heat flows
Can do work	Cannot do work
Measured with a calorimeter	Measured with a thermometer
Causes change in degree of temperature	Temperature is determined by heat generated

End of lesson assessment:

The teacher asks the pupils the following questions

i. What is temperature?

ii. What is heat?

iii. List 3 differences between heat and temperature

iv. One can measure the degree of hotness or coldness of a body by using a …………..?

Reflection:

Assignment:

The pupils are to draw two different thermometers.

8^{TH} WEEK

LESSON PLAN 14

Date:

Theme: Basic Science

Sub-theme: Living and Non -Living Things

Topic: Heat and Temperature

Sub-topic: Types of thermometers

Class: Primary 5

Duration: 40 minutes

Instructional materials: charts showing various types of thermometers, different thermometers, boiling water, containers, source of heat, small bucket of iced block, text tubes and different liquids.

Entry Bahaviour: Learners are familiar with change in temperature. They can feel hot or cold temperature.

Behavioural Objective: Pupils should be able to:

Skills:

Measure temperature using different types of thermometers

Cognitive:

To mention different thermometers.

Affective:

Find out the temperature of different substances.

Class Activities

Step	Teacher's Activities	Learner's Activities
Step 1	Previous knowledge on temperature and heat is revisited by the teacher. The teacher provides two to three different thermometers for pupils to measure different solution.	a) Learners quickly state the difference between heat and temperature. b) Pupils measure different solution and their body temperature. c) pupils record their findings in their note.
		d) Pupils get feedback from the teacher.
Step 2	The teacher leads the pupils to discuss their findings about the temperature, body temperature and recording of heated water at 2 minutes' interval.	a) Pupils compare the measurement values of different solution. b) Pupils discuss their findings about the different boiling points.
Step 3	The teacher guides the pupils to examine the different thermometers supplied and describes them.	a) Pupils examine the different thermometers supplied b) Pupils write the differences between the thermometers provided.

Summary:

The teacher summaries the lesson thus:

Mercury in glass thermometer: mercury is generally preferred as thermometric liquid because:

i.It is a good conduction of heat ii.It is opaque and therefore easily seen in glass tube iii.It does not wet the glass wall of the tube iv.It ensures temperature from 35^0C - 350^0C, so it is suitable for measuring high temperature

Formative Assessment: The teacher revisits the behavioural objectives to ensure understanding of the objectives

Reflection: Based on the formative assessment the teacher revisits the difficult areas of the topic, then move to the next topic.

Reflection:

Assignment:

9^{TH} WEEK

Lesson plan 15

Date:

Theme: Basic Science

Sub-theme: Living and Non -Living Things

Topic: Heat and Temperature

Sub-topic: units and symbols of temperature

Class: Primary 5

Duration: 40 minutes

Entry Bahaviour: Learners are familiar with change in temperature.

Instructional materials: different thermometers

Behavioural objectives: At the end of the lesson, the pupils will be able to:

Skills:

To measure the temperature of different liquid

Cognitive:

Identify and write the units and symbols of temperature

Affective:

Find out why boiling points of different liquid differs.

Class Activities

S/N	Teacher's activity	Pupils' activity
Step 1	The teacher assesses pupils' prior knowledge of temperature and heat and the units of temperature. Pupils are asked to define temperature again, how do we measure temperature and what are the units and symbols of temperature?	a) Pupils define temperature. b) Pupils state how to measure temperature.
Step 2	The teacher guides pupils to recognize the units of measuring temperature as Celsius, Fahrenheit, kelvin. The teacher asks pupils to write the temperature of boiling water, freezing water, room temperature in Celsius and Fahrenheit	a) Pupils write the units of Celsius and Fahrenheit b) Pupils write the temperature of boiling water in Celsius and Fahrenheit.
Step 3	Teacher asks pupils to convert 230 Celsius to	a) Pupils convert 230 Celsius to
	Fahrenheit	Fahrenheit b) Pupils get feedback from the teacher.
Step 4	The teacher guides pupils to write the symbol of Celsius and Fahrenheit	a) Pupils write the symbol of Celsius and Fahrenheit in their note book b) Pupils get feedback from the teacher.

Summary: The lesson is summarized thus:

There are three scales for measuring temperature. They are the Celsius scale, Fahrenheit scale, and the kelvin scale. The commonest of the scales are Celsius and Fahrenheit. The symbol for Celsius is degree centigrade ^{0}C while the symbol for Fahrenheit is ^{0}F. the symbol for kelvin is K

End of lesson assessment:

The teacher asks the following questions to assess understanding of the topic taught

1. Write the symbols for the following Celsius, Fahrenheit and kelvin.
2. Convert 30 kelvin to Celsius

Reflection: The teacher reflects on the lesson and if satisfied with the level of understanding moves to the next subtopic.

Assignment:

9^{TH} WEEK

Lesson plan 16

Date:

Theme: Basic Science

Sub-theme: Living and Non -Living Things

Topic: Heat and Temperature

Sub-topic: Uses of thermometers.

Class: Primary 5

Duration: 40 minutes

Instructional materials: containers with liquid, ice box.

Entry Bahaviour: Learners are familiar with clinical thermometer.

Behavioural objectives: At the end of the lesson, the pupils will be able to:

Skills:

Use clinical thermometers and laboratory thermometers

Cognitive:

Uses the thermometer to measure the temperature of objects accurately.

Affective:

Cooperative with others to measure body temperature.

Class Activities

Step 1	The teacher introduces the topic for the lesson and guides the pupils to measure different object accurately by using different thermometers.	a) Pupils measure their body temperature b) Pupils record the body temperature in their notebook. c) Pupils measure room temperature and record.
Step 2	The teacher guides the pupils to identify thermometer as Liquid in glass thermometer, liquids in the glass are commonly called mercury. Gas thermometer Resistant thermometer Thermocouple or thermoelectric thermometer Radiation thermometer	a)Pupils identify the different thermometers provided b) Pupils state the differences between the thermometers provided
Step 3	The teacher asks the learner to find out why glass thermometer is usually preferred as thermometric liquid.	a) Pupils examine the clinical thermometer and maximum and minimum thermometers. b) Pupils draw minimum and maximum thermometers.
Step 4	Teacher guides pupils to state the differences between single thermometer and maximum and minimum thermometers.	In tabular form pupils state the differences between a single thermometer, maximum and minimum thermometer.

Summary:

The teacher summaries the lesson thus:

Heat is directly proportional to the amount of temperature.

Temperature can be measured by using thermometer.

The thermometer used depends on the object that the temperature is to be measured.

End of lesson assessment:

Mention three types of thermometers.

Which thermometer is useful for measuring boiling water?

Reflection:

The teacher reflects on the lesson if satisfied, the class moves to the next topic.

Assignment:

Pupils are to draw two types of thermometers .

APPENDIX III
INSTRUCTIONAL GUIDE FOR TEACHER ON CONVENTIONAL TEACHING STRATEGY

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An instructional guide for teachers to deliver conventional teaching method

Being Experimental Group 3 of a Doctoral Research

Introduction

The strategy adopted by a teacher depends on many factors. The essential consideration is what promotes the best learning outcomes of the curriculum. It has been said that no teaching strategy is totally bad and no strategy is hundred percent effective at all times. What the teacher should consider is what is best for the learner having taken the subject matter of the curriculum into consideration. It has been suggested that a number of teaching strategies be utilized for effective learning outcomes.

Generally, teaching strategies can broadly be classified as teacher-centred or learner-centred.

The teacher centred teaching strategy is referred to as convectional or traditional approach. The convectional approach is the approach mostly used in teaching basic science in many schools Oduolowu and Akintemi (2017), Oshokoya (2013). The Teaching approach specified for the teaching of basic science at the primary school is learner centred approach based on the assumption that children construct knowledge by interacting with their environment.

The convectional approach like other two approaches is centred on the behavioural objectives but teacher centred. The teacher takes control of the teaching, he/she is the most active in the learning process. The approach consists of behavioural objective, instructional material, teacher's presentations, evaluation and assignment.

The guide below has been planned to cover the eight weeks it will take to cover the topics: Human bones and joint, Reproduction in plants, Acids, bases and salt and Heat and Temperature.

CONVENTIONAL TEACHING STRATEGY LESSON PLAN FORMAT

General Information

Theme……………… **Subtheme**…………… **Class**………………….

Topic………………………………. **Subtopic**…………………………

Duration……………………………

Instructional Resources:……………………………………………………..

Behavioural Objectives:………………………………………………………

1 Introduction

2 Presentation

3 Summary:

4 . **Evaluation:**

5 5.**Assignment:**

LESSON PLAN 1

Theme;	Basic Science
Sub-Theme:	Living Things
Class:	Primary 5
Topic:	Human Body: bones and joints.
Sub-Topic:	Joints
Duration:	35 minutes

Specific Behavioural objectives:

At the end of this lesson, the pupils should be able to:

i. Identify major bones in the body.
ii. Identify the location of the bones in the body of human.

Instructional Resources

Model of Human Skeleton, Chart, Individual Bones of a mammal, clay, labels, Pencil, Paper, Eraser.

Presentation

Step 1

1. The teacher familiarizes himself /herself with the pupils

2. The teacher assesses pupils previous knowledge.

3.The teacher introduces the lesson

4.The teacher defines a bone.

Step 2

The teacher tells the pupils the major bones of the body.

The major bones are 1. Long bones 2. Vertebrae 3skull 4phalanges

Step 3

The teacher explains to pupils what the bones of the hands and toes are. The small bones of the fingers and toes are collectively called phalanges

Step 4

The teacher asks the pupil individually to mention the name of the items labeled A-H. (A-Skull, B-Backbone, C-Rib, D- Long Bones, E-Bones of the hands, F-Bones of the palm, H- Bones of the feet).

Summary

The teacher summarizes the lesson thus:

- Bone are hard, white substances found in the bodies of some animals -Bones do different works in the bodies of some animals.
- Bones are of different types. Some are long, some are short.
- Bones are for movement, protection and production of some useful substances in the body and support.
- Pupils are to state the part of the skeletal system for movement, protection, production of red blood and support.

Evaluation: The teacher asks the pupils the following questions

1. What is a bone?

Assignment

The pupils are to draw the diagram of the human skeleton using circle and lines to represent the different parts

LESSON PLAN 2

Theme;	Basic Science
Sub-Theme:	Living Things
Class:	Primary 5
Topic:	Human Body: Bones and joints.
Sub-Topic:	Bones
Duration:	35 minutes

Specific Behavioural objectives: At the end of this lesson, the pupils should be able to:

i. Mention long and short bones in human skeleton
ii. Identify the long bones of the body
iii. Identify the bones of the vertebral column

Resources

Model of Human Skeleton, Chart, Individual Bones of another mammal, clay, labels, Pencil, Paper, Eraser.

Presentation

Step 1

Assessment of previous knowledge of Human skeleton.

1.The teacher introduces the lesson

Step 2

i. The teacher explains the location and size of bones of the long bones.
ii. The teacher also draws the diagram of the long bones on the chalk board.
iii. The teacher explains that the long bones of the body are found in arm and the legs.
iv. The upper arm is called the radius connected to the shoulder.
v. The radius and the ulna are two bones lying on top of each other in the lower arm.
vi. The bigger of the two ones is called radius while the smaller one is called ulna
vii. The upper part of the leg is called femur connected to the hip.
viii. The tibia and the fibula are the long bones of the lower part of the leg. They also lie on top of each other.

Step 3. The teacher and pupils identify the short bones of human skeleton.

Teacher explains the characteristics of the vertebra column.

The back bone is made up of the small bones as follows:

Cervical in the neck region.

Thoracic in the upper back region

Lumbar in the lower back region

Sacrum in the hip part

Caudal in the tail region

Step 4. The teacher and the pupils differentiate the bones of the vertebrae: cervical, thoracic, lumbar, sacral and caudal

The teacher evaluates the lesson activities thus

1. Bones of the backbone are called what?
2. Long bones of the body are ………………… and …………………………………
3. The vertebra column can be grouped as ____________________, _____________, _______________, ____________________ and __________________________________.

Step 5. The teacher gives assignment-

pupils are to draw the diagram of a femur and a humerus.

LESSON PLAN 3

Theme;	Basic Science
Sub-Theme:	Living Things
Class:	Primary 5
Topic:	Human Body: bones and joints.
Sub-Topic:	Joints
Duration:	35 minutes

SPECIFIC BEHAVIOURAL OBJECTIVES

At the end of this lesson, the pupils should be able to:

i. Identify the major joints in the human body e.g. joints of the elbow, shoulder, knee, skill, trunk

Presentation

Step 1

The teacher assesses the prior knowledge of pupils to ensure the topic is well mastered. The teacher tells the pupils to touch where two or more bones meet on the human skeleton or charts and on their body.

Step 2

The teacher tells pupils where the different joints are in the body. The teacher demonstrates the following actions.

- The teacher moves the joint between shoulder and humerus in clock-wise direction
- The teacher moves the joint between femur and tibia and fibia back ward
- The teacher moves the joint between the femur and hip.

Step 3

The teacher tells the pupils the function of different joints in the body

Step 4

The teacher asks the pupils to write down the number of bones joined at the:

a.Elbow

b. Shoulder

c. Hip

d. Hand and feet

Step 5

The teacher guides the pupils to identify the joints and the number of bones at the joints. She tells them the names of bones at the joint

1. Ball and socket joint
2. Hinge joint – of the elbow joint 3.Gliding joint of the wrist and ankle
3. **Evaluation**:

The teacher asks the pupils the following questions:

i. What is a joint? 2.Mention three types of joints in human skeleton

ii. List two functions of joints

Assignment

Pupils are to write the number of bones at the following:

i.Ball and socket joints of shoulder and hip ii.Hinge joints of elbow and knee

iii.Gliding joints of wrist and ankle

Pupils are given a set of bones to identify.

LESSON PLAN 4

Theme;	Basic Science
Sub-Theme:	Living Things
Class:	Primary 5
Topic:	Human Body: bones and joints.
Sub-Topic:	Functions of bones and joints
Duration:	35 minutes

SPECIFIC BEHAVIOURAL OBJECTIVES

At the end of the lesson, the pupils should be able to:

i. State the functions of bones
ii. State the functions of the following joints.

Step 1

The teacher assesses pupils' prior knowledge on joints. The teacher tells the pupils to touch where two or more bones meet on the model of human skeleton or charts or on their body.

Step 2

The teacher tells the pupils the function of the following:

1. skull it protects the brain
2. Humerus for movement
3. Ulna and Radius for movement
4. Femur for movement
5. Vertebra
6. Rib for protection and breathing
7. Bones of hand for movement
8. Bones of the feet for movement

Step 3

The teacher explains the functions of the following joints

4. Ball and socket joint
5. Hinge joint – of the elbow joint 3.Gliding joint of the wrist and ankle
6. **Evaluation**:

The teacher asks the pupils the following questions:

1. Mention 4 functions of bones
2. List two functions of joints

Assignment

Pupils are to draw the diagram of the joint between humerus and femur

LESSON PLAN 5

Theme:	Basic Science
Sub-Theme:	Living Things
Topic:	Reproduction in plants
Sub-Topic:	Parts of a flower
Class:	Primary Five
Duration:	35 minutes

Specific Behavioural objectives:

Learner's behaviour at the end of the lesson

i. Identify the parts of a flower

ii. State the importance of the flower.

Reference books:

Basic Science and Technology, pupil's Book 5 by Igwe et al Nelson publishers. Basic Science and Technology Curriculum by NERDC.

Instructional Materials

Different flowers with diverse features, pictures of insect pollinated flowers (e.g. insect pollinated and wind pollinated flowers), hand lens, drawing book, pencil,

PRESENTATION

Step 1

The teacher asks pupils general questions on plants such as

What part of the plant produces the flower?

What is the importance of the flower in plants?

Step 2

The teacher shows the floral whorl of the flower of hibiscus to the pupils

The floral whorls are calyx made up of sepals, corolla made up of petals, the male reproductive part androecium and the female part carpels or gynoecium. The teacher draws the diagram of a flower on the chalk board to show the different parts of a: flower.

They are made up of stamens. Each stamen is made up of two parts, the anther and the filament. The gynoecium is the female part of the flower which consist of carpel. A carpel has three parts namely: the ovary which consists of ovules, the style and the stigma.

Step 3

The teacher uses a razor blade to cut the flower into two equal parts. The parts are passed round for the pupils to see.

Step 4

The teacher shows the pupils a flower at different stages of development.

Summary: The teacher summarizes the lesson thus:

- The flower is the reproductive organ of the plant.
- The four main part of the flower are the calyx, the corolla, the androecium and the gynoecium
- For the plant to reproduce, the male part must be transferred to the female part. this is termed pollination.
- **Evaluation:**

The teacher asks the following questions

1.Identify four main parts of the flower.

2. Mention types of pollination.
3. State four agents of pollination.
4. Mention the features of the flower that promote pollination.

Assignment: pupils are to bring an insect pollinated and wind pollinated flowers to the class.

LESSON PLAN 6

Theme:	Basic Science
Sub-Theme:	Living Things
Topic:	Reproduction in plants
Sub-Topic:	Pollination and fertilization in plants
Class:	Primary Five
Duration:	35 minutes

Specific Behavioural objectives:

Learner's behaviour at the end of the lesson

i. Define pollination
ii. Explain types of pollination
iii. Mention agents of pollination
v. Identify the features of a flower that promote pollination
vi. Identify parts of the flower concerned with pollination and fertilization

Reference books:

Basic Science and Technology, pupil's Book 5 by Igwe et al Nelson publishers. Basic Science and Technology Curriculum by NERDC.

Instructional Materials

Different flowers with diverse features, pictures of insect pollinated flowers (e.g. insect pollinated and wind pollinated flowers), hand lens, drawing book, pencil,

PRESENTATION

Step 1

The teacher shows the pictures of an insect pollinated flower and a wind pollinated flower to the pupils.

Step 2.

She then explains the meaning of pollination as the transfer of the pollen grains from the anther of a flower to the stigma of the same flower or anther flower of the same kind. **Step 3**

She demonstrates pollination to the class by collecting anther from the stigma and putting it on the stigma. The agents of pollination are: insect, man, and other animals that comes to the flower because of its attractive petals and nectar.

Summary: The teacher summarizes the lesson thus:

- The flower is the reproductive organ of the plant.
- The four main part of the flower are the calyx, the corolla, the androecium and the gynoecium
- For the plant to reproduce, the male part must be transferred to the female part, this is termed pollination.
- There two types of pollinations namely: self-pollination when the pollen grain of a flower is transferred to the stigma of the same flower or cross pollination when the anther of a flower is transferred to the stigma of another flower but of the same kind
- **Evaluation:**

The teacher asks the following questions

1.Identify four main parts of the flower.

2.Mention types of pollination.

3. State four agents of pollination.
4. Mention the features of the flower that promote pollination.

Assignment:

pupils are to bring an insect pollinated and wind pollinated flowers to the class.

LESSON PLAN 7

Theme:	Basic Science
Sub-Theme:	Living Things
Class:	Primary 5
Topic:	Reproduction in Plants
Sub-topic:	Fertilization in plants
Duration:	35 minutes

Time:

Specific Behavioural objectives: At the end of the lesson the pupils will be able to

i.Identify the stages of development in a plant

ii.State the differences between pollination and fertilization

Instructional Materials

Flowers at different stages of development, hand lens, pencil, drawing book, razor blade

Presentation

Step 1

The teacher assesses pupils' knowledge of part of the flower and pollination in plants by asking the following questions:1. name the four main part of the flower.

i. What are the male and the female part of the flower?

ii. What is pollination?

Step 2

The teacher draws the diagram of the half flower of hibiscus flower to show fertilization in plant.

Step 3

The teacher defines fertilization and what happens during fertilization

Fertilization is joining together of the male and female gametes after pollination

After pollination, the pollen grain transferred to stigma of the flower germinates to form a pollen tube. The tube grows through the style of the female part to meet the ovules, the pollen tube opens to meet the ovules, it then fused with the ovules to form a zygote which is a fertilized egg. This egg divides many times to form the embryo. The embryo develops to form the fruit and seeds.

Step 4

The teacher states the differences between pollination and fertilization.

Summary: The lesson is summarized thus:

Fertilization is the fusion of the male and the female gametes to form a zygote. The zygote divides severally to form the fruit and the seeds.

Assignment

Pupils are to write the differences between pollination and fertilization.

LESSON PLAN 8

Theme:	Basic Science
Sub-Theme:	Living Things
Class:	Primary 5
Topic:	Reproduction in Plants
Sub-topic:	Fertilization in plants
Duration:	35 minutes

Specific Behavioural objectives: At the end of the lesson the pupils will be able to

i.Identify the stages of development in a plant

ii.State the differences between pollination and fertilization

Instructional Materials

Flowers at different stages of development, hand lens, pencil, drawing book, razor blade

Presentation

Step 1

The teacher assesses pupils' knowledge of part of the flower and pollination in plants by asking the following questions:1. name the four main part of the flower.

i. What are the male and the female part of the flower?

ii. What is pollination?

Step 2

The teacher draws the diagram of the half flower of hibiscus flower to show fertilization in plant.

Step 3

The teacher defines fertilization and what happens during fertilization

Fertilization is joining together of the male and female gametes after pollination

After pollination, the pollen grain transferred to stigma of the flower germinates to form a pollen tube. The tube grows through the style of the female part to meet the ovules, the pollen tube opens to meet the ovules, it then fused with the ovules to form a zygote which is a fertilized egg. This egg divides many times to form the embryo. The embryo develops to form the fruit and seeds.

Step 4

The teacher states the differences between pollination and fertilization.

Summary: The lesson is summarized thus:

Fertilization is the fusion of the male and the female gametes to form a zygote. The zygote divides severally to form the fruit and the seeds.

Assignment

Pupils are to write four differences between pollination and fertilization.

LESSON PLAN 9

Theme:	Basic Science
SubTheme:	Living and Non-Living Things
Topic:	Acids, Bases and Salts
Sub-Topic:	Acids
Class:	Primary five
Duration:	35 minutes

Specific Behavioural objectives: At the end of the lesson the pupils should be able to

i. Define acids.

ii. States some physical properties of acids.

iii. Mention some chemical properties of acids.

Instructional Materials

Water, wood ash, lime juice, lemon juice, toilet soap, table salt, red and blue litmus papers, containers, toilet soap, tea bag, stirring rod.

PRESENTATION

Step 1

The teacher asks pupils questions to find out pupils' previous knowledge.

Step 2

The teacher asks the pupils to describe what they feel when they: taste lemon or lime. Touch soap

Step 3

The teacher explains the physical properties of acids by performing the following activities

The teacher gets four containers A, B, C, D.

In A she puts lemon juice

In container B, she puts liquid soap

In container C, she puts tomatoes

In container D, she mixes wood ash with water.

In each of the containers red and blue litmus papers are dipped into the solutions.

Pupils are to write their observation

Step 4

The teacher explains to the pupils that solutions that turn blue litmus red are acids.

Step 5

The teacher leads the pupils in class discussion on their findings when red litmus papers were dipped in the solution in containers A-D.

Summary

The teacher guides the whole class to define acids as:

i. Acids are corrosive, ie. they can burn when on the skin and clothes

ii. They are sour to taste (they are not to taste acid)

iii. They turn moist blue litmus paper red

iv. They combine with bases to form salt and water only.

Evaluation

The teacher guides the pupils to answer the following questions:

What is acid?

What are the physical properties of acids?

What are the chemical properties of acids?

Assignment

The pupils are to find out names of three common acids

LESSON PLAN 10

Theme: Basic Science

Sub-Theme: Living and Non-Living Things

Topic: Acids, Bases and Salts

Sub-Topic: Bases

Class: Primary five

Duration: 35 minutes

Specific Behavioural objectives: At the end of the lesson the pupils should be able to

i. Define bases

ii. ii. states some physical properties of bases

iii. iii mention some chemical properties of bases

Instructional Materials

Water, wood ash, lime juice, lemon juice, toilet soap, table salt, red and blue litmus papers, containers, toilet soap, tea bag, stirring rod.

PRESENTATION

Step 1

The teacher asks pupils questions to find out pupils' previous knowledge.

Step 2

The teacher asks the pupils to describe what they feel when they:

Touch soap and wood ash and water

Step 3

The teacher explains the physical properties of bases by performing the following activities

The teacher gets four containers A, B, C, D.

In A she puts lemon juice

In container B, she puts liquid soap

In container C, she puts tomatoes

In container D, she mixes wood ash with water.

In each of the containers red and blue litmus papers are dipped into the solutions.

Pupils are to write their observation

Step 4

The teacher explains to the pupils that solutions that turn blue litmus red are acids.

Step 5

The teacher leads the pupils in class discussion on their findings when red litmus papers were dipped in the solution in containers A-D.

Summary

The teacher guides the whole class to define bases as:

Features of bases

i. Bases have bitter taste (do not taste they are corrosive) (they burn when they touch the skin).
ii. They turn moist red litmus paper blue.
iii. They combine with acids to form salts and water.

iv. They are slippery when they are touched.

Evaluation

The teacher guides the pupils to answer the following questions:

What is a base?

Mention three physical properties of bases

State two chemical properties of bases

Assignment

The pupils are to find out names of three strong and two weak bases

LESSON PLAN 11

Theme:	Basic science
Sub- Theme:	Living and Non-living things
Class:	Primary 5
Topic:	Acids, Bases and Salts
Sub-topic:	Types of acids and bases
Duration:	35minutes

Specific Behavioural objectives: at the end of the lesson, the students are able to:

I. list strong or weak bases

II. State types of salts

III. Mention uses of acids, bases and salts

Instructional Materials

Water, table salt, some solution of acids and bases, paper, pencil, eraser, solution of some food items.

Presentation

Step 1

The teacher guides the pupils to reviews their knowledge on acids and bases

Step 2

The teacher drops some strong solution of hydrochloric acid, (Hcl), trioxonitrate (V) acid (HNO_3) and tetraosxosulphate (VI) acid (H_2SO_4) on paper and asks pupils to put their observation on paper.

Step 3

The teacher guides he pupils to identify weak and strong acids and bases as

Strong Bases	Weak bases
Sodium hydroxides (NaOH)	Calcium hydrocxide - Solution of wooden ash
Potassium hydrocxide	

Acids

Strong acids	Weak Acids
Hydrochloric acids (HCl)	Methanoic (HC00H) Methanoic acid
Trioxonitrate (V) acid (HNO_3)	Ethamoic acid (H_3C00H)
Tetraoxosulphate (VI) acid (H_2S0_4)	

The teacher guides the pupils to summarise the lesson thus:

Depending on the strength of acids and bases, they are classified as:

Acidic:

Basic:

Neutral:

Evaluation: The teacher guides the pupils to answer the following questions

i. Mention two strong bases

ii. List two weak bases

iii. State two strong acids

iv. State one strong acid

v. Salts can be grouped as ………………., …………………… and ……………….

vi. Mention one neutral salt.

Assignment: In a tabular form state three uses of acid, bases and salts.

LESSON PLAN 12

Theme:	Basic Science
Sub-Theme:	Living and Non-living things
Class:	Primary 5
Topic:	Acids Bases and Salts
Sub-topic:	Salts
Duration:	35minutes

Specific Behavioural objectives: at the end of the lesson, the students are able to:

Instructional Materials

Water, table salt, some solution of acids and bases, paper, pencil, eraser, solution of some food items.

Presentation

Step 1

The teacher guides the pupils to reviews their knowledge on acids and bases

Step 2

State the uses of acids and bases

The batteries of cars contain an acid called sulphuric acid

Acid is neutralized by bases to form salt and water

Step 3

The teacher guides pupils to define salt

Step 4

The teacher guides the pupils to identify salts as: strong, weak and neutral

Acid Salt - Sodium hydrogen tetraoxosulphate – $NaHS0_4$

Basic Salt - Sodium trioxocarbonate (IV) – $N9_2C0_3$

Neutral Salt - Calcium Chloride CaCl2, Sodium Chloride (NaCl)

Assignment: State three uses of acid, bases and salts.

LESSON PLAN 13

Theme:	Basic Science
Sub-Theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Heat and Temperature
Sub-topic:	Types and Uses of Thermometer
Duration:	35minutes

Specific behavioural objectives: At the end of the lesson, the pupils will be able to:

i. Define temperature

ii. Differentiate between heat and temperature

Instructional materials: charts showing various types of thermometers, different thermometers, boiling water, containers, source of heat small bucket of iced block, different liquids.

Reference books

Presentation

Step 1

The teacher guides the pupils to recall their previous knowledge on heat and energy. The following questions are asked the pupils to find out their previous knowledge on heat and energy.

What is heat? - Heat is a form of energy

How can a body be heated? –

Step 2

The teacher defines temperature -. As the degree of hotness or coldness of a body. That the temperature of a body is usually changed by addition or loss of heat. **Step 3**

The teacher guides the pupils to differentiate between heat and temperature

Heat	Temperature

Heat is a form of energy	It is the degree of hotness or coldness of a body
Measured in joules	Measured in (^{0}C) or (^{0}F) or K
Flows from a hotter body to a colder one when placed in contact	determines directions in which heat flows
Can do work	cannot do work
Measured with a calorimeter	measured with a thermometer

The teacher explains to the pupils that the use of the sense of touch to measure or estimate temperature is not reliable and not accurate. The thermometer is a more accurate means of measuring temperature.

Evaluation

The teacher asks the pupils the following questions

i. What is temperature?

ii. What is heat?

Give 3 differences between heat and temperature

iii. One can measure of the degree of hotness or coldness of a body by using a…………?

Assignment

The pupils are to draw a thermometer.

LESSON PLAN 14

Theme:	Basic Science
Sub-Theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Heat and Temperature
Sub-topic:	Types and Uses of Thermometer
Duration:	35minutes

Specific behavioural objectives: At the end of the lesson, the pupils will be able to:

i. measure temperature using different types of thermometers

ii. Identify uses of thermometer.

Instructional materials: charts showing various types of thermometers, different thermometers, boiling water, containers, source of heat small bucket of iced block, different liquids.

Reference books

Presentation

Step 1

The teacher guides the pupils to recall their previous knowledge on heat and energy.

State two differences between heat and temperature

Step 2

The teacher explains to the pupils that the use of the sense of touch to measure or estimate temperature is not reliable and not accurate. The thermometer is a more accurate means of measuring temperature.

Step 3

The teacher shows pupils a thermometer

The teacher shows how thermometer is calibrated

The teacher explains the unit of measurement of the thermometer.

Summary: The teacher guides the pupils to summaries the lesson thus

Temperature can be measures by using thermometer

Evaluation

The teacher asks the pupils the following questions

Assignment

The pupils are to draw three different thermometers.

LESSON PLAN 15

Theme:	Basic Science
b-Theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Heat and Temperature
Sub-topic:	Types and Uses of Thermometer
Duration:	35minutes

Specific behavioural objectives: Learner's behaviour at the end of the lesson:

i. Identify types of thermometers

ii. List uses of thermometers.

Step1:

The teacher shows three types of thermometers

Step 2:

The teacher lists the uses of thermometers

Step 3:

The teacher guides pupils to match the different thermometers with their uses

Summary

i. The teacher summaries the lesson thus:

ii. Temperature is the degree of hotness or coldness of a body.

iii. Thermometer is used to measure the degree of hotness or coldness.

iv. Temperature is measure in Celsius, kelvin, or Fahrenheit.

Evaluation

The teacher asks the following questions.

1.What is temperature?

2.Identify the differences between heat and temperature

3. What is the unit of temperature?

4. What instrument can you use to measure temperature?

Assignment: Pupils are to draw and compare Celsius with kelvin temperature scales.

LESSON PLAN 16

Theme:	Basic Science
Sub-theme:	Living and Non -Living Things
Class:	Primary 5
Topic:	Heat and Temperature
Sub-topic:	Types and Uses of Thermometer
Duration:	35minutes

Specific behavioural objectives: Learner's behaviour at the end of the lesson:Identify and state the units and symbols of temperature correctly.

i. Temperature in laboratories during experiment.

ii. Measure body temperature

iii. Temperature of a room or its surroundings

iv. Some industrial products

v. Temperature of some drugs and vaccines.

vi. Maximum and minimum temperature of the day.

Step 1

The teacher explains the units and symbols of temperature scales

Step 2

The teacher differentiates between the different temperature scales

Step 3

The teacher evaluates the three periods on Heat and Temperature

Summary

The teacher summaries the lesson thus:

i. Temperature is the degree of hotness or coldness of body.

ii. Thermometer is used to measure the degree of hotness or coldness.

iii. Temperature is measure in Celsius, kelvin, or Fahrenheit.

Evaluation

The teacher asks the following questions.

1.What is temperature?

2.Identify the differences between heat and temperature

3.what is the unit of temperature?

4. what instrument can you use to measure temperature?

Assignment: Pupils are to draw and compare Celsius with kelvin temperature scales.

APPENDIX IV

BASIC SCIENCE ACHIEVEMENT TEST (SAT)

This Basic Science Achievement Test consists of two sections.

Answer the questions in sections A and B as accurately as possible.

SECTION A

DEMOGRAPHIC INFORMATION

Name of School:______________________

Age:________________________________

Sex:____________________________________

Type of school: _______________________________

SECTION B

Each question is followed by four options. Tick the option that best answer the questions.

QUESTIONS

1. If the back bone is injured and removed what will happen to the individual?

a) he will not be able to move b) he will not be able to think
c)he will not be able to talk d) he will not be able to hear

2. The following are functions of the bone EXCEPT

a) It gives support.
b) It protects vital organs
c) It helps in production of mineral.
d) It is a metal.

3. The transfer of the pollen grain from the anther to the stigma of a flower is called (a)pollination (b) fertilization(c) stigmatization (d) reproduction

4. What part of the flowering plants form the fruit after fertilization?

a) ovary b) ovule c) style d) pollen tube

5. An acid solution may be neutralized by adding…….?

a) Water solution (b) salt solution (c) sugar solutiond)alkali solution

6. The following are acids EXCEPT:

a) Hydrochloric acid. b) potassium hydroxide acid. c) trioxonitrate (v) acid. d)teraoxosulphate (vi) acid

7. The degree of hotness and coldness of a body is called………..

a) Thermo freeze (b) Thermostat (c) Thermometer (d) Temperature

8. Heat is a form of …………………………..

a) Temperature (b) energy (c) Scale (d) body

9. Thermometer is used to measure

a) Energy b) Heat c) Rainfall d) Temperature.

10. A thermometer dipped in a liquid that rises up as heat is applied to the container containing the liquid, is …………?

a) Liquid in glass b) radiation thermometer c) gas in thermometer d) solid in glass.

11. Brown patches on a petal down to the base of the petal helps the flower in

a) fertilization b) pollination c) ovulation d) infusion

12.Ball and socket joint is found in the

a) ankle (b) elbow (c) fingers (d) hip

13.The longest bone in human body is called

a)femur (b) fibula(c) humerus(d) radius

14. The sugary fluid at the base of flowering plant is called?

(a) glucose (b) sugar (c) sweet (d)nectar

15. A blue litmus paper dipped in a solution in a container, the litmus paper turn red.

This means the solution is………

(a) acid (b) alkaline (c) base (d) salt

16. Which of the following insects is an agent of pollination?

(a) bug b) butterfly c) housefly d) sandfly.

17. The hydrogen and hydroxide ions of two solutions were compare and one has more hydrogen ions than the other, the one with more hydrogen ion is more….?

a)acidic (b) alkaline (c) neutral (d) salty

18. The reaction between acids and alkali solution is called

(a) acidification (b) purification (c) sublimation (d) neutralization

19. The part of the flower that attracts insect to flower is called

a) anther (b) petal (c) ovary (d) stigma

20.A base turns the colour of a moist litmus paper from red to

a)blue (b) brown (c) green (d) white

21.Where does fertilization takes place in the flower?

a)petal (b) style (c) ovary (d) sepals

22. The joint in the skull is called….

a) Gliding joint. (b) suture joint. (c) hinge joint (d) Ball and socket joint.

23. Heat is measure with

a) a calorimeter b) ammeter. c) barometer d) galorimeter.

24. The commonly used temperature scale are EXCEPT:

a) Celsius scale. b) Kelvin scale c) Fahrenheit scale d) joule scale.

25. One of these is a property of salt:

a) It is corrosive. b) it turns blue litmus paper red c) It turns red litmus paper blue it is neutral to litmus paper.

APPENDIX V

BASIC SCIENCE ACHIEVEMENT TEST SCORING GUIDE INVENTORY (SATSGI)

1.	A	**10.**	B	**19.**	B
2.	D	**11.**	D	**20.**	A
3.	B	**12.**	C	**21.**	C
4.	A	**13.**	D	**22.**	B
5.	E	**14.**	B	**23.**	A
6.	D	**15.**	C	**24.**	D
7.	D	**16.**	A	**25.**	D
8.	D	**17.**	D		
9.	A	**18.**	B		

APPENDIXVI

BASIC SCIENCE PROCESS SKILLS RATING SCALE (SPSRS)

SECTION A

School: …………………………………………

Gender: …………………………………………..

Age: ……………………………………………..

Section B

4 = EXELLENT 3 = GOOD 2 = NEEDS INPROVEMENT1= POOR

S/N	SC. PROCESS SKILLSINDICATORS	4	3	2	1
1.	Observing: This is the ability of the pupil to use any of the senses to gather information on an object				
3	Classifying: This is the ability of the pupil to group object based on similarities and differences of an object				
3.	Predicting: This is the ability of the pupil to tell the next event based on present evidence				
4.	Measuring: This is the ability of the pupil to use a standard measure to take the quantity of an object				
5.	Inferring: This is the ability of the pupil to make conclusion based on prior knowledge				
6.	Communicating: This is the ability of the pupil to write, describe, draw, speak orally about an object				

APPENDIX VII

SCIENCE PROCESS SKILLS RUBRIC

S/N	Sc. Process Skills Indicator	Excellent Performance (3)	Good performance (2)	Fair performance (1)	No performance (0)
1.	Observing	Can feel the temperature and report all correctly.	Can feel the temperature but report only 2 correctly	Can feel the temperature but cannot report correctly	Cannot feel the temperature
2.	classifying	The pupil can group more than two and identify at least names of 2 groups	The pupil can group more than two groups of the bones	The pupil can group 2 pout of the five groups	The pupil cannot group the bones correctly
3	Predicting	The pupil can predict the agent of pollination of four flowers and state three features that indicate the type of pollination	The pupil can predict the agent of pollination of three flowers and state two features that indicate the type of pollination	The pupil can predict the agent of pollination of two flowers and state a feature that indicates type of pollination	The pupil can predict the agent of pollination of one flower but cannot state a feature that indicates the type of pollination

4	measuring	The pupil can measure the length of bone given in cm and can state four functions	The pupil can measure the length of bone givenin cm and state three functions	The pupil can measure the lengthof bone given in cm and state one	The pupil Cannotmeasure the length of the bone and cannotstate
		of bone.	of bone.	function of bone.	any function of bone.
5	Inferring	The pupil can infer the acidity or alkalinity of four different juice/liquid in the containers and state two properties of acids and two properties of bases.	The pupil is able to infer the acidity or alkalinity of three of the four different juice/liquid.	The pupil is able to infer the acidity or alkalinity of two different of the four different juice/liquid.	The pupil is able to infer the acidity or alkalinity of just one of the four different juice/liquid.
6	communicating	The pupil can draw the diagram of the flower given and label the 4 floral whorls).	The pupil can draw the diagram of the flower given and label three of the floral whorls.	The pupil can draw the diagram of the flower given and label two of the floral whorls.	The pupil cannot draw the diagram of the flower given and not able to label any of the 4 floral whorls.

APPENDIX VIII

ACTIVITY WORKSHEET FOR BASIC SCIENCE PROCESS SKILLS

Instruction

Carry out the instruction given to you by the teacher and answer the following questions 1.Which of the containers A , B and C has:

a. Hot temperature …………..

b. Cold temperature ………….

c. Warm temperature ………..

2.Group the bones given to you and try to name the groups:

a. Group A …………………

b. Group B …………………

c. Group C ………………..

d. Group D ……………………

e. Group E ……………………

3. What are the agents of pollination of the flower given and give three reasons

a……………………..

b…………………………….

c………………………………….

d…………………………………

4. Measure the length of the bone in cm and state four functions of bone.

a. Lenght in cm……………………..

b. Four functions

i………………… ii……………….. iii………………. iv……………

5.Which of the liquid /juice is acid or basic?

i………………………………. ii………………………………

iii……………………………..

2 properties of acids

i……………………

ii………………….

2 properties of bases

i…………………..

ii…………………

6.Draw the flower and label the four major parts

i………………..

ii………………

iii…………......

iv……………….

APPENDIX IX

QUESTIONAIRE ON PUPILS' ATTITUDE TO BASIC SCIENCE (QPABS)

SECTION A

Name of School:

Age: Sex: Class:

SECTION B

Please fill this section as accurately as possible. There are three options. Tick the option that expresses your feelings about the statement. The options are: Not Sure (NS), Disagree (D), Agree (A).

S/N		***NS***	***D***	***A***
1	I do not enjoy learning Basic Science.			
2	I see Basic Science as a hard subject.			
3	I will love to have more time for Basic Science.			
4	Basic Science is one of my best subjects.			
5	Basic Science will help with my future job.			
6	What I am learning in Basic Science will help me know more about my environment and other places.			
7	I do not need Basic Science to choose my future job.			
8	Basic Science learning is not interesting.			
9	Basic Science class activities are easy for me.			
10	I enjoy reading my Basic Science note and text book.			
11	I love participating in Basic Science activities.			
12	I love doing my Basic Science home work.			
13	I don't even want to read Basic Science.			
14	No matter how hard I try, I cannot do well in Basic Science.			
15	If I work harder, I will do well in Basic Science.			
16	I will like a school where there is no Basic Science.			
17	I will do well in all my subjects except Basic Science.			
18	Basic Science is for lazy pupils.			
19	I do not need Basic Science to be great in life.			
20	I wish the Basic Science teacher does not come to my class again.			

APPENDIX X

TRAINING OF TEACHERS / RESEARCH ASSITANTS FOR TEACHER-PUPILPROJECT COLLABORATION INSTRUCTIONAL GUIDE

EXPERIMENTAL GROUP 1

Period of training: one week

Mode of training: verbal and demonstration Procedure of training:

Step 1

Welcoming and introduction. The researcher welcomes the participants to the workshop and short introduction takes place.

Step 2

The researcher asks participants who are teachers/research assistants what they know about project- based learning. The teacher listens to two responses.

Step 3

The researcher explains step by step project- based strategy. The role of the teacher, role of pupils, the material resources and the important role of technology to assess information. Simply put project-based strategy is inquiry learning that utilizes information from many sources to answer a driving question formulated by pupils. Pupils cooperate to find answers to the driving question. At the end of their activities, there is class presentation.

Step 4

The researcher hands over the guideline on Teacher-pupil collaboration lesson plan to the pupils. Together the researcher and the participants go through the lesson plan guide. Issues that are not clear are clarified.

Step 5

Participating teachers/ research assistants engage in micro teaching.

Step 6

Participating teachers/ research assistants are assessed to ensure their suitability for the study.

Step 7

Necessary correction and clarification done and the Participating teachers/ research assistants are good to participate in the study.

APPENDIX XI

TEACHERS'/ RESEARCH ASSISTANT' EVALUATION SHEET FOR TEACHER – PUPIL PROJECT COLLABORATION INSTRUCTIONAL STRATEGY

S/N	Teacher's skill	satisfactory	Need more help	Not satisfactory
1	Teacher's ability to elicit pupils' prior knowledge			
2.	Teacher's ability to state the background to the topic			
3	Teacher's ability to bring out the vocabulary from the topic			
4	Teacher's ability to divide the class into groups			
5	Teacher ability to inculcate team spirit in pupils			
6	Teacher's ability to guide the class to establish class rules			
7	Teacher's ability to guide pupils to derive the driving question during class interaction			
8	Teacher's ability to create a pupil centred class			
9	Teacher's ability to guide pupil to get necessary feedback to refine their project			
10	Teacher's ability to guide pupil to reflect on their project			
11	Teacher's ability to encourage pupil to communicate their findings?			

APPENDIX XII

TRAINING OF PARTICIPATING TEACHERS/ RESEARCH ASSISTANTS FOR EXPERIMENTAL 11(HANDS- ON ACTIVITIES)

Period of training: two days

Mode of training: verbal and demonstration Procedure of training:

Step 1

Welcoming and introduction. The researcher welcomes the participants who are teachers or research assistants to the workshop and a short introduction takes place.

Step 2

The researcher asks participants to demonstrate hands- on activities using human bone as example

Step 3

Researcher guides the group to brainstorm on the activities in hands-on, minds -on class

Step 4

The researcher hands over instructional guide on hands-on activities to the participants.

Step 5

The researcher and participants go through the instructional guide lesson by lesson.

the resource materials are examined

Step 6

The researcher clarifies issues bothering on resources, the strategy and other related issues.

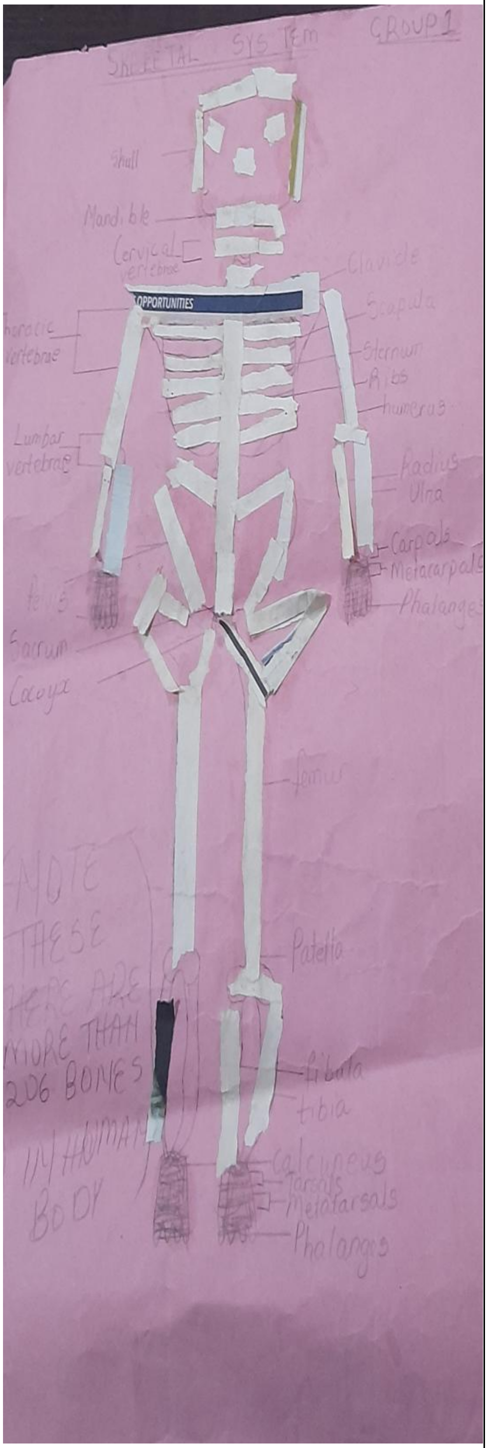
Step 7

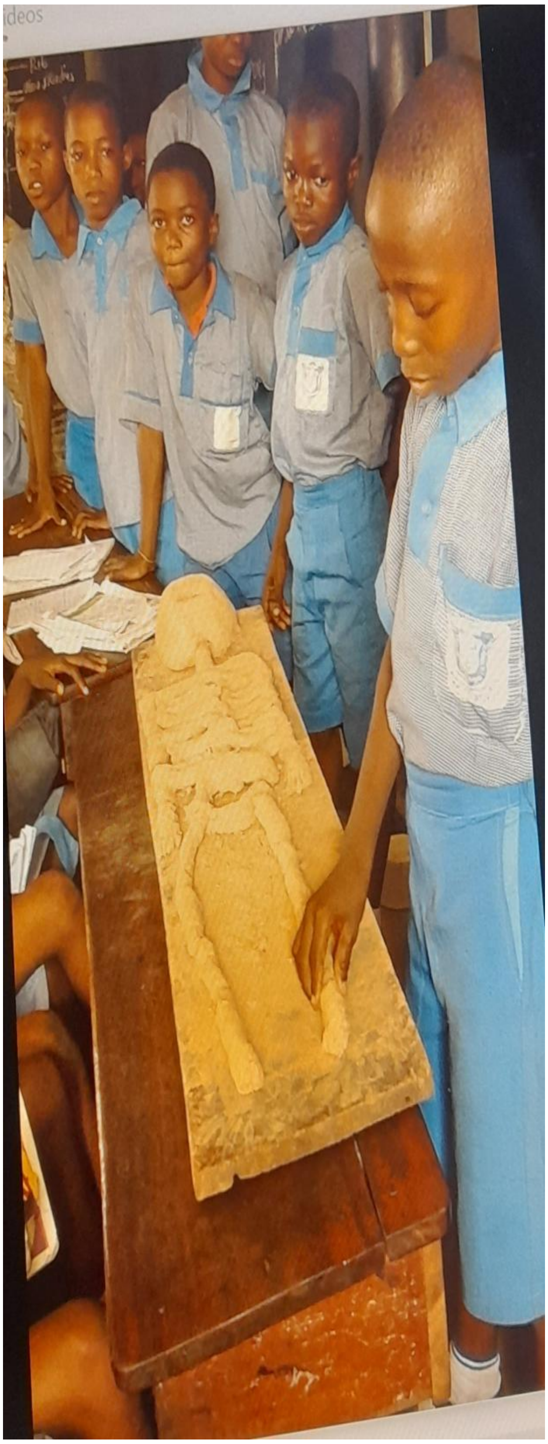
Participants engage in micro teaching and the evaluation is done.

APPENDIX XIII

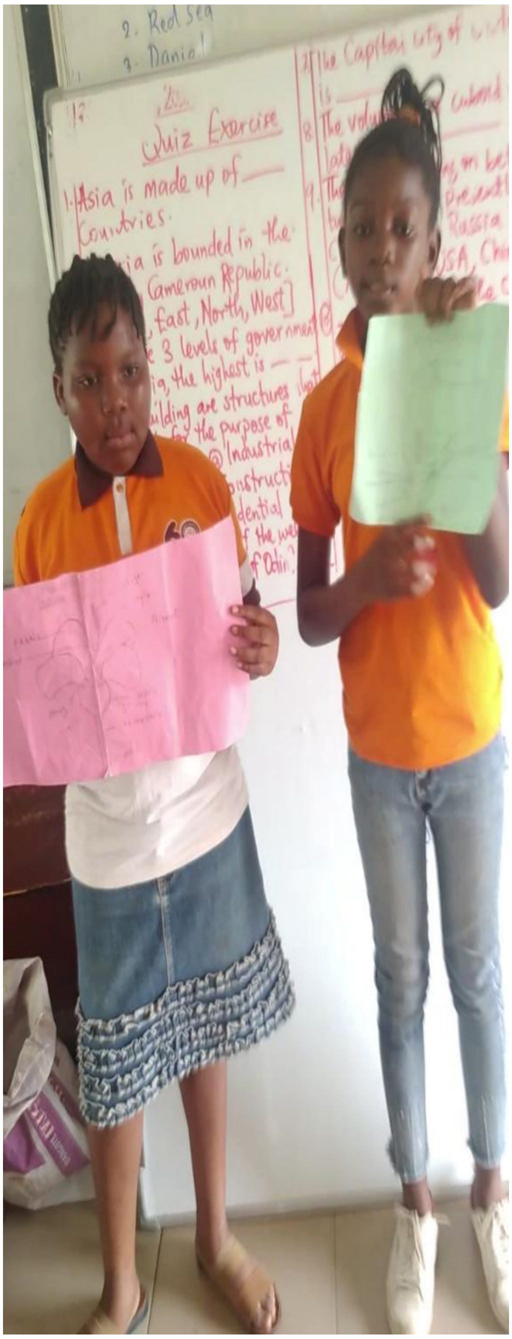
TEACHERS'/ RESEARCH ASSISTANT'S EVALUATION SHEET FOR HANDS- ON ACTIVITIES INSTRUCTIONAL STRATEGY.

S/N	Teacher's skill	satisfactory	Needs more help	Unsatisfactory
1	Teacher's ability to elicit pupils' prior knowledge			
2	Teacher's ability to encourage pupils to work on group basis			
3	Teacher's ability to utilize the teaching aid to involve pupil in active learning			
4	Teacher's ability to coordinate all the groups in the class			
5	Teacher's ability to demonstrate and encourage pupils to be creative			
6	Teacher's ability to move around the groups and give needed support.			
7	Teacher's ability to assess pupils' work in order to ensure independent acquisition of knowledge			





Project-based learning strategy



Pupils' presentations in Project-based learning strategy

pp

Hands-on activities learning strategy

pConventional teaching strategy

Conventional teaching strategy