PERSONAL FACTORS, INSTRUCTIONAL SUPPORTS, ICT USE AND BIOLOGY LEARNING OUTCOMES OF STUDENTS WITH HEARING IMPAIRMENT IN OYO STATE, NIGERIA

BY

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CERTIFICATION

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DEDICATION

This work is dedicated to the Almighty God, the Lover of my soul.
Also, to my loving and caring husband, Venerable Moses Olubowale Oyawole and, to my wonderful angels, Mercy, Favour, Shallom and Sharon. I love them all.

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ABSTRACT

Biology is a compulsory subject for students seeking admission into many science-related courses in Nigeria higher institutions. However, reports have shown that students' learning outcomes in biology at both internal and external examinations are poor, particularly among students with hearing impairment in Oyo State, Nigeria. Extant literature largely concentrated on enhancing regular students' performance in Biology through survey and interventions, neglecting students with hearing impairment. This study was, therefore, carried out to investigate personal factors (onset of hearing loss, degree of hearing loss, self efficacy and learning styles), instructional supports (human support and technical support), ICT use and biology learning outcomes (performance in and attitude towards biology) of students with hearing impairment in Oyo State, Nigeria.

The Constructivist and Social Learning theories were adopted as the framework, while the survey design of correlational type was used. Seven secondary schools having students with hearing impairment were purposively selected. The schools comprised two private and five public schools. Two hundred and twenty-four Senior School II students were enumerated - 191 from public and 33 from private schools, respectively. The instruments used were Audiology and Audiometric Report, Grasha-Riechmann Learning Style (r=0.85) and Self-Efficacy Formative (r=0.78) questionnaires, Biology Performance Test (r=0.77), Attitude towards Biology Scale (r=0.91), Inventories on Instructional Supports (r=0.77) and ICT use (r=0.88). Data were analysed using descriptive statistics, Pearson's Product Moment Correlation and Multiple regression at 0.05 level of significance.

The respondents' age was 16.30 ± 1.50 years; 55.8% experienced onset of hearing loss after birth and 65.2% had profound degree of hearing loss. The participants' self-efficacy was high (3.12) as against the threshold of 2.50, while their learning styles were slightly high: visual (2.92) and kinaesthetic (2.79) against the test norm of 2.50. Sign language interpreters, note-takers, science laboratories, CD-ROM, control software, multimedia, computer and video tape player were available and utilised as instructional support tools. However, lip-readers, communication support workers, radio microphone system, induction loop, digital recorders, turtle graphics, overhead projector and PowerPoint were not utilised. There was a significant positive relationship between self-efficacy (r=0.46), learning style (r=0.58), ICT use (r=0.38) and students' performance in biology, while instructional supports and onset of hearing loss were not significant. There was a significant positive relationship between students' self-efficacy (r=0.49), learning style (r=0.58), ICT use (r=0.80) and students attitude towards biology, while instructional supports and onset of hearing loss were not. There was a significant joint contribution of the independent variables (onset of hearing loss, degree of hearing loss, self-efficacy, learning style, human support, technical support and ICT use) to performance ($F_{(5188)}$=23.32; Adj.R^2= 0.37), accounting for 37.0% of its variance. There was a significant joint contribution of independent variables to attitude ($F_{(5188)}$=128.35; Adj.R^2=0.77), accounting for 77.0% of its variance. Learning styles (β=0.43), self-efficacy (β=0.16), and ICT use (β=0.13) contributed to performance in biology but did not to attitude.

Learning style, self-efficacy and ICT use enhanced biology learning outcomes of students with hearing impairment in Oyo State, Nigeria. Teachers should take cognisance of these factors during the teaching and learning process.

Keywords: Students with hearing impairment, Performance in biology, Attitude towards biology, Onset of hearing loss

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TABLE OF CONTENTS

CHAPTER FOUR: RESULTS AND DISCUSSION

LIST OF TABLES

LIST OF FIGURES

CHAPTER ONE
INTRODUCTION

1.1 Background to the Study

Every human society is characterized by different individuals with diverse beliefs, opinions, behaviours and attitudes. This is also true of different classrooms at all levels of educational system because a classroom is a hybrid of children with various special needs. These include students with various disabilities such as physical, intellectual, hearing challenges as well as the gifted and talented. Among these groups, those with hearing impairment are the most likely to present serious challenge in the classroom and learning situations (Oyewumi, 2013). It was observed by the American Speech Language – Hearing – Association in Daily Chronicles (2019) that students with hearing impairment often experience delays in speech and language development. These delays cause learning problems, affecting academic performance. Students with hearing impairment cannot hear soft sound, they speak too loudly or not loud enough, this condition leads to isolation, low self-esteem and difficulty in making friends. These disabilities have been defined in several ways. USlegal (2019) described hearing impairment as a condition that results in a full or partial decline in the capacity to detect or understand sound. Individuals with disabilities Education Act (IDEA, 2018) defined hearing impairment as hearing Difficulty which may be either permanent or fluctuating and adversely affect the child's educational performance. Nchearingloss (2018) also defined the term hearing impairment as a technically precise description of persons who have difficulty to hear. According to Sue Watson (2017), a learner who is deaf or who have difficulties in hearing have language and speech deficiency as a result of a decrease or lack of sound response. Indications of hearing impairment include: problem in following verbal directions and difficulty with oral expression. Usually, the child exhibits some form of articulatory difficulty, request for repetition of words, not responding to or confusing verbal direction, speaking in arbitrarily loud or low tones, discharge from the ears, bending towards speaker’s mouth among others.

The term ‘hearing impairment’ covers a wide range of auditory disorders. Indications may be mild, moderate, severe, or profound. A patient with mild hearing impairment may have difficulties comprehending speech, particularly if there is a lot of noise around, while those with moderate hearing impairment may need hearing aid. Some individuals are severely deaf and rely on lip reading to interact with others. Those with profound deafness cannot hear in any way and they can find themselves completely dependent on reading the lip. Nordquist (2018) mentioned other terms which are often used interchangeably in describing people with hearing impairment, these include; the deaf, those with hearing impairment, acoustically handicapped, hard of hearing, congenitally deaf, adventurously deaf, postlingually deaf, prelinqually deaf, and many others. Parameters such as age of onset, cause, degree and type are considered in arriving at these terms. Aussie Deaf kid (ADK, 2018) expressed that hearing impairment can be congenital, which is a condition that starts before birth or at the birth of a child. It can also be adventitious or acquired; this is hearing loss in people who were born with normal hearing but lost some or all of it as a result of illness or a mishap. Hearing impairment could be either prelingual (before acquisition of speech and language, precisely before the age of two) or post lingual, (after the acquisition of speech and language). Causes of hearing loss have been identified to be included in the following categories: Prenatal causes which include: infection during pregnancy, like rubella, syphilis, and toxin consumed by the mother during pregnancy, abuse of drugs, accident, meningitis, Rhesus factor, babies born prematurely, genetic problem. Peri-natal causes are use of forceps during child birth, anoxia and prolonged labour. Post natal causes are accidental fall, infections such as meningitis, measles, or chicken pox, ear infection like Otitis Media, jaundice, and exposure to noise. Other causes like accident, otosclerosis, meniere’s disease, usher’s syndrome, acoustic neuroma, x-ray, perforation of ear drum, mumps, poor nutrition, and ototoxicity are responsible for various degrees of hearing impairment in children and adults (Wilke, 2017).

A major and obvious effect of hearing impairment is on spoken communication. Hearing loss does not affect the person physically, but it can cause communication issues (Hear-it, 2018). Individuals with Disabilities Education Act (IDEA, 2018) indicated that Sign Language Interpreters and Assistive Listening Devices (ALDs) such as: Frequency Modulation (FM) systems and induction loops are major supports needed by such students. Public Broadcasting Service (PBS, 2018)

stated that hearing impaired learners' education in a conventional classroom setting rests largely on the belief that they are expected to learn to read, write and do mathematics. This is because the aim of special education in Nigeria is to equalise all people, regardless of their genetic makeup, social or physical disabilities, sensory, mental, psychological, or emotional disabilities, should have access to educational opportunities. (National Policy on Education, 2013) Children with disabilities have equal opportunities to learn and perform optimally as their age mates who are without limitations (Spring School, 2018). Deafness has no effect on the acquisition of literacy abilities, according to Raymond (2019), students with hearing impairment have the same intellectual capability just like every other person.

It is important that educational needs of all children are catered for. At the Salamanca World Conference on Special Needs Education in 1994, UNESCO stated that every child has a fundamental right to education and that every child must be accorded the opportunity to attain and sustain a satisfactory level of education. Also, the Federal Government of Nigeria stated in its National Policy on Education (2014) that all individuals with disabilities should be given a suitable education to enable them contribute their quota and, as a result, acquire psychological fulfilment. The major challenge that students with hearing impairments are faced with is the unusual language and communication structures (Oyewumi, 2013). Students with hearing impairment are characterized by difficulty in understanding concepts presented to them in verbal form because of the effects of hearing impairment which include limited vocabulary in their repertoire as well as inability to process the various messages. Therefore, verbal means of imparting knowledge does not favour this set of students who have hearing challenges. As a result, many of them develop negative attitude towards learning.

Science subjects like Biology, Chemistry, Mathematics and Physics among others are offered and taught in schools both at the senior secondary and tertiary institutions. Science education is rested on the idea an elementary knowledge of science, its abilities and processes can help in improving the quality of life of people with and without hearing loss, thereby increasing the human race's survival rate. Biology is the study of life that entails all activities that living organisms engage in such as nutrition, respiration, growth and development, reproduction, evolution, and ability to adapt and cope effectively with their environment. It is concerned with life and its processes. The subject engages students in varied process abilities like

examining, categorising, interpreting, designing, organising and reporting events, experiment and making prediction adequately. Biology should be taught in senior secondary schools, according to the National Policy on Education (2013). It is one of the eight (8) subjects in the Science and Mathematics field of study. As a result, it is an important subject in the Nigerian secondary school curriculum, with the majority of students enrolling in the Senior Secondary School Certificate Examination (SSCE) (West African Examination Council, 2018) irrespective of their special needs. However, many students with hearing impairment performed poorly in the subject in the WASSCE conducted between 2010 and 2018.

Table 1.1: Performance of Oyo State Students in May/June West African Senior School Certificate Examination (WASSCE) in Biology (2010-2018)

Year	Total Number of candidates	Candidates with credit Passes		Candidates with failure	
		Number	Percentage	Number	Percentage
2010	41545	9497	22.69	32048	77.14
2011	45970	6236	13.57	39734	86.43
2012	43164	6586	15.26	36578	84.74
2013	74670	24153	32.80	48679	66.12
2014	24098	6092	25.28	18006	74.72
2015	19371	5937	30.65	13434	69.35
2016	19942	13495	67.67	6447	32.32
2017	11698	7052	60.28	4646	39.72
2018	15686	8118	51.76	7568	48.24

Source: Planning and Statistics Department Oyo State Ministry of Education, Science and Technology 2019

Table 1.2: Performance of Oyo State Students with Hearing Impairment in May/June West African Senior School Certificate Examination (WASSCE) in Biology in Ibadan (2010-2018)

Year	Total Number of candidates	Candidates with credit Passes		Candidates with failure	
		Number	Percentage	Number	Percentage
2010	6	2	33.33	4	66.67
2011	25	-	0	25	100
2012	12	-	0	12	100
2013	1	-	0	1	100%
2014	-	-	-	-	-
2015	15	1	6.67	14	93.33
2016	19	4	21.05	15	78.95
2017	23	21	91.30	2	8.70
2018	21	08	38.10	13	61.90

Source: Methodist Grammar School Bodija (Deaf Unit) 2019

Table 1.3 Performance of Oyo State Students with Hearing Impairment in May/June West African Senior School Certificate Examination (WASSCE) in Biology in Oyo (2010-2018)

Year	Total Number of candidates	Candidates with credit Passes		Candidates with failure	
		Number	Percentage	Number	Percentage
2014	33	1	3.03	32	96.97
2015	17	0	0	17	100
2016	13	13	100	0	0
2017	15	14	93.33	1	6.67
2018	45	25	55.56	20	44.44

Source: Durbar Grammar School Oyo (Deaf Unit) 2019

Tables 1.2 and 1.3 indicated increase in the failure rates in WASSCE Biology between 2017 and 2018 for the Deaf Unit of Methodist Grammar School, Bodija, Ibadan and Durbar Grammar School, Oyo. Adigun (2016) affirmed that learning outcomes of students with hearing impairment in Biology has not been satisfactory. Nwagbo (2015) is also of the view that one subject most students opt for in their final examination is Biology, yet performance has not been encouraging. Abimbola and Abidoye (2013) as well as the Chief Examiner's report of West Africa Examination Council (WAEC) in 2018 observed that there is a yearly increasing enrolment in science subjects, especially Biology but the performance of students, including those with hearing impairment, in the Senior Secondary Certificate Examination (SSCE) has been rather poor.

Perhaps most students with hearing impairment have difficulties with understanding concepts in Biology which led to their poor performance as revealed in the Tables above. Auwalu, Mohd and Muhammed (2014) explained that abstract nature of biology, as well as the absence of knowledge of certain biological constructs including terms are said to be reasons adduced for poor performance of students in the subject. Achor, Ochnogor and Daikwo (2011) also stated that in spite of the importance of Biology to Nigerian students, the performance of students with hearing impairment at senior secondary school stage is reported to be poor as most students still learn Biology as an abstract subject. This poor performance of students with hearing impairment can still be hinged on difficulties in solving questions on concepts such as gene, chromosomes, Mendelian genetics and hormones (Hadiprayitno, Muhlis and Kusimiyato, 2019). Ahmed and Abimbola (2011) thus submitted that with the persistent use of conventional method of instruction in Biology, students' tendency of become passive rather than active learners will continue to be relatively high as the method does not promote adequate learning and long-term retention of some abstract concepts in Biology.

Researchers have adopted different types of instructional strategies to enhance academic performance of students in Biology. Mind (2019) opined that concept maps aid in improving awareness of concepts by presenting the correlations with other concepts. National Science Teachers' Association (NSTA, 1996) believes that there are a number of specific concepts in Biology where students could benefit more from inquiry-based activities than traditional learning by lecture. Studies by Ajaja and Eraavwoke (2012) found a significantly higher retention of Biology and Chemistry by

students taught with learning cycle than those taught with lecture method. Despite all the strategies that have been used, literature revealed that there is still low performance in Senior Secondary Certificate Examination (SSCE) by students with hearing impairment. Gambari, Yaki, Gana and Ugbuowa (2014) opined that the conventional teaching method is classroom based and consists of lectures and direct instructions conducted by the teacher which has constituted a cog in the wheel of students' performance in biology. Etobro and Fabinnu (2017) indicated that many science teachers prefer the traditional expository or lecture method of teaching and therefore sees the need for a shift to a more progressive mode of teaching – learning process which increases the interest of learners. Bukoye, (2017) asserts that instructional materials play a vital role in teaching learning process, teaching should be activity based through the use of visual materials (Video, 3D materials, real life objects, technology instruments) through practical work (experiment, observation and inquiring) connecting the topics with the real world and establishing the links with the topics. Ndihokubwayo (2017) argued that many schools do not have the required laboratory facilities quality materials for teaching biology practical. Hence, students fail to acquire the necessary science laboratory skills because their teachers were faced with difficulty in conducting practicals as they would like to and this has always had inevitable consequences on students' learning. Other factors include: Inability to identify the appropriate instructional strategies for effective learning (Ajaja, 2013); Teachers' quality (Melissa, 2011); Overcrowded classroom and large classroom size (Michael 2016); Poor teaching methods (Ige, 1998 and Sangodoyin, 2011). Despite all the strategies that have been used, literature revealed that there is still low performance in Senior Secondary Certificate Examination (SSCE) results on students with hearing impairment.

In a quest to improve the performance of hearing impaired students, it is necessary to consider students' attitude towards biology. Attitude, according to Sakariyau, Taiwo, and Ajagbe (2016), is a proclivity to classify objects and events and to react to them with evaluative consistency. The term "attitude towardsward science" refers to a long-term, positive or negative attitude towardsward science (Thomas and Frank, 2010). In their own study, Sofiani, Maulida, Fadhilla, and Sihite (2018) found that students' positive attitude towardsward science were moderate, with no significant differences in attitudebetween female and male students. Anwar and Bhutta (2014) also believe that students should be actively involved in science learning in order to

maintain and improve their positive attitude towardsward the discipline as they get older.

Apart from the attitude of students with hearing impairment, other factors that could affect their performance are referred to as personal factors; they include onset of hearing loss, degree of hearing loss, self-efficacy and learning style. The onset of hearing loss is crucial to the acquisition of the spoken language and it is one of the most significant for the education of the deaf (Bengal Speech and Hearing, 2018). Onset of hearing loss among other factors could influence learning outcome among students with hearing impairment. Shemesh (2010) noted that hearing impairment exists either before or after the acquisition of speech and language. Careerforce (2018) stated that a Prelingual hearing loss occurred before a child developed speech and language. Therefore, students with hearing impairment usually were either born deaf or lost their hearing before the age of one (hearing loss in children occurred mostly at this period). Hearing loss acquired after speech and language development is referred to as a post lingual hearing impairment that means the hearing loss that was diagnosed before speech and language have developed may cause significant educational difficulties. Hearing loss that was not present at birth but develops later in life is known as acquired deafness (Ogundiran and Olaosun, 2013). The person who develops hearing loss later in life must have acquired some communicative skill (especially verbal signals) that allowed him or her to function better in academic and interactive settings than the prelingually hearing impaired person (Ademokoya, 2006). According to Healthy Hearing (2018), hearing loss has a significant negative effect on academic performance, the degree not withstanding (mild or severe). However, Adigun (2016) ascertained that there was no significant main effect of onset of hearing loss on performance of students with hearing impairment in Biology.

Another student factor closely related to the onset of hearing loss is extent of hearing loss, which refers to the severity of the hearing loss that an individual experiences, according to Boys Town National Research Hospital (BTNRH, 2018). People with this impairment can be divided into two groups, hard-of-hearing and deaf, based on the magnitude of their hearing loss as reported by the Conference of Executives of the American School for the Deaf Washington. Hard of hearing, according to Deaf TEC (2018), is defined as someone who has little or no functional hearing and communicates using sign language. Under this category are people with mild (26-45dB) and moderate (46-65dB) hearing loss. A deaf person refers to an

individual whose hearing is so defective to an extent that it is difficult to understand speech sound through the ear even with amplification, for ordinary purpose of life. Those in this category have severe (66-85dB) or profound (90dB and above) hearing loss. Nordquist, (2018) stated that students who have hearing level for speech at 40dB or below may have normal speech, but will have some difficulties, understanding faint or distant sound. Students with hearing level for speech at 40dB and 55dB may understand conversational speech of not too much distance from the speaker.

However, hearing for classroom purpose may be difficult, especially if the speaker's voice is not strong or if he (speaker) fails to face the child. Those that have hearing level for speech between 56dB and 70dB can understand conversational speech only if it is loud. There will be difficulty in group and classroom discussions. They show evidence of limited language and vocabularies as well as articulation and voice disorders. Students with hearing impairment with the hearing level for speech between 71dB and 90dB will not perceive sound of a loud about one foot from the ear and some environmental noises may not be distinguished by them. Meanwhile, difficulties with consonants are evident even with the use of hearing aids with students having hearing level for speech from 91dB and above. Even though, these students may hear some very loud sounds, they are deaf; they can never rely on the auditory channel as a primary pathway of communication. Persons with considerable levels of hearing loss, according to Heward (2013), have difficulty understanding speech. Consequently, such individuals would greatly rely on their vision to engage in academic and non-academic communication.

Besides the level of hearing loss, people's assessments of their ability to plan and implement courses referred to as self-efficacy differs (Bandura, 1977). This divergent view on perception is in tandem with the Social Cognitive Theory of Bandura (1977). Self-efficacy is defined as "people's judgements of their abilities to plan and perform courses of action needed to accomplish chosen kinds of performances". Bandura (1977) identified self-efficacy in his word as a major component of social cognitive theory. Self-efficacy is defined as the optimistic self-belief in our competence or chances to successfully accomplish a task and produce a favourable outcome (Akhtar, 2018). Self-efficacy, according to Bandura (1977), is based on prior experiences and has a strong influence on behaviour. The higher one's level of self-efficacy, the greater one's perception of being in charge of one's destiny and being able to choose which path to take (Bandura, 1995). Self-efficacy is

positively related to academic performance among special needs students, according to Eheh and Oladayo (2015).

It is critical to consider how one learns and applies knowledge. Learning style, according to Grasha (1996), is a personal characteristic that affects a student's ability to acquire information, interact with peers and teachers, and subsequently acquire learning experience. The characteristic, strength, and preference in the way people receive and process information is referred to as learning style (Hsieh, Jang, Hwang, Chen, 2011). Rajshree (2013) Learning style is the characteristic cognitive, affective, social, and physiological behaviors that serve as relatively stable indicators of how learners perceive, interact with, and respond to the learning environment. He further stated that learning style can be described as a set of factors, behaviours and attitudes that facilitate learning for an individual in a given situation. Styles influence how students learn, how teacher teach, and how the two interact.

Some external factors that could affect academic performance of students with hearing impairment may be instructional supports, which may be human or technical. Human support (These are specialist support workers who help students with hearing impairment to access what the tutor and other students are saying) they are - Sign Language Interpreters, Note takers, lip - speakers and communication support workers. Sign language Interpreter is a specialist who will translate what is said by the lecturer or tutor into sign and will provide a voiceover for the deaf student's own signed contribution if required. Note takers are the specialists that take note for the students with hearing impairments in the classroom. Using note taker may be the only way that students with hearing impairment have for obtaining a permanent record of the lecture. Lip speaker is a specialist who repeats the word of the speaker without voice to students with hearing impairment in the classroom. They create the shape of the words, as well as the flow, rhythm, and phrasing of natural speech, and they repeat the speaker's stress. The communication support workers for students with hearing impairment are specialists who work in support role for education and environment. They allow the learners gain the knowledge and understanding to fully assist students with hearing impairment in a supportive role. Technical supports (these are hearing technology used by those students with hearing impairment that have residual hearing to manage problems of distance, background noise and acoustic conditions) examples are Radio Microphone System, Induction Loops, Digital Recorder. A radio microphone system comprised of a lecturer's microphone transmitting to a receiver

worn by the learners. Induction loops are used in conjunction with a microphone used by the speaker and sometimes with an existing amplifying system to help eliminate the effect of distance and background noise. Learners with a significant proportion of residual hearing can use a digital recorder to keep a record of lectures that can be listened to at their leisure and saved as sound files on their computers if they desire. Putting technical supports in consideration in this study may have positive effect on students with hearing impairment learning outcome in Biology in Oyo State.

National Centre on Safe Supportive Learning Environment (NCSSLE, 2018) stated that the support staff consists of a diverse group of professionals providing specialised instructional support and also assistance to students as they are using school amenities. They play a major role in making sure that students learn in a secure and supportive environment. Such people include Sign Language Interpreter, lip-speaker, note – taker, communication support workers among others. Geni (2014) stated that major factors predicting the poor academic performance of students with this group are communication barrier, lack of specialised teachers as well as specialised equipment. Geni (2014) also found out that students with hearing impairment performed well in subjects that were taught by specialist teachers than in those subjects taught by non - specialist teachers. Students must be visually oriented and educational materials must be supported by sign language.

In a study reported by St Joseph University (2019), it was discovered that when working with children with hearing impairments, educators should utilise the most up-to-date methods and equipment for teaching. Preventing background noise allows learners with hearing impairments to concentrate on the lecture and assignment (Sharilyn, 2012). American Sign Language Association (ASLA, 2018) stated that teachers should ensure that any background noise is minimised in the classroom when teaching students with hearing impairment. The main challenge students with hearing impairments face is the inability to hear what their teacher and peers are saying and this problem is worse when all of the background noise is considered in a typical classroom. He stated further that children will do better in a quieter classroom. Ademokoya (2008) identified lack of proper audiological assessment procedure necessary for therapeutic intervention, inappropriate school placement, instructional practices failure to comprehensively identify and manage some latent disorders and unfavourable cultural norms as some problems characterising the education of the child with hearing impairment. Mosha (2011) noted that availability and use of

teaching and learning materials as well as specialised equipment is important in facilitating learning in students with hearing impairment.

Performance of hearing impaired students in SSCE could be improved based on the fact that in today's Nigeria, a considerable attention has been focused on science and technological development. The need to align with modern technology and interactivity have made computer very relevant within the educational realm. The oldest method of teaching in Nigeria is a conventional method. It is a traditional 'talk –chalk' package. According to Egaga and Aderibigbe (2015), the majority of teaching strategies and approaches used by teachers during lessons are traditional or passive in nature; these approaches are widely used in schools to convey instruction, and the longer students with hearing impairment struggle with the inadequacies of traditional approaches in facilitating knowledge and understanding, the more frustrated they become. According to Shimbi (2016), this has been identified as one of the major flaws affecting science learning and higher performance.

ICT includes any medium for storing information, as well as technology for broadcasting information (radio, television), and technology for communicating via voice, sound, or images, such as microphones, cameras, and loudspeakers. The rationale for using Information & Communication Technology (ICT) according to Ciccarelli, Straker, Mathiassan and Pollock (2011) is used to manipulate and communicate information through voice and sound; or images such as computers, computer-based assistive technology, and special software. The application of ICT in educating and studying by students with hearing impairment may be of importance to their learning outcome in Biology.

There have been researches on personal factors and ICT, but the fact is inconclusive. Studies on personal factor, instructional supports, and ICT on learning outcome of students with hearing impairment are still very few and evidence base is very limited. In addition, the observed inconsistency such as onset of hearing loss, degree of hearing loss, self-efficacy, learning style and instructional supports (Human and technical supports) in previous studies underscore the need to carry out the present research for a better understanding on the relationship of the independent variables (personal factors, instructional supports and ICT) and learning outcome of students with hearing impairment in Biology in selected special schools in Oyo State. Therefore, this study examined the relationship between personal factors, instructional supports, ICT use and learning outcome of students with hearing impairment in

Biology in Oyo State.

1.2 Statement of the problem

Students with hearing impairment have found it difficult to process verbal messages. Thus, these students could not benefit maximally from regular classroom interactions. This is evident in the poor performance of this group of learners in the West Africa Senior Secondary School Certificate Examinations in Biology. Also, the students have developed negative attitude towards the subject. Attempts made by various researchers to improve learning outcomes of students in Biology include the use of concept maps, cooperative learning, peer tutoring, inquiry – based activities, use of 5-E learning cycle, team-based learning among others. However, literature revealed that students with hearing impairment have low performance in and exhibit poor attitude towards Biology. Perhaps academic performance of students with hearing impairment may not only be consequent on their intelligence quotients or the disability but could be due to other factors such as, onset of hearing loss, degree of hearing loss, self-efficacy, learning style and instructional supports. There is also the need for science teachers to develop innovative activities to encourage active learning among the students using Information and Communication Technology (ICT). Therefore, this study examined the relationships of personal factors, instructional supports, ICT use and Biology learning outcomes of students with hearing impairment in Oyo State, Nigeria.

1.3 Research Questions

The following Research Questions were answered in this study

1. What are the descriptive indices of students with hearing impairment with respect to:
    a. onset of hearing loss
    b. degree of hearing loss
    c. self-efficacy
    d. learning style?
2. What are the level of availability, accessibility and utilization of
    a. instructional support?
    b. information communication technology (ICT) with respect to students with hearing impairment in Biology?

3. What is the performance level of students with hearing impairment in Biology?
4. What are the attitude of students with hearing impairment to Biology learning?
5. What is the relationship of personal factors to:
    a. performance
    b. attitude of students with hearing impairment to Biology?
6. What is the relationship between the use of instructional support and
    a. performance
    b. attitude of students with hearing impairment to Biology?
7. What is the relationship between ICT use and
    a. performance
    b. attitude of students with hearing impairment to Biology?
8. What is the composite contribution of independent variables (personal factors, instructional support, and ICT) on
    a. performance
    b. attitude of students with hearing impairment to Biology?
9. What is the relative contribution of independent variables (personal factors, instructional support, and ICT) on
    a. performance
    b. attitude of students with hearing impairment to Biology?

1.4 Scope of the Study

The study examined the relationships of personal factors (onset of hearing loss, degree of hearing loss, self-efficacy and learning style), instructional supports (human supports and technical supports) and information communication technology (ICT) use to SSII students with hearing impairment Biology learning outcomes. Participants were drawn from Eruwa, Ibadan, Iseyin, Ogbomoso and Oyo towns in Oyo State.

1.5 Significance of the Study

The study would be of great benefits to students, teachers, researchers, curriculum planners and developers, policy makers, special educators, school personnel, parents, specialists, and other stake holders in the education of students with hearing impairment.

The findings of this study would be of great benefits to students with hearing impairment, as it may enhance their performance in and attitude towards Biology. Personal factors, instructional supports and the use of ICT would positively influence the performance of this group of students in Biology. Also, students would be able to identify and ameliorate the personality factors affecting them in their studies.

The findings would help teachers in identifying learners in their classes who have low self-efficacy and developing specific or personalised coaching programmes to help them. Teachers as well as researchers would like to know more about the instructional supports that can assist learners with hearing impairment and effectively utilize different instructional supports that can aid their learning and improve their performance in and attitude towards Biology. The study would also assist teachers to endeavour to identify and categorise students learning behaviour and this may help the teachers to assist the students, use motivational techniques. Counselling and encouragement may be necessary at times to help students develop self-confidence and a positive self-image.

The findings of this research would be beneficial to curriculum developers, policymakers and other stake holders in educating hearing impaired students to organise workshop and seminar for special educators, school personnel, parents, and specialists on how to identify different factors affecting individuals in their academics and provide instructional supports needed for them. Teachers and syllabus developers should pay attention of the results of this study and try to incorporate them into their specific responsibilities as a way of assisting students with hearing impairments in their academic pursuits.

The findings of this study would be used in determining best practices to assist students with hearing impairment in reaching personal or academic goals in educational institutions. The findings would again inform the parents of this category of students better on how to understand their children and plan their education. This research work would equally serve as intellectual resource material for future research works.

1.6 Operational Definition of Terms

The following terms were defined according to how they were used in the study.

Academic Self-efficacy: This refers to the belief of students with hearing impairment about their ability that they can successfully perform a task. This was measured by Student Academic Self Efficacy Scale (SASES).

Performance in Biology: This refers to level of learning outcomes of students with hearing impairment as measured by scores obtained in Student Biology Performance Test (SBAT).

Attitude towards Biology: This is the disposition of students with hearing impairment towards biology in the secondary school. It was measured by Students Attitude towards Biology Scale (SABS).

Communication support workers: Communication support workers are specialists who serve as key workers and ensure that hearing technology works, raising deaf awareness in the college, and assisting students with their independence and social integration.

Degree of hearing loss: This is the severity of the hearing loss students with hearing impairments experience; it is ranked as mild, moderate, severe or profound. It is measured through screening and the result of hearing test is shown on a chart known as audiogram. Hearing loss is measured in decibels hearing level (or dBHL).

Digital Recorder: It is a technology used by students who have a significant amount of residual hearing, and it is used to keep a record of lectures that could be listened to at their leisure and saved as sound files on their computers if desired.

Hearing impairment: This is a permanent or fluctuating disability in hearing that can adversely affect academic performance and attitude towards Biology of students with hearing impairment. This was measured by carrying out various tests to find out the types, onset and degree of hearing loss of the hearing impaired students by the audiologist.

Human support: These are specialist support workers who assist learners with hearing impairments in the Biology class to understand what the tutor and other students are saying.

Induction Loop: This is a technology that helps in eliminating the impacts of distance and background noise in the classroom during Biology instruction.

Information Communication Technology: This is the range of technologies that

require the availability, accessibility and utilization to participate in, and benefit from educational programme. The inventory of ICT was measured by Students' Inventory on ICT (SIICT).

Instructional supports (Technical and Human supports): These are the supports that students with hearing impairment need to help them maximize their success in the classroom. This was measured by Students' Questionnaire on Instructional Support (SQIS).

Learning outcomes: These are the academic performances and attitude of secondary school students with hearing impairment in Biology. These were measured using BAT and SABS.

Learning Style: It is the style by which students with hearing impairment adopt for learning and applying knowledge. This was measured using Grasha-Riechmann Student Learning Style Scale (GRSLSS).

Lip - speaker: A lip speaker is a specialist trained to produce perfect lip patterns using unvoiced speech, reproducing the rhythm and phrasing of speech as used by the speaker and incorporating facial expressions and natural gesture to clearly convey the message in the classroom during Biology instruction.

Note takers: These are specialist support workers who help students with hearing impairment to take note or write down what is being said in lectures and tutorials.

Onset of hearing loss: It refers to the age at which an individual sustains hearing impairment. It could be either prelingual, (before acquisition of speech and language, precisely before the age of two) or post lingual (after the acquisition of speech and language) hearing loss.

Personal factors: Personal factors are factors that affect the performance of students with hearing impairment, which include age of onset of hearing loss, degree of hearing loss, self-efficacy and learning style.

Radio Microphone System: It is a technology that helps to eliminate problems of distance and background noise in a classroom setting.

Sign Language Interpreter: This is an individual who provides services to students with hearing impairment so that the speech of the hearing is transmitted to the student with hearing impairment by using conventional signs, finger spellings, oral cues and body language to enable such individuals understand what is being discussed simultaneously and relay information or question asked by the student with hearing impairment in the classroom.

Technical supports: These are hearing technology used by those students with hearing impairment that have residual hearing to manage problems of distance, background noise and acoustic conditions.

CHAPTER TWO
LITERATURE REVIEW

This chapter covers a broad review of related literature. It is arranged as follows:

2.1 Theoretical Review

This is anchored on two theories which are Constructivist Theory (Bruner, 1960) and Social Learning Theory (Bandura, 1989).

2.1.1 Constructivist Theory (Bruner, 1960)

The Bruner Constructivist's theory has it that important learning outcomes include not only concepts, categories and problem-solving procedures that have been created by culture in the past as well as the ability to come up with these ideas on one's own. His theory is a broad educational framework, and his focus is on the cognitive aspect of learning. Much of the theory is based on studies on child development (especially Piaget). Bruner (1960) derived his concept from a conference on science and mathematics. Learning is an active process in which learners construct new ideas or concepts based on their current or previous encounter, according to Bruner's theoretical framework. The learner uses the cognitive structure to select and interpret data, formulate hypotheses and make decisions. Experiences are given meaning and organization by cognitive structure (schema, mental model), which allows the individual to "go beyond the information provided.

Learning is a constructive process, according to constructivists, in which the learner creates an internal illustration of knowledge, a personal interpretation of experience. The structure and links forming the foundation to which other knowledge structures are attached are constantly open to modification. Learning is an active process in which meaning is found through experience. The view of knowledge does not necessarily deny the existence of the real world, and agrees that reality imposes constraints on concepts, but claims that all we know about the world are human interpretations of our observations of it. The sharing of numerous representatives and

the simultaneous transformation of our internal representation in response to these perspectives, as well as our cumulative experience, all contributes to conceptual growth. As far as education is concerned, Bruner (1996) believed that students needed to be motivated by instructors to discover principles on their own. Teachers and learners should have a lively discussion (i.e. Socratic learning). The teacher's job is to convert the information to be taught into a format that is appropriate for the student's current level of understanding. The syllabus should be structured in a spiral so that learners can build on what they've learned so far.

A theory of instruction, according to Bruner (1966), should address four major aspects:

1. a proclivity to learn new things.
2. the organization of a body of knowledge in such a way that it can be easily comprehended by the student.
3. the most efficient order in which to present information, and
4. the nature of rewards and punishments, as well as their timing. Good knowledge structuring methods should make it easier to generate new ideas and increase the amount of information that can be manipulated.

The fundamentals

1. Instruction must focus on the experiences and context that motivate and enable students to learn.
2. Instruction should be designed in such a way that the student can easily understand it (spiral organisation).
3. Instructions for extrapolation and/or filling in the blanks should be created (going beyond the information given).

Implication to the Study

The theory's implications to this study are as follows:

1. The use of instructional supports will make the learners to construct new ideas using their prior knowledge as outlined in Brunner’s constructivist theory.
2. The learners also structure the ideas, select them and transform information in learning process.

2.1.2 Social Learning Theory (Bandura, 1989)

According to social learning theory, learning occurs when a person observes a modelled behaviour that they value, observes an act of the model, has a role model or admired status, and imitates a learned behaviour (Bandura and Ribes-Inesta, 1976). The theory's basic foundations are used in education policies, understanding psychological disorders, training courses, behavioural modelling, in the media, and a variety of other areas in today's society. People learn from one another through observation, imitation, and modelling, according to Bandura's social learning theory. Because it encompasses attention, memory, and motivation, the theory has been dubbed a bridge between behaviourist and cognitive learning theories. Bandura (1989), who proposed that observational learning can occur in relation to three models, coined the term "social learning theory."

- A live model is one in which a real person exhibits the desired behaviour.
- Verbal instruction - in which a person describes the desired behaviour in detail and instructs the participant on how to perform it.
- Symbolic – when modelling is done through the media, such as movies, television, the internet, literature, or radio. A real or fictional character demonstrates the behaviour in this type of modelling. The emphasis on reciprocal determinism is a key feature of Bandura's social learning theory. The environment and the person's characteristics influence an individual's behaviour, according to this theory. In other words, a person's behaviour, environment, and personal characteristics all have an impact on one another. The modelling process, according to Bandura, consists of several steps:

1. Attention - in order to learn something, an individual must pay attention to the characteristics of the modelled behaviour.
2. Retention – In order to learn and later reproduce a behaviour, humans must be able to remember details of it.
3. Reproduction – in order to reproduce behaviour, an individual must organize his or her responses to match the model behaviour. With consistent practice, this ability can be enhanced.
4. Motivation – the individual's reproduction of the behaviour must be driven by an incentive or motivation. Even if all of the above factors are present, if the person is not sufficiently motivated, he or she may not engage in the behaviour.

Implication of the theory to the study

The implication of the theory to this study is that

1. The use of instruction supports and ICT to aid learning is a reciprocal of models which learners imitate and observe which the hallmark of Bandura's social learning theory.
2. The effect of the environment in the learning process identified in this study is in line with the social learning theory by Bandura which emphasised that the environment and also the qualities have an impact on a person's behaviour

2.2 Conceptual Review

2.2.1 Concept of Personal factors

2.2.1.1 Onset of hearing loss

There is an array of varied definitions of hearing impairment due to the professionals concerned with hearing (Udaya, 2013). DeafTEC (2018) stated that hardness of hearing refers to an individual whose hearing is impaired to the point where understanding speech sound through the ear alone, with or without amplification is difficult for ordinary purpose of life. Careerforce (2018) stated that a Prelingual hearing loss occurred before a child developed speech and language. Therefore, students with hearing impairment usually were either born deaf or lost their hearing before the age of one (hearing loss in children occurred mostly at this period). Hearing loss acquired after speech and language development is referred to as a post lingual hearing impairment that means the hearing loss that was diagnosed before speech and language have developed may cause significant educational difficulties. Hearing loss that was not present at birth but develops later in life is known as acquired deafness (Ogundiran and Olaosun, 2013)

2.2.1.1.1 Characteristics of Hearing Impairment

According Mayoclinic (2021), some of the most common signs and symptoms of deafness that are observable in classrooms situations are as follows:

1. Muffling of speech and other sounds
2. Difficulty understanding words, especially against background noise in a crowd
3. Trouble hearing consonants
4. Frequently asking others to ask to speak more slowly, clearly and loudly.

5. Needing to turn up the volume of the television or radio
6. Withdrawer from conversation
7. Avoidance of some social settings.

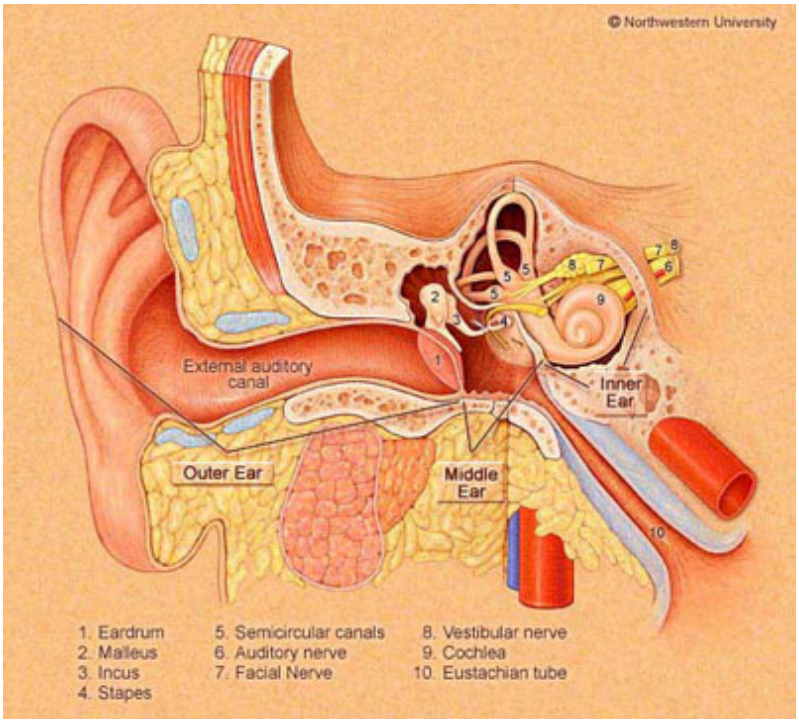

Figure 1 Anatomy of the Ear

Source: Master ear drawing – North western University Evanston, Illinois

2.2.1.1.3 Hearing Loss Types

Hearing loss is labelled according to the levels rather than percentages. Hearing loss can be mild, moderate, moderately severe, severe, or profound, and it can vary in severity and pitch. A simple hearing test compares the amount of volume loss you have to an average of many other adult listeners with normal auditory ability to determine a person's hearing deficit. The volume (or intensity) of sounds is measured in decibels (dB), with 0 dB representing the softest whisper and 120 dB representing a jet engine. Thresholds are the softest sounds a person can hear. Adults' normal hearing thresholds range from 0 to 25 decibels.

Mandy (2018) describes three types of hearing loss: “conductive hearing loss, sensorineural hearing loss, and mixed hearing loss” as follows

Conductive Hearing Loss

A problem with the way sound is conducted to the inner ear and a structure called the cochlea causes conductive hearing loss. The ear canal, eardrum (tympanic membrane), or middle ear may be the source of the problem (ossicles and Eustachian tube). This type of hearing loss has no effect on the inner ear. The cause of conductive hearing loss is mechanical. That a physical condition or disease prevents sound from traveling from the outer or middle ear to the inner ear, where nerves are stimulated to carry sound to the brain. The cause of conductive hearing loss can frequently be determined and treated. People who have conductive hearing loss may complain that sounds are muffled or that they are very low or quiet. Hearing aids can then be used to compensate for any remaining or residual hearing loss. Hearing aids are typically effective for conductive hearing loss. Ear wax buildup, growth in the ear canal, otosclerosis, tympanosclerosis, outer or mid ear diseases (otitis externa or media), allergy with serous otitis media, ossicular chain trauma, such as a temporal bone fracture, mid ear tumors, ossicular chain erosion (cholesteatoma), and perforation of the tympanic membrane are all possible causes

The diagnosis is usually made by listening for a "air-bone gap" on audiometry. Depending on the source of the problem, conductive hearing loss can be temporary or permanent. Medical treatment for conductive hearing loss frequently results in partial or complete hearing improvement. It can help with some cases of conductive hearing loss, while amplification may be a better option in cases that have been present for a long time or are permanent.

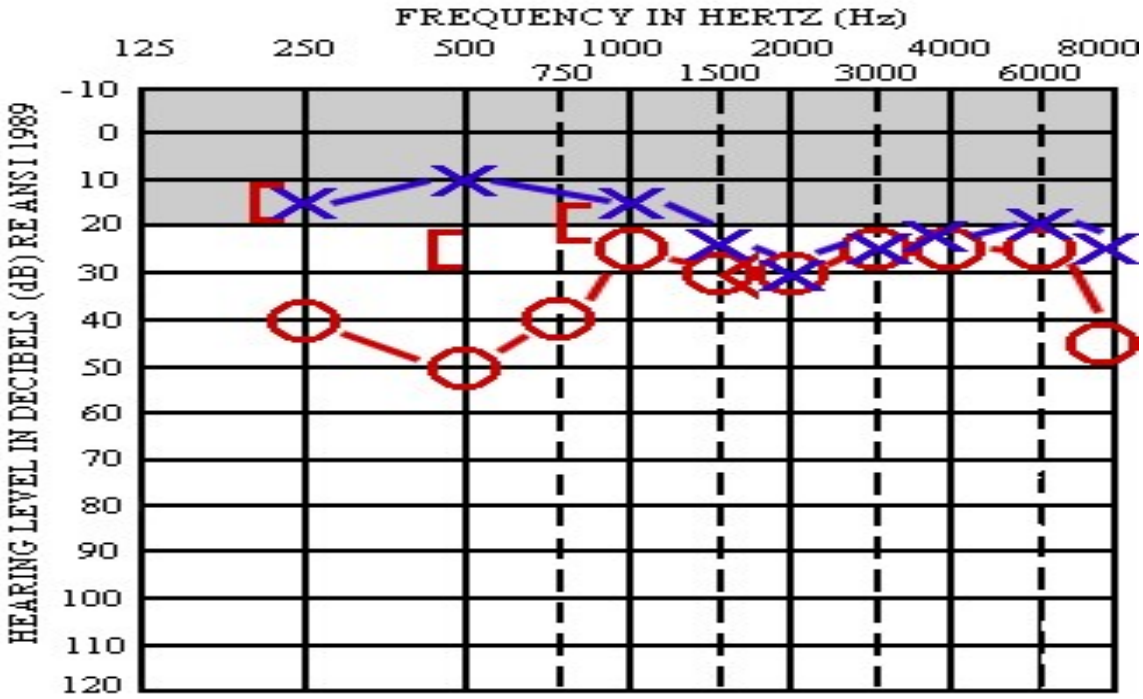

Figure 2: Tympanoscloris audiogram –

Source: North western University Evanston, Illinois.

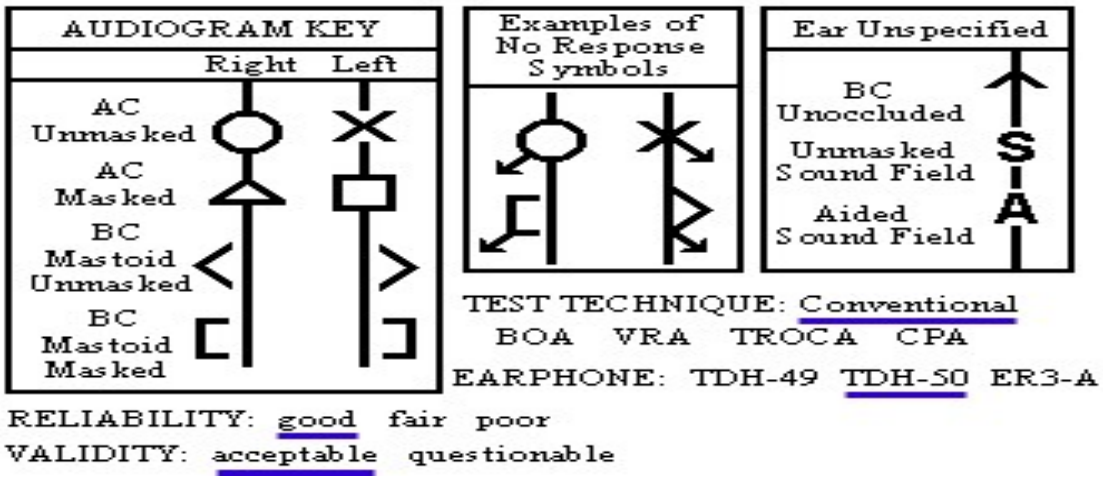

Figure 3: Tympanoscloris audiogram –

Source: North western University Evanston, Illinois

Children or learners with deafness or hard-of-hearing disabilities experience delays in language and speech development as a result of a decreased or absence of auditory response to sound. Students will have varying levels of hearing loss that can make it very hard for them to learn verbal words. It's important not to assume that a student with hearing loss is experiencing other developmental or intellectual delays. Many of these students are intelligent, on par with or better than average.

Sensorineural Hearing Loss

Sensorineural hearing loss affects the large number of people with hearing loss. This happens when there's a problem with the inner ear's sensory (hair cells) and/or neural structures (nerves) (cochlea). Sensorineural hearing loss is most commonly caused by damage to the tiny hair cells that vibrate and release chemical messengers that stimulate the auditory nerve when sound waves activate them. The auditory nerve is made up of numerous nerve fibers that carry sound-related signals to the brain. While damage to the tiny hair cells is the most common cause of sensorineural hearing loss, it can also be caused by damage to the auditory nerve. Muffled speech, ringing in the ears (tinnitus), difficulty hearing background noise, and others not speaking clearly are all symptoms of sensorineural hearing loss.

The intensity of sound is reduced when you have a sensorineural hearing loss. However, even when the sounds are loud enough, a sensorineural hearing loss can distort what is heard. That's why people with sensorineural hearing loss have a hard time understanding words, especially certain spoken consonant sounds, and in noisy environments. Exposure to loud noise, aging, medicines that damage the ear (ototoxic), illnesses such as meningitis, measles, and certain autoimmune disorders, genetics (hearing loss runs in families), head trauma, structural malformation of the inner ear, and others are some of the causes of sensorineural hearing loss. Sensorineural hearing loss is typically described as an irreversible, permanent condition that cannot be reversed with medical treatment. Sensorineural hearing loss is usually permanent and may improve or deteriorate over time. Hearing tests should be done on a regular basis to keep track of your hearing loss. The most common treatment is amplification, which may include hearing aids or cochlear implants in the most severe cases.

Mixed Hearing Loss

A sensorineural hearing loss combined with a conductive hearing loss is known as a mixed hearing loss. The ability of an individual's outer or middle ear to transmit

sound properly to the inner ear is harmed in mixed hearing loss. There is also an issue with the outer or middle ear, which makes the hearing loss worse, in addition to some irreversible hearing loss caused by an inner ear problem. However, the conductive hearing loss may be successfully treated, and the individual may benefit from hearing aids to help manage the remaining sensorineural hearing loss. Additionally, the cochlea, auditory nerve, or other inner ear structures that are responsible for interpreting sound and relaying it to the brain are malfunctioning. Mixed hearing loss can have a mild to severe impact, and the causes of mixed hearing loss are as varied as the separate causes of sensorineural and conductive hearing loss. It can happen as a result of a head injury, a long-term infection, or a hereditary disorder. One or both ears may be affected by hearing loss. It can happen all of a sudden or slowly worsen over time. Hearing aids are common treatment recommendation for mixed hearing loss, which can sometimes be treated with medical management.

2.2.1.1.4 The origin of Hearing Impairment

The origin or **c**auses of hearing impairments can be considered under three-tune periods; before birth also known as pre-natal, delivery or peri-natal; and after birth or post-natal. Mayoclinic. (2021) described the causes as follows:

Causes of hearing loss and deafness

Although these factors can be encountered at different periods across the life span, individuals are most susceptible to their effects during critical periods in life.

Prenatal Period

- Genetic factors - Include hereditary and non-hereditary hearing loss
- Intrauterine infections – such as rubella and cytomegalovirus infection

Perinatal period

- Birth asphyxia (a lack of oxygen at the time of birth
- Hyperbilirubinemia (severe jaundice in the neonatal period)
- Low-birth weight
- Other perinatal morbidities and their management

Childhood and adolescence

- Chronic ear infections (chronic suppurative otitis media)
- Collection of fluid in the ear (chronic **nonsuppurative** otitis media)
- Meningitis and other infections

Adulthood and older age

- Chronic diseases
- Smoking
- Otosclerosis
- Age-related sensorineural degeneration
- Sudden sensorineural hearing loss

Factors across the life span

- Cerumen impaction (impacted ear wax)
- Trauma to the ear or head
- Loud noise/loud sounds
- Ototoxic medicines
- Work related ototoxic chemicals
- Nutritional deficiencies
- Viral infections and other ear conditions
- Delayed onset or progressive genetic hearing

2.2.1.1.5 Impacts of hearing impairment on well-being of students

Fact-sheets (2021) stated that **w**hen hearing loss occurs at an early age , there is an impact on the development of spoken language, on reading ability and educational attainment, and, ultimately, on employability. These persons are usually considered deaf, and a good number may use American Sign Language or a similar sign system as their preferred mode of communication. When hearing loss occurs after the development of spoken language, and particularly when it occurs slowly, as it does in aging or as the result of prolonged noise exposure, there is a loss of functional hearing ability, but other cognitive skills and competencies are not greatly affected. The terms “hard-of-hearing” and “late deafened” are often used to describe these individuals.

Researchgate (2021) stated that World Federation for the Deaf data base, approximately 70 million people are considered deaf globally with 50% of these living in developing countries (World Federation of the Deaf, 2020). Based on the recent UN (2019) report on person with disability, physically challenged persons are said to encounter multiple barriers in terms of accessing education. People with disability were found to be less likely to attend school, complete school, drop out of school, possess basic skills and have fewer school year opportunities. The report further stated that discrimination and prejudice, absence of qualified teachers, lack of educational materials and disaggregated data research about disability continue to deny persons with disability the right to quality education globally (UN, 2019). WFD further observes that the deaf are among the poorest of the poor with limited access to education. Various problems inhibit learners with special needs education to attain their fullest potential by hindering their full participation. These include stigma by community or community attitude, inadequate specialist teachers and resource centres, shortage of specialised teaching and learning resources and assistive devices, ignorance or unawareness of most people that disability is not inability (Malawi Government, 2020)

2.2.1.1.6 Problems Associated with Hearing Impairment

Cochlear (2018) explained that can have a significant physical and emotional impact on a person's quality of life. Hearing impairment has been linked to stress, depression, loneliness, job achievent, and physical and mental health problems. Hearing impairment, like other disabilities such as blindness or physical deformity has some social and psychological effects on the victims. Socially, person with hearing impairment tends to isolate himself from the hearing individuals. Severally, persons with hearing impairment cluster around themselves forming what is known as the ‘hearing impaired community’. The hearing impaired therefore, tends to keep away from the hearing people because they are not easily understood. On the other hand, the hearing people may want to keep away from the hearing impaired because they lack the means of communication with persons with hearing impairment.

Touchette (2015) sees students with hearing impairment as those suffering from social, psychological and physical consequences. He discussed these problems further as follows:

Social consequences

Problems or a decrease in social activity or getting involved in social activities

Communication issues with your spouse, friends, or relatives

Workplace communication issues

Isolation and withdrawal

Inability to concentrate

Psychological consequences

Embarrassment, shame, guilt, and rage

Grief or depressive symptoms

Suspicion and apprehension

Low self-esteem/confidence and self-criticism

Physical consequences

Exhaustion and fatigue

Headache

Stress

Problems with eating and sleeping

Sexual issues

2.2.1.1.7 Remedy to problem of hearing loss.

Solutions to the problem of hearing impairment according to Shelly (2018) are:

1. **Quietude:** Value the sound of silence. Avoid loud environments, such as noisy restaurants, where decibel levels can reach levels higher than a lawn mower; phone apps like dB Volume and decibel help you tell when a place is too loud. If one is heading to a concert, such should try high – fidelity earplugs, like Ety plugs (etymotic.com); they dampen sound but preserve the clarity of speech and music.
2. **Better earphones:** Ill-fitting ones don't block ambient noise (crowds' traffic). Making you crank up the tunes. You should listen to music at no more than 60% of maximum volume for no more than 60 minutes. Nix unwanted sounds with Earskinz. Earbud covers that conform to the shape of your ear, or invest in ear – covering headphones from Shure or Klipach.

3. **Cupping:** The Eh? sign really works. Redirecting sound into your ear by pushing your flap (the auricle) forward can gain you a small boost of up to 10 decibels. Or depending on your anatomy, pressing your ears against your skull might open your ear canal to let in more sound.
4. **Drug avoidance:** Listen to side effects. Check medication side effects for "may cause hearing loss." May cause ringing or tinnitus. Or "ototoxicity. "especially if your hearing is already impaired. Potentially problematic drugs include some antibiotics and diuretics.
5. **Wax removal:** You unplugged. Ear wax is perfectly normal, but some people temporarily lose hearing due to a build-up. But, put down the Q-tips: step one is to have your doctor confirm wax is the problem.
6. **Medication:** For underlying problems. If hearing loss or a sense of fullness in your ear is paired with pain, dizziness, fluid draining from the ear, or fever; you might have a middle ear infection and need antibiotics. If hearing declines suddenly, you might require steroids to treat inner ear inflammation.
7. **Ear tubes:** Pipelines to better hearing. Hearing loss may be due to recurrent fluid accumulating in the middle ear (which can also breed infections). An ear, nose, and throat doctor can place a tiny, temporarily tube through the eardrum to drain fluid and equalize pressure so fluid isn't drawn into the middle ear. If the fluid isn't infected, consider waiting a few months before
8. **Hearing aid:** Wearable sound-boosting devices are more discreet and better fitting than ever.
9. **Cochlear implant:** Hearing stand-in. Implants may be worth considering if hearing aids aren't enough. They convert sound into digital information, which is sent to an electrode surgically implanted in the inner ear, which transmits the sound to the brain through the auditory nerve. Implants do not restore hearing to its "natural" state. However, they provide a useful approximation of sounds that can aid in speech comprehension.

2.2.1.2 Levels of Hearing Loss

The degree of hearing loss, according to ASHA (2015), refers to how much hearing a person has lost. The level of hearing loss is classified into five categories: Normal hearing loss, mild hearing loss, moderate hearing loss, severe hearing loss, and profound hearing loss are the different types of hearing loss.

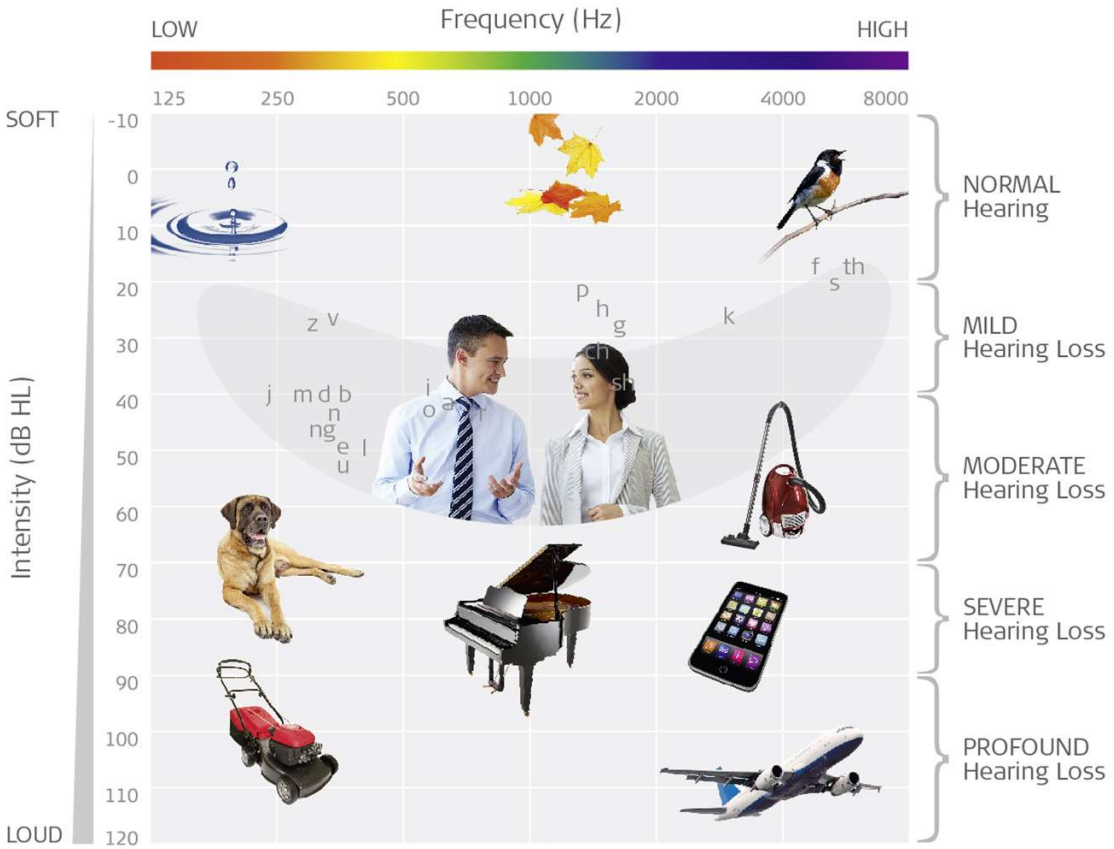

Figure 4: Degree of Hearing loss chart

Source:American Speech Language Hearing ASHA (2015)asha.org

Normal Hearing Loss

A person with normal hearing loss can hear sounds between 0 and 20 decibels (dB), meaning they can hear almost any sound, even the quietest ones, such as falling leaves or birds chirping, without any assistance.

Mild Hearing Loss

The next level of hearing loss is mild hearing loss. Many sounds softer than 20–40 dB are inaudible to someone with mild hearing loss. This implies they can hear an individual's inside voice, which is around 65dB, but not softer sounds like a ticking clock, dripping faucet, or many of the softer speech sounds. Understanding speech can be difficult for students with mild hearing loss. When listening to a single person speaks in a quiet environment, they can usually hear clearly. They, on the other hand, have a harder time hearing faint or distant speech. Hearing aids and other hearing support devices, which amplify these quiet sounds with a speaker to make them easier to hear, are usually beneficial to students with mild hearing loss.

Moderate Hearing Loss

If left untreated, a moderate degree of hearing loss can have a significant impact on a person's daily life. Sounds softer than 40–70 dB are inaudible to someone with moderate hearing loss. This implies they may be unable to hear sounds such as normal conversation or a phone ringing. For students with moderate hearing loss, listening is a challenge. While they can understand what someone says if they are close by, hearing someone else in a noisy environment can be difficult. Students with moderate hearing loss may miss 50–75 percent of what is said in a conversation, and they will frequently need to have parts of it repeated. Hearing aids and other hearing assistive technologies can usually help students with moderate hearing loss. More powerful hearing aids, middle ear implants, or bone conduction implants may be used to treat moderate hearing loss, depending on the person's health.

Severe Hearing Loss

An individual's daily life will often be affected by severe hearing loss. A person with severe hearing loss is unable to hear sounds that are less than 70–90 decibels. They may be unable to hear sounds such as a loud conversation or traffic noise as a result of this. A person with severe hearing loss may seek increasingly powerful hearing aids, but even the most powerful hearing aids aren't always enough.

If they don't work, they can try middle ear implants or cochlear implants, which they may not have heard of before.

Profound Hearing Loss

The most severe form of hearing loss is profound hearing loss. A person with profound hearing loss is unable to hear sounds that are less than 90–120 decibels. This implies they may be unable to hear extremely loud sounds such as airplane engines, passing trucks, or fire alarms. Speech will not be heard by students with profound hearing loss. They are usually aware of vibrations (movements) around them and can detect very loud sounds. Individuals with this level of hearing loss may rely on their vision (sight) to communicate with others rather than their hearing. People with severe and profound hearing loss may stand to gain from technologies that amplify sound (make sounds louder), but a cochlear implant or signing as a mode of communication may be more beneficial.

Table 2.1: Degree of hearing loss

Degree of Hearing Loss	Threshold Hearing Level (dB HL)	Effect on Communication	Use of Hearing Aids
Normal	−10–15	no hearing impairment	
Slight	16–25	speech understanding not affected	
Mild	26–40	speech understanding reduced, especially in noisy environments	may be helpful
Moderate	41–55	conversation noticeably difficult	highly beneficial; strongly recommended
Moderately severe	56–70	speakers must raise their voice to be heard	Essential
Severe	71–90	conversational speech cannot be heard	of less benefit
Profound	91 or higher	Deaf	of little benefit; cochlear implants may be considered

Source: www.noisehelp.com/degree-of-hearing-

Hearing tests determine how much sound we are capable of hearing. Having a trained audiologist or medical professional check one's hearing is the best way to find out. An audiogram will be used to display the results of this hearing test. In this example audiogram, the person has a mild hearing loss in the low frequencies that progress to a profound hearing loss in the high frequencies. Dogs barking are usually audible to someone with this hearing loss, but a doorbell ringing is not.

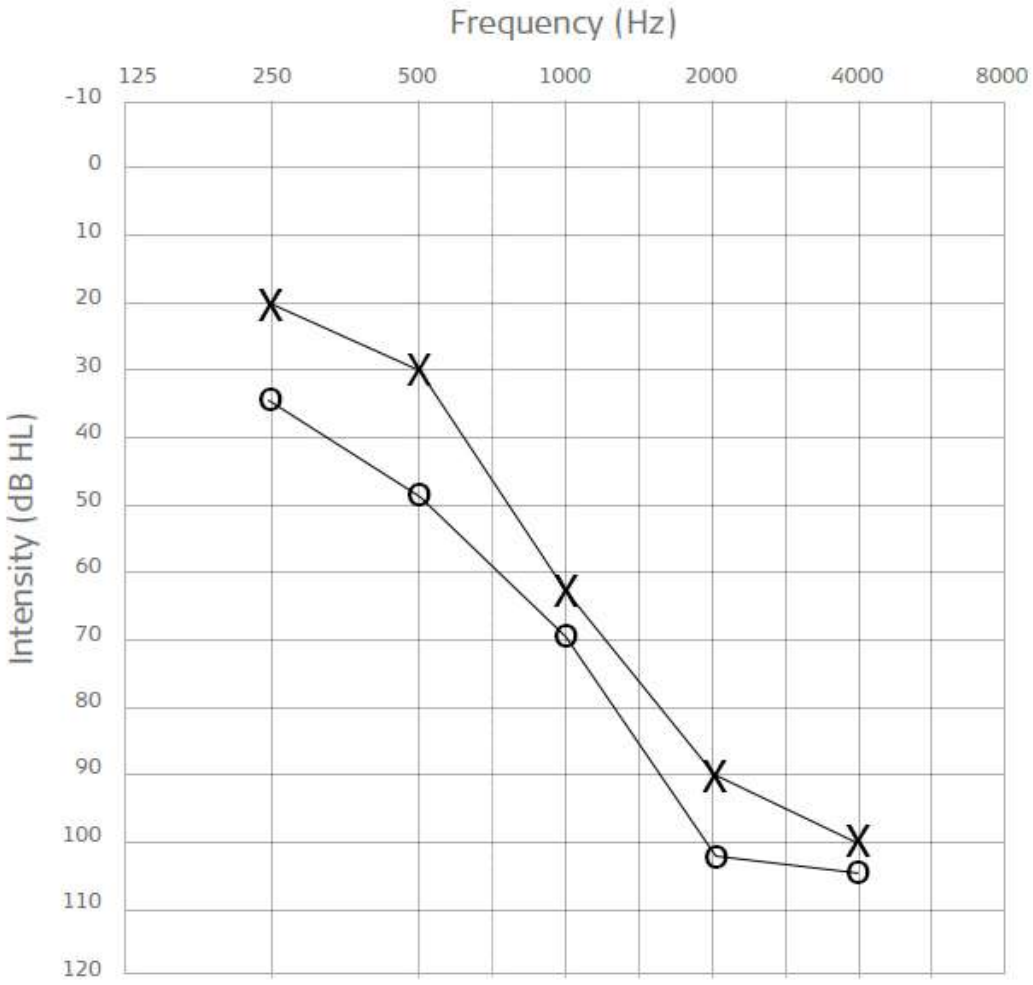

Figure 5: Frequency Chart

https://blog.medel.com/degree-of-hearing-loss/

2.2.1.3 Self-Efficacy

Self-efficacy can influence not only how you feel about yourself, but also whether or not you achieve your life goals. Albert Bandura's social cognitive theory emphasizes the role of observational learning, social experience, and reciprocal determinism in the development of a personality, and the concept of self-efficacy is central to that theory. According to Bandura, self-efficacy is a component of the self-system, which includes a person's attitudes, abilities, and cognitive skills. This system has a big influence on how we perceive things and how we react in different situations. This self-system is incomplete without self-efficacy.

Overview of Self-Efficacy

According to Albert Bandura, self-efficacy is "the belief in one's capabilities to organize and execute the courses of action required to manage prospective situations,". A person's self-efficacy is their belief in their own ability to succeed in a given situation. These beliefs, according to Bandura, are determinants of how people think, behave, and feel. Since Bandura's seminal 1977 paper, "Self-Efficacy: Toward a Unifying Theory of Behavioural Change," the topic has become one of psychology's most researched topics. Self-efficacy, as demonstrated by Bandura and other researchers, has an impact on everything from psychological states to behaviour to motivation. How we think, act, and feel about our place in the world is influenced by our belief in our own ability to succeed (Bandura 1977). Self-efficacy also influences what goals we set for ourselves, how we go about achieving them, and how we evaluate our own performance.

Self-Efficacy and Its Importance

Almost everyone can think of goals they'd like to achieve, changes they'd like to make, and things they'd like to change. Most people are aware, however, that putting these plans into action is not so simple. Bandura and others discovered that a person's self-efficacy influences how they approach goals, tasks, and challenges (Bandura 1997).

Individuals who have a high sense of self-efficacy include:

- Increase their enthusiasm for the activities in which they participate.
- Develop a stronger sense of commitment to their hobbies and interests
- Quickly bounce back from setbacks and disappointments

- Approach difficult problems as tasks to be completed.

Individuals who have a low sense of self-efficacy include:

- Stay away from difficult tasks.
- Believe that difficult tasks and situations are out of their reach.
- Pay attention to personal flaws and negative outcomes.
- Quickly lose faith in one's own abilities

What Causes Self-Efficacy to Grow?

Early on in life, we develop our sense of self-efficacy by dealing with a wide range of experiences, tasks, and situations. Self-efficacy development, on the other hand, does not stop in adolescence and continues throughout life as people gain new skills, experiences, and understanding.

There are four major sources of self-efficacy, according to Bandura (1997):

Experiments in Mastery

"Mastery experiences are the most effective way of developing a strong sense of efficacy," Bandura explained. Our sense of self-efficacy grows when we complete a task successfully. Failure to deal adequately with a task or challenge, on the other hand, can undermine and weaken self-efficacy.

Social Modelling

Another important source of self-efficacy is seeing other people complete a task successfully. "Seeing people similar to oneself succeed through sustained effort raises observers' beliefs that they, too, possess the capabilities to master comparable activities to succeed," according to Bandura (1997).

Social Persuasion

People can be persuaded to believe that they have the skills and capacities to succeed, according to Bandura. Consider a time when someone said something encouraging and positive to you that aided you in achieving a goal. Receiving verbal encouragement from others assists people in overcoming self-doubt and focusing instead on completing the task at hand.

Psychological Reactions

Self-efficacy is influenced by our own responses and emotional reactions to situations. Moods, emotional states, physical reactions, and stress levels can all have an impact on how a person perceives their own abilities in a given situation. In these situations, a person who becomes extremely nervous before speaking in public may develop a low sense of self-efficacy. "It is not the sheer intensity of emotional and physical reactions that is important," Bandura (1997) adds, "but how they are perceived and interpreted." People's sense of self-efficacy can be improved by learning how to reduce stress and elevate mood when faced with difficult or challenging tasks.

Examples of People Who Have a High Level of Self-Efficacy

The following are some examples of high self-efficacy:

- A man who is struggling to manage his chronic illness but is confident that by working hard and following his doctor's recommendations, he can get back on track and improve his health.
- A student who is confident in her ability to learn the material and perform well on a test.
- A woman who has just accepted a job offer in a role she has never held before but believes she is capable of learning and performing well in it.

In health psychology and how people manage their health, nutrition, and illness, self-efficacy can be very important. People who are trying to quit smoking, for example, can benefit from having a high sense of self-efficacy. Maintaining a weight-loss plan, managing chronic pain, abstaining from alcohol, sticking to an exercise routine, and adhering to an eating plan can all be influenced by a person's self-efficacy levels.

According to Bandura (1997), self-efficacy can improve a person's sense of well-being in a variety of ways. They, for example, remain upbeat and confident in their abilities even when things get tough. Because people with high self-efficacy see challenges as opportunities rather than threats, they are more intrinsically motivated to complete tasks. Difficulty and failure do not mean defeat for these people; instead, they redouble their efforts and seek new ways to succeed.

Low Self-Efficacy Problems

People with low self-efficacy perceive difficult tasks as threats to be avoided. As a result, they avoid setting goals and have low levels of commitment to those that they do set. When they experience setbacks, they often give up quickly. They are more likely to experience feelings of failure and depression because they lack confidence in their ability to achieve. Stressful situations can be difficult to handle, and people with low self-efficacy are less resilient and less likely to recover. Bandura et al., 1997

Self-Efficacy Strength Assessment

The General Self-Efficacy Scale (GSE) and the Self-Efficacy Questionnaire are two scales that are used to assess levels of self-efficacy.

Consider the following questions for a quick, informal assessment of your own self-efficacy levels:

Self-Efficacy Development

Self-efficacy, fortunately, is a psychological trait that you can develop and strengthen. Begin by considering how you can apply Bandura's sources of self-efficacy to your own life.

Celebrate your accomplishments

In the development of self-efficacy, mastery experiences are crucial. This was identified by Bandura (1997) as the single most effective way to develop a strong sense of self-belief.

When you succeed at something, you can develop a strong belief in your own abilities. Failure, on the other hand, can sabotage these feelings, especially if you're still developing your sense of personal efficacy.

The ideal kinds of successes, on the other hand, aren't always easy to come by. If you have a lot of easy success, you may be more willing to give up when you finally do encounter failure. As a result, work on setting goals that are attainable but not easy. It will take time and effort to achieve them, but once you do, you will have a greater belief in your own abilities.

Look at what others are doing.

Vicarious experiences gained through peer modelling were also identified by

Bandura as an important means of establishing and strengthening self-efficacy. Seeing others put forth effort and succeed can boost your confidence in your own ability to succeed.

The similarity of the model to yourself is one factor that influences the effectiveness of this approach. Your observations are more likely to increase your sense of self-efficacy if you feel you are more alike.

Seek out affirmations that are positive

Receiving positive feedback from others can also help you feel more self-assured. Similarly, try to avoid soliciting feedback from people you know are more likely to have a negative or critical opinion of your work.

For example, hearing from your doctor that you're sticking to your diet plan well can be motivating. Friends, mentors, health practitioners, and other people you respect can all help you feel more confident in your own abilities.

Positive social feedback can help you strengthen your sense of efficacy, but negative comments can have the opposite effect. Bandura (1997) suggested that while social feedback alone isn't enough to boost self-esteem, it can be a helpful tool when you need a boost.

Pay Attention to Your Feelings and Thoughts

If you find yourself becoming stressed or nervous before a difficult event, you may doubt your ability to complete the task at hand. Another way to improve your self-efficacy is to find ways to control your thoughts and emotions about the task at hand.

2.2.1.4 Learning Styles

In a 1992 study by Neil D. Fleming and Coleen E. Mills, the acronym "VARK" was used to describe four modalities of student learning. After thousands of hours of classroom observation, these different learning styles—visual, auditory, reading/writing, and kinesthetic—were identified. The authors also created a questionnaire that educators can use to help students identify and understand their own learning preferences.

Visual Learners

Visual learners are students who best internalize and synthesize information

when it is presented to them in the form of a graphic depiction of meaningful symbols. They may react to arrows, charts, diagrams, and other information hierarchy visualizations, but not always to photographs or videos. (2019, Vark-learn) Because visual learners are holistic learners who process information best when presented as a whole rather than piecemeal, when they are presented with summarizing charts and diagrams rather than sequential slides of information, they are more likely to see positive educational outcomes (Child 1st.com)

Auditory Learners

When auditory (or aural) learners are given the opportunity to hear information presented to them vocally, they are most successful. Because students with this learning style may choose not to take notes during class in order to maintain their uninterrupted auditory attention, educators may mistakenly believe they are less engaged than their peers. These students may simply have decided that taking notes is a waste of time and that paying attention is a more valuable way to learn (medium.com 2019)

Auditory learning is a two-way street: students who learn best in groups, where they are asked to discuss course materials verbally with their peers, and they may benefit from reading their written work aloud to themselves to help them think it through (Vark-learn.com)

Students who are learning to read and write

Students who work best in the reading/writing modality have a strong preference for the written word as a learning tool. This includes both written information presented in class as handouts and PowerPoint slide presentations, as well as the opportunity to synthesize course content through written assignments (teach hub.com 2019). Because many information-rich sources on the internet are text-heavy, this method lends itself to conducting research online (Vark learn.com 2019)

Students who enjoy reading and writing should be encouraged to take copious notes during class lectures to help them process information and recall it later.

Kinesthetic Learners

Kinesthetic learners are hands-on, participatory learners who need to be physically active in order to achieve their best educational outcomes. Kinesthetic

learners are sometimes referred to as "tactile learners," but this is a misnomer; rather than relying solely on touch, they tend to use all of their senses equally in the learning process (Vark learn.com 2019).

Kinesthetic learners have the most difficulty succeeding in traditional classroom settings due to their active nature. Some teachers have had success encouraging kinesthetic learners to use flashcards to turn rote memorization into an interactive experience in subjects like math and English. These students often excel in scientific subjects that include lab components, as the skills-based, instructional training they receive in these settings keeps them engaged and productive.

2.2.2 Concept of Biology

Biology, generally is defined as the study of life, it is one of the major subjects offered at both, the secondary school stage and at higher institutions in Nigeria. Biology as a subject is of paramount importance to any nation. It is a vital subject in the Nigerian school system. According to National Policy on Education (2013), the curriculum at the senior secondary school compromise compulsory subjects which are English Language and Mathematics, One major Nigeria language, one vocational subject and a selection of three subjects from the subject area of interest in the Art and Social Sciences, Sciences, Vocational studies or Technical education. This indirectly makes Biology a necessary subject for students from the subject area. A sound theoretical and practical knowledge of Biology is very necessary for the management of our national resources, provision of good health facilities for the masses, adequate food supply and favourable life environment.

Biology as a subject is very essential on our everyday life and day to day activities. The knowledge of Biology has helped to establish a common understanding between man and his environment or the ecosystem. The teaching of Biology has hugely offered perspectives and solution that positively impact societies as well as contributed in national development across societies all over the world. According to Araoye (2009), biology education exposes students to a wide range of topics that are relevant to all aspects of life. Biology, as a branch of science and a prerequisite for many fields of study, contributes significantly to the nation's technological advancement as well as the development of manpower in medicine, forestry, nursing, pharmacy, nanotechnology and several other areas (Abimbola, 2011). Biology contains many unifying concepts that are explainable for equipping students with a

functional knowledge of life and the development of scientific literacy (Akinkumi and Oluwafoose, 2011). Biology is unquestionably important in understanding and responding to some of today's most pressing issues, such as the numerous challenges posed by population growth, genetics, and services to climate change and sustainability. The unique position of Biology in the school curriculum cannot be overemphasized as it is central to so many science – related courses.

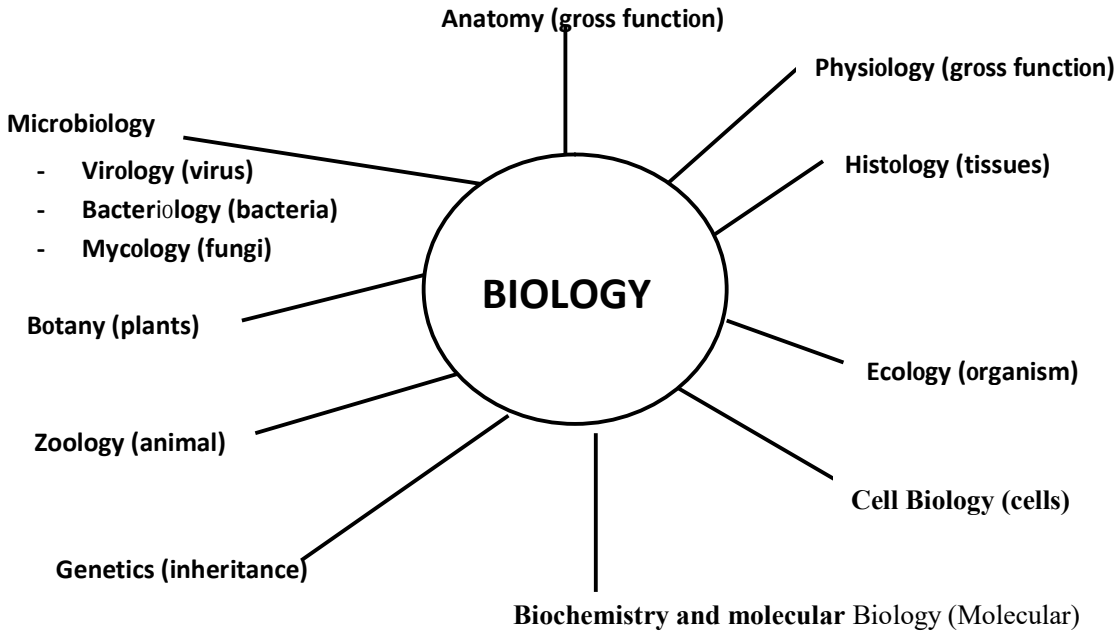

Figure 6: Branches of Biology

Source: **Pallai (2012) http://www.zimbio.com**

2.2.2.1 The place of science (Biology) in school curriculum

Biology is a natural science which is all about the environment, human life, plant cell, animals, its functions, evolutions and all other living organisms around us. The main view of studying biology is to know about ourselves, body parts, nature around us, etc. It is the most interesting subject which is all about life, its composition, development and about nature, environment, experiments, inventions and lot more.

Biology is a study of life and living organisms. To learn more about the living organisms and other importance of biology, we all should have a minimum knowledge about this subject. This subject has a great contribution to the existence of life on earth and hence it is taught in every school. There are many facts to prove the importance of biology, listed below are a few of them.

Biology explains in detail about the parts of the Human Body

With the knowledge of biology, we are able to know about the different metabolic activities occurring in our body. Along with these, the basic knowledge of the human anatomy, morphology, and physiology can be acquired by studying biology. With the introduction of this subject in the school syllabus, it has given rise to several scientists, doctors, and technicians who are involved in research and other investigations like examining the patient's blood groups, mode of infections, and different medicines and cure for dreadful diseases.

Understanding Our Environment

We, humans, are not the only living beings, apart from us, there are millions of other living creatures from microorganism to huge mammals. Biology explains, how to differentiate the organisms based on their body structures, features, and other habitats. Along with this, this subject enables us to know more about the biotic and abiotic factors, their uses, how they interact and balance our environment.

Having proper Nutrition

Biology has provided us the complete knowledge about the different types of nutrition available, their sources and their benefits to our body. Nutrition is all about the carbohydrates, vitamins, fats, and proteins. Today we all are aware of how much quantity of fat is required for a healthy lifestyle and which food source has more proteins and vitamins.

Several diseases and the role of medicines

There are a number of diseases caused by microbes and other agents both in humans and in animals, such as malaria, dengue, rabies, plague, etc. and has killed many lives. Among which, AIDS, a deadly syndrome alone has taken more than 20 million lives. The study of biology has helped in discovering the main causes of the diseases, their transmission, treatments, along with different methods of preventions and eradication of diseases.

Biology is not only about the study of life and **human body anatomy**, it is a vast subject which includes a complete study of plants, animals, microorganisms, diseases, about the environment, etc. Apart from all these points, there is a lot more information to learn about biology. It has many branches including, Anatomy, botany, biotechnology, evolution, genetics, immunology, microbiology, zoology, etc.

Objectives of teaching biology at secondary school

According to Chaudhari (2013) the objectives of teaching biology includes:

1. Conceptualizing scientific facts and principles, as well as their applications, in accordance with one's cognitive stage.
2. Developing abilities and awareness of the tools and approaches that lead to the creation and validation of scientific knowledge
3. Understanding and appreciating issues at the intersection of science, technology, and society, both locally and globally.
4. Obtaining the theoretical information and pragmatic technological competencies necessary to enter the workforce
5. In science and technology, developing nature and natural curiosity, aesthetic sense, and creativity

6. Instilling the values of honesty, integrity, cooperation, concern for life, and environmental preservation, as well as cultivating a "scientific temper" characterized by objectivity, critical thinking, and a lack of fear and prejudice.

2.2.2.2 Biology Education and Students with Hearing Impairment

Science is vital to an individual's growth and development as well as the growth and development of a nation. Science has an impact on man in all aspects of life today, including feeding, clothing, shelter, health care, communication, transportation, space, and leisure. Medical and technological applications, as well as their effects on health care, lifestyles, and social structures, are the most visible effects of science, according to Elechi (2010).

According to Jean (2017) students with hearing impairment need to learn about a plethora of other concepts such as the life cycles of plants and animals, the water cycle and weather, about the moon and the tides, scientific method, about the solar system, gravity and so on. Students with hearing impairment are not privy to incidental learning because their family members do not sign. That means they need teachers and interpreters skilled in American Sign Language around them who can communicate about science facts and processes. They need to acquire background knowledge about science so teachers often must prepare extra teaching materials to prepare them before the actual assignment.

He further stated that students with hearing impairment also need to learn about science writing during activities such as journal writing and writing-up of experiments. The teachers may also benefit from learning about DeafSpace so that their classrooms and laboratories are set up so students can view the signing as well as the experiments and other demonstrations. DeafSpace refers to removing architectural and physical barriers and provide adequate lighting in the classroom so that Students with hearing impairment children can see the signing around them from teachers and their peers. And still another challenge is learning science terminology.

Andrews & Rusher (2010) opined that American sign language (ASL) and fingerspelling are widely used in the science classroom because of its visual nature and use of iconicity. Classifiers can be used to label instruments, beakers, test tubes and other items. Some hearing teachers do not use fingerspelling much in the classroom because they think that if students with hearing impairment do not read or spell words much then they will not understand fingerspelling. However, research

shows that the spelling of words is only one use of fingerspelling, its capacity to teach language is much greater. Fingerspelling also plays an important role in the science classroom because there are many science words with no signs. So we must describe the meaning of the word in several signs, then provide the written word and fingerspell the word. This is often called an ASL expansion or it can be called chaining or sandwiching. Facial expressions, mouth movements, repetition, questions, sequencing are all parts of ASL that can be used to teach science concepts and meanings as well. Ademokoya, (2008) posits that the main objective of deaf education was to achieve 'normalization,' which can be accomplished through the training of student with hearing impairment to speak like the hearing students.

2.2.3 Concept of Instructional supports

2.2.3.1 Human supports:

Alberta (2018) described classroom as a community of learners, each of whom who come with unique learning preferences, interests, strengths, needs and potential. Teachers use effective instructional practices and strategies to support student engagement, performance and success. Owen (2018) defined instructional Supports as a positive, success-oriented program which uses specific assessment and intervention techniques to help remove educational or behavioural stumbling blocks for all students in the regular classroom. These are the aids that students with hearing impairment needs to help them maximize their success in the classroom which include: Human support (These are specialist support workers who help students with hearing impairment to access what the tutor and other students are saying) they are - Sign language, Note takers, Interpreters, lip - speaker and communication support workers, and Technical supports (these are hearing technology used by those students with hearing impairment that have residual hearing to manage problems of distance, background noise and acoustic conditions) they are-Radio Microphone System, Induction Loops and Digital Recorder . According to National Deaf Children Society (NNDCS 2013), many deaf students need additional support to access what the tutor and other students in the class are saying. These specialist support worker include: sign language interpreters, note takers, communication support workers, the needs of each learner will determine the nature of the support that is required. Sometimes more than one type of support may be necessary. NDCS (2018) explains these additional supports further:

Sign Language Interpreter

Sign language interpreters are professional who play a significant role in facilitating communication between students with hearing loss and their teachers as well as other stakeholders particularly in an educational environment. Sign language interpreters have special knowledge, skills , and credentials that qualify them for these services (Alquaryouti, 2010).This is an individual who provides services to hearing impaired learners so that the speech of the hearing is transmitted to the student with hearing impairment by using conventional signs, finger spellings, oral cues and body language to enable such individuals understand what is being discussed simultaneously and relay information or question asked by the student with hearing impairment in the classroom. Depending on the student's preference, a sign language interpreter will translate what is said into British Sign Language (BSL) and/or Sign Supported English (SSE). They can also convert signed documents into written documents and vice versa. If a deaf student's speech is difficult to understand, they may voice over what they are saying. An interpreter would not normally assist a deaf student in completing tasks, explaining things to them, or advocating for them. Their role differs significantly from that of a communication support worker in this regard. The Association of Sign Language Interpreters and the Scottish Association of Sign Language Interpreters both register professional interpreters.

Techniques of operation of interpreter

Techniques of operation of interpreter according to Gbegbin (2017) are described as follow.

1. **Sign Language Interpreter:** The first thing that comes to mind is sign language and speech as a supplementary.
2. **Deaf-Blind interpreting:** The interpreter signs into deaf –blind person's hand
3. **Verbatim interpreting:** This is the method of interpreting words of speaker in details. 'signing to the hearing persons, word for word' (without missing any word out). In such a situation, the interpreter uses total communication. It has advantage of giving full information to the receiver. However, the interpreter may be stressed unless the speaker speaks slowly. If the hearing impaired is not proficient in receptive sign language, he would miss out many words and concepts during such lecture.
4. **Summarized (contrived) interpretation:** This is the technique where the

interpreter sieves the speech and interprets the cogent points in sign language for hearing impaired viewers.

Roles and Responsibility of Sign Language Interpreter

Isarinde, Kolawole and Ogungbade (2017) highlighted roles of Sign Language Interpreter thus:

1. Communication Facilitation
2. Student Assessment
3. Planning
4. Materials and Assistive Technology
5. Counselling role

Communication Facilitation

Educational interpreters enable deaf or hard-of-hearing students to communicate by facilitating an accurate representation of instruction, dialogue, and/or sound information in the mode of communication used by the hearing impaired learners. There are various types of interpreting depending on the child's communication mode, or language, and method, such as American Sign Language, Simcom, Signed Exact English, Oral, Cued Speech, and so on. The interpreter's job is to make sure that the students can get all of the information they need. Both "receptive" (incoming) and "expressive" (what the student has to say or sign) communication can be conveyed by interpreters. According to Castilo (2012) in guiding educational interpreting for students who are deaf, the following communication facilitating roles are highlighted and expected from interpreters:

1. Assists students, teachers, peers, and others with sign-to-voice, voice-to-sign, sign-to-print, and print-to-sign interpretation.
2. Encourages students, teachers, peers, and others to communicate directly with one another.
3. Interprets school activities such as assemblies, lectures, films, and discussions, among others.
4. Interprets in a way that is understandable to the students.
5. Establishes procedures for using an educational interpreter in specific settings with their educational team.
6. Thinks about and consults with teachers and students about environmental

factors (such as lighting for students and interpreters, visuals, and so on).

7. Meets with mainstream teachers to discuss the need for communication.

Student Assessment Role

It is part of the educational interpreters' role to be involved in the students' assessment. The interpreters are not the assessors but their role in the process is very important. Their roles include:

1. Interpret oral and written evaluation/test materials (directions and questions) as appropriate and allowed.
2. Interpret students' responses to the lecturer/teacher.
3. Consult with the mainstream teachers and the teachers of the deaf/hard of hearing regarding the accommodations and/or modifications of materials for them during assessments.

Planning Roles and Responsibilities

For effective teaching and learning, the educational Sign Language Interpreters also need to be involved in planning process. Parts of their responsibilities are:

1. Consult with the supervisor to establish educational interpreter preparation time and breaks during work hours.
2. Ask the classroom teacher in advance, for the week lesson plans, including audio and visual materials in order to prepare for the interpreting.
3. Obtain class texts, handouts or other instructional materials, films and videos as needed.
4. Meet with the teachers of hearing impaired students on regular basis to discuss as appropriate progress in monitoring session, discuss issues regarding interpreting services.

Materials and Assistive Technology

Educational Sign Language Interpreters also have roles to play in the area of materials and the use of assistive technology for effective teaching and learning of the hearing impaired students. Their responsibilities include:

1. Collaboration with the educational team who may assist in the identification of students' needs for supplemental materials or technology;
2. Interpret written materials (print-to-sign, sign-to-print) as determined by the

team or teacher.

3. Support the implementation of assistive technology where necessary.

Counselling Roles

Educational Sign Language Interpreters should be able to counsel the hearing impaired students particularly on his/her educational goals and aspiration using his past experiences to educate them where necessary. Parts of the roles of educational interpreter are to relate with the parents of the impaired and give the parents necessary information about their children and to communicate to the children through interpretation.

Note taker

A note taker is a person who takes accurate note while watching an interpreting or speech reading the instructor at the same time (DeafTEC, 2018). Students with hearing impairment rely on their vision, which makes it hard or almost impossible to look at their teacher or interpreter while taking adequate notes. In lectures and tutorials, a note taker records what is said. They take notes on everything that happens in the lecture/tutorial, which the deaf student reads as the note taker writes – the notes can be read later as well. Taking notes can be done manually or electronically. Manual note taking may be preferable in subjects with a lot of diagrams, formulae, or flow charts, as well as during out-of-town visits. The language may be changed to accommodate the student's reading abilities. The note taker should record as many student discussions, asides, and jokes as possible. A student's laptop is connected to an electronic note taker, who types notes into it. Students can add their own notes using special software such as Speed text, Stereotype, and Typewell. Because electronic note takers use a standard ‘qwerty' keyboard, they can't type as quickly as spoken language.

Process of good notetaking

A good listener is required of a good notetaker. Listening, on the other hand, necessitates active concentration. It is well-intentioned and self-monitoring. Many students who become notetakers are already good listeners, but you can always improve your listening skills with practice. Hastings, Breclein, Cermak, Reynolds, Rosen, Wilson (2018) listed process of good note taking thus**:**

Take an interest in it. A good listener tries to find something interesting and useful in what he or she hears, and does not pass judgment on a presentation until the entire presentation has been heard.

Ignore the speaker's delivery flaws. A skilled listener focuses on the message by listening for the content and looking for body language clues that will help identify main ideas, even if the speaker's mannerisms, clothes, voice, or delivery are distracting or annoying.

Keep an ear out for concepts. Isolated facts are meaningless and difficult to remember; skilled listeners connect them to central themes and principles, and draw parallels with their own lives. An instructor's lecture outline can be very useful in assisting a notetaker in this task.

Be attentive. To select important information and retain it while writing it down while simultaneously monitoring the ongoing presentation, a high level of concentration is required.

Put off distractions. Allowing distracting conversations and behaviour from classmates detracts from attention, and the notetaker should politely request that these distractors be quiet if necessary.

Consider difficult material as a test. In order to understand complicated or technical information in class, you'll need to focus.

Pay attention for indications of importance. Explicit or implicit cues can be used. Explicit cues are those that are stated explicitly, such as "Remember this." Voice inflection, loudness, and repetition are all implicit cues that information is important. The information on the chalkboard is frequently important and should be copied into the notes.

Notetaking for students who are deaf or hard of hearing

The following guidelines are intended for anyone taking notes for deaf or hard-of-hearing students.

Notes' appearance: Notes' appearance can either attract or repel the reader. The main points should be clearly stated. Margins should be wide, and indentations should be used liberally to separate information. Pages should not be completely covered with notes; there should be enough white space on each page for the notetaker or user of the notes to add information later. Standard formatting cues like capitalization, underlining, and asterisks should be used consistently to help clarify the information

being presented. Important information, rules, and warnings should all be highlighted. Whenever possible, use lists, diagrams, and illustrations.

Language: Students with severe hearing loss frequently have difficulty communicating in English. Simple sentence constructions, such as writing verbs in the simple present or past tense and in the active voice, should be used in notes to aid reading comprehension. Vocabulary that is difficult or technical should be defined in simple terms. Examples should be given when necessary to better explain concepts and relationships.

Organization: Information should be organized and presented in a logical and orderly manner. The reader should be able to follow the sequence of facts and information. To aid the notetaker in this task, he or she can request an outline of the lecture notes or clarification of the concepts being taught from the instructor. If a note taker forgets something during a class, he or she should leave a space in the notes for the instructor to clarify later. Noes should be as detailed and accurate as possible. The notetaker may need to rework the notes after the class in order to produce high-quality notes.

Assignments and tests: It is especially important for the notetaker to keep meticulous records of the assignments given to the class, including their due dates and other pertinent information. Complete information about upcoming tests given to the class by the instructor should also be recorded clearly.

Student feedback: The notetaker should solicit feedback from the student(s) for whom he or she is taking notes and tailor the notes to the student's language and instructional requirements. Students should be encouraged to share any concerns or suggestions they have about their notetaking needs in the course with the notetaker.

Note-taking ethics

1. All assignment-related information must be kept strictly confidential by notetakers. When discussing a class or its students, notetakers must exercise discretion. In some cases, seemingly insignificant information that is accidentally disclosed can be harmful. If any of the parties involved have a disagreement, the notetaker will refer them to the notetaker's immediate supervisor.
2. Notetakers are expected to transcribe lectures as accurately as possible. In order to record all of the major points of the lecture, notetakers must learn to store information as they listen. At all times, proper English is required. To

provide a complete picture of classroom activities, the notes should include diagrams, examples, student questions and answers, and student comments. It is preferable to provide information that students do not require than to risk them missing something important. Notetakers should write whenever they are unsure. Most instructors give hints about what will appear on tests, either directly or indirectly. Anything that is stressed in class should be stressed in the notes as well. It's a good idea to keep track of the teacher's comments on the important items.

3. Notetakers are not permitted to give advice, express personal opinions, or counsel the student. Notetakers are not allowed to add personal opinions to recorded notes, just as they are not allowed to omit important information.
4. Takers of notes should keep in mind that they are not responsible for what is said and should not allow their emotions to interfere with or add to the lecture. Paid notetakers are not allowed to speak in class except to ask clarification or spelling questions.
5. Although notetakers and students frequently become friends, this personal relationship must not interfere with the notetaker's paid service.

A lip speaker

Association of lipspeakers (2021) A Lipspeaker is a hearing person trained to repeat a speaker's message to lipreaders accurately, without using their voice. They produce clearly the shape of words, the flow, rhythm and phrasing of natural speech and repeat the stress as used by the speaker. The lipspeaker also uses facial expression, natural gesture and fingerspelling (if requested) to aid the lipreader's understanding. A lipspeaker may be asked to use their voice thus enabling the lipreader to benefit from any residual hearing. A Lip speaker provides communication support to people with hearing loss who communicate through lipreading and speech. They silently repeat what a speaker says, producing the shape of the words clearly and, where necessary, using facial expressions to show meaning. They will sit in front of the deaf student, making the best lip movements to aid lip reading, imitating the speaker's rhythm and phrasing, and incorporating facial expressions and natural gestures to clearly convey the message.

A lip speaker may use additional forms of communication support, such as finger spelling, depending on the needs of the deaf student. A lip speaker works with deaf students who are fluent in English and have become hard of hearing or deafened as a result of learning spoken language. And if somebody has difficulty understanding a person with hearing loss, the Lip speaker might be able to relay what that person is saying. Lip speakers can be needed in a variety of situations, such as, workshops or conferences, work meetings, parent/teacher meetings.

Role of the Lip speaker

A lip speaker uses unvoiced speech to accurately convey a speaker's message to lipreaders. This necessitates the Lip speaker's ability to clearly produce word shapes. The Lip speaker also mimics the speaker's rhythm and phrasing, as well as supporting the message with natural gestures and facial expressions. Fingerspelling will be used if the lipreader requests it.

Position of the Lip speaker

1. There should be plenty of light on the Lip speaker. Lip speakers should not be positioned at the front of a window or in front of a light source because this darkens the face.
2. The background should be visually clear and calm behind the Lip speaker. A busy pattern on the wall can be distracting or taxing on the eyes.
3. Depending on the type of assignment, the ideal position for the Lip speaker will change. – In a job interview, it's best if the interviewer and applicant face each other, with the Lip speaker next to the hearing person. In a round table meeting, the Lip speaker should be opposite any deaf participants. – At a conference, the Lip speaker should be placed as close to the presenter as possible, as well as any visual aids, so that deaf people in the audience can see both quickly and easily.
4. Give deaf people time to look at visual material (e.g. slides, handouts). They are unable to simultaneously watch the Lip speaker and read materials.
5. Speakers should use a clear voice and speak at a moderate speed.
6. Meetings should be structured so that only one person is allowed to speak at a time.
7. During the day, the Lip speaker should take frequent breaks. If this isn't

possible, two Lip speakers should be scheduled. Deaf people will also appreciate breaks, as staring at a Lip speaker for long periods of time can be exhausting (www.nrcpd.org.uk).

Ethical Code

1. Lip speakers will speak as accurately as possible with their lips. They will not add to or subtract from the meaning of what has been said, and they will remain true to the spirit of what has been said.
2. If problems arise during an assignment, Lip speakers will use their professional skills to resolve them. If this is not possible, they will stop lip-syncing and inform customers of the problem.
3. They will not give their work to another Lip speaker unless all parties involved agree.
4. Lip-synching evidence may be required for training or assessment. Lip speakers will protect the consumer's right to privacy. Consumers may agree to a prepared statement or lip speakers may leave out agreed information.
5. They may also give information about their work if they risk being prosecuted if they don't or if they are required to by law.
6. They may also provide information to protect an individual's or a community's welfare.
7. Information given and spoken aloud in public is not private.
8. In a lip speaking assignment, lip speakers will not give advice or express personal opinions about anything that is being discussed or about the people in the room.
9. When communicating, they will be objective and show no bias or preference for one side over the other.
10. Lip speakers will not work in any situation where their impartiality may be called into question.
11. They will not gain an unfair advantage from knowing information gained while working.
12. Lip speakers will disclose any business, financial, or other interests that may make impartiality difficult. They must do this either before or as soon as possible after the assignment is completed.
13. They will work to improve the lip speaking profession's reputation as well as

its professional standards and status. They will not destroy the profession in any way.

14. Lip speakers will be respectful of other professions' ethics and working practices.
15. Lip speakers will use their understanding of appropriate environmental conditions to assist deaf and hearing people in communicating. This includes ensuring that the lighting, positioning, and background are all in good working order.
16. They will not wear clothing or jewellery that may cause deaf people to become distracted.
17. Lip speakers are allowed to advertise their services, but the information must be accurate, relevant, and not misleading. It will not be detrimental to hearing impairments or the lip-speaking profession.
18. They will support each other when working together. Lip speakers Lip speakers will work cooperatively with other Human Aids to Communication (e.g., BSL/English Interpreters, STT Reporters, Deafblind Interpreters) to ensure that their work is not made more difficult.
19. Lip readers will strive to improve and broaden their knowledge and skills. They will make every effort to take advantage of any training and development opportunities that are made available to them.
20. They will support and encourage other Lip speakers as they advance in their careers.
21. They will make every effort to provide learning opportunities for new Lip speakers.

Communication Support Worker

A Communication Support Worker (CSW) is defined by ADEPT (2014) as a highly skilled professional with a communication support qualification who facilitates communication access by using a variety of support strategies and communication modes to match individuals' needs and preferences. CSWs communicate with a variety of professionals, including deaf educators, audiologists, teachers, lecturers, other CSWs, and team leaders. This type of assistance usually entails a two-way exchange of information via BSL, written notes, or clear speech, and it gives students access to information and opportunities within the educational institution. Many students require

more than one type of assistance at the same time, and thus may require the services of multiple professionals during the same session. In schools, universities, colleges of further education, adult education centres, and other learning environments, the CSW facilitates access to the curriculum and the wider learning environment, and meets the needs of the individual deaf learner whenever possible. It is critical to encourage the hiring of appropriately qualified and experienced CSWs, ideally to work as part of a team rather than as the sole "specialist." Within certain topics of education, it is good practice to match the needs of the deaf learner with the skills and experience of an individual CSW. Catering, health and social care, and English are just a few examples.

The role of the Communication support workers.

ADEPT 2014 listed roles of communication support workers thus;

1. To provide equal access to information and education in order to meet the needs of students.
2. To empower the learner through the use of a variety of appropriate support strategies by the CSW, encouraging the individual learner's development within educational, social, linguistic, and cultural contexts.
3. To consider the learner's needs in the context of their peer group, and to provide appropriate communication strategies based on a variety of skills, assisting in the group's successful integration.
4. Provide access to a variety of learning materials through suitable methods of communication that are tailored to the needs of each individual student.
5. To respond to all communication needs that may arise in the learning environment and with Assistive Technologies, as well as to implement, review, and adapt communication strategies as needed.
6. Enable and empower students to discuss their individual learning needs with teachers and other professionals.
7. Provide Deaf Awareness training, advice, and guidance to teaching staff and/or peer groups, with learners involved whenever possible. Train the front-of-the-house staff as well.
8. To make wider college services, such as counselling, financial aid, the library, and learning resources, more accessible.
9. To work as part of a team that evaluates, delivers, and evaluates the learner's individual support needs.

10. Enable students to make their own decisions and learn from their mistakes.
11. For the purposes of management, inspection, and audit, keep accurate records of work and perform support-related administration as needed.

Benefits of Instructional Supports

Owen (2018) stated some Benefits of Instructional Support as follows:

1. It aids in the identification of students who require academic, emotional, or behavioural assistance.
2. It uses a variety of screening methods and referral procedures to identify students who are at risk of failing.
3. It enables teachers, students, and parents to receive immediate and timely assistance.
4. It takes a collaborative approach that always encourages parental involvement.
5. It searches systematically for problems to identify and prioritize, as well as strategies to help students.
6. It keeps track of the student's progress.
7. It assesses the progress and makes recommendations.

2.2.3.2 Technical Support

According to NDCS (2018), Technical supports are hearing technology that those hearing impaired learners that have residual hearing used to manage problems of distance, background noise and acoustic conditions. These assistive technologies are any type of devices or technology that helps student with a hearing impairment to communicate more effectively with others. ALD are often used to amplifier sound for individual with hearing impairment in larger situation. These are Radio Microphone System, Induction Loops and Digital Recorder. These devices will not work if a learner's residual hearing is insufficient to use a hearing aid. He further explained them as follows:

A Radio Microphone System:

The abbreviation FM stands for Frequency Modulation, and it is the generic name or term for radio aids. Radio waves are used in FM systems to transmit sound from a sound source to a receiver worn by a hearing impaired person (ASHA, 2015). The lecturer is given a microphone, which transmits to a receiver worn by the student.

It is ideal for lectures and to a lesser extent seminars because it helps to eliminate distance and background noise issues. Lecturers should be aware that questions from the audience will not be heard, so they should be repeated before responding. In a seminar setting, students with hearing impairment will either place the microphone in the center of the table to pick up individual contributions, or pass it around to whoever is speaking if the microphone is not sensitive enough. The main benefit for Hearing Aid users is that FM transmission is noise and interference resistant, allowing the sound quality and clarity to be preserved.

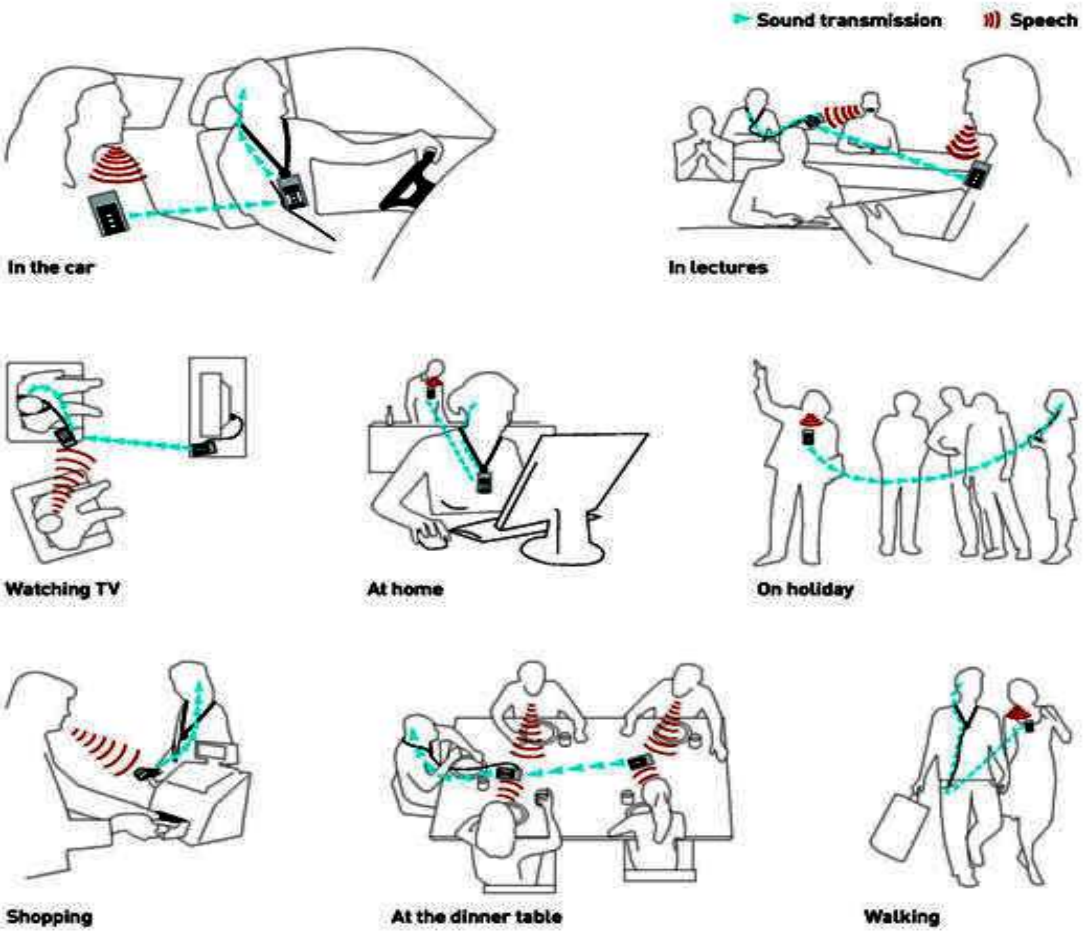

Figure 7: A Radio Microphone System

Source: @hearinglink.org

Depending on the manufacturer, transmitters and receivers differ. Some have only manual controls, while others have manual controls plus a small screen with menu selections for setting the transmission frequency between the transmitter and receiver and selecting whether or not to use the audio input. The battery level, frequency channel, and microphone direction may also be displayed on the screen.

Receivers

Receivers come in a variety of shapes, sizes, functions, and ways to work with hearing aids or cochlear implants. One functional difference is that some receivers have an inbuilt microphone that can be used without the transmitter depending on the situation.

Figure 8: A Radio Microphone System:

Source: @hearinglink.org

Induction loops

An induction loop is used in public places where background noise is likely, such as a lecture hall or a church. Induction loops use a wire loop cable that is placed around the room to create a magnetic field in which an amplifier can produce an audio frequency signal, which is then transmitted to the listener's receiver. To receive the signal, people with hearing impairments can use a hearing aid with a telecoil (T-switch) feature or a loop listening headset. The induction loop bypasses the hearing aid's microphone and sends the signal directly to the receiver, reducing background noise interference. It also helps to reduce the effects of distance and background noise, and is used in conjunction with the speaker's microphone and, in some cases, an existing amplifying system. The microphone is connected to an induction loop that is placed around the room's perimeter. Within the loop, the student can hear sound picked up by the microphone through his or her hearing aid. The deaf student will not be able to hear anything that is not said into the microphone.

Induction loops are installed in the majority of lecture halls. There are also portable systems that can be moved from room to room. Induction loop systems are most common in areas with a large number of people. They are also available for personal use. Hard-wire loops convert sound to magnetic forces and are installed under floors or around walls. T-coils, or telephone switches, in hearing aids pick up these forces and convert them to unds.

Figure 9: Induction Loops

Source: http://www.ampetronic.co/how-do-loops-work

Audio Inputs 1 feed an audio signal into an Induction Loop Amplifier 2 from an existing audio source such as a P.A. system or from dedicated microphone inputs. A current is driven into Loop 3 or a series of loops by the amplifier. As current flows through the cable, a Magnetic Field 4 is created in the required area – careful loop and amplifier design ensures that the vertical component of the field is even and free of dropouts and dead zones wherever the user is. A small coil known as a Telecoil 6 is found inside most Hearing Aids 5 and picks up the magnetic field signal, which is amplified and delivered directly to the hearing aid user's ear.

Digital Recorders: Students with a significant amount of residual hearing can use digital recorders to keep a record of lectures that can be listened to at their leisure and saved as sound files on their computers if desired. The benefit of recording is that any difficult-to-hear words or sentences can be replayed several times, possibly with the aid of a neck loop and hearing aid or a pair of lightweight headphones. Lecture capture systems are expected to eventually replace the need for personal recording.

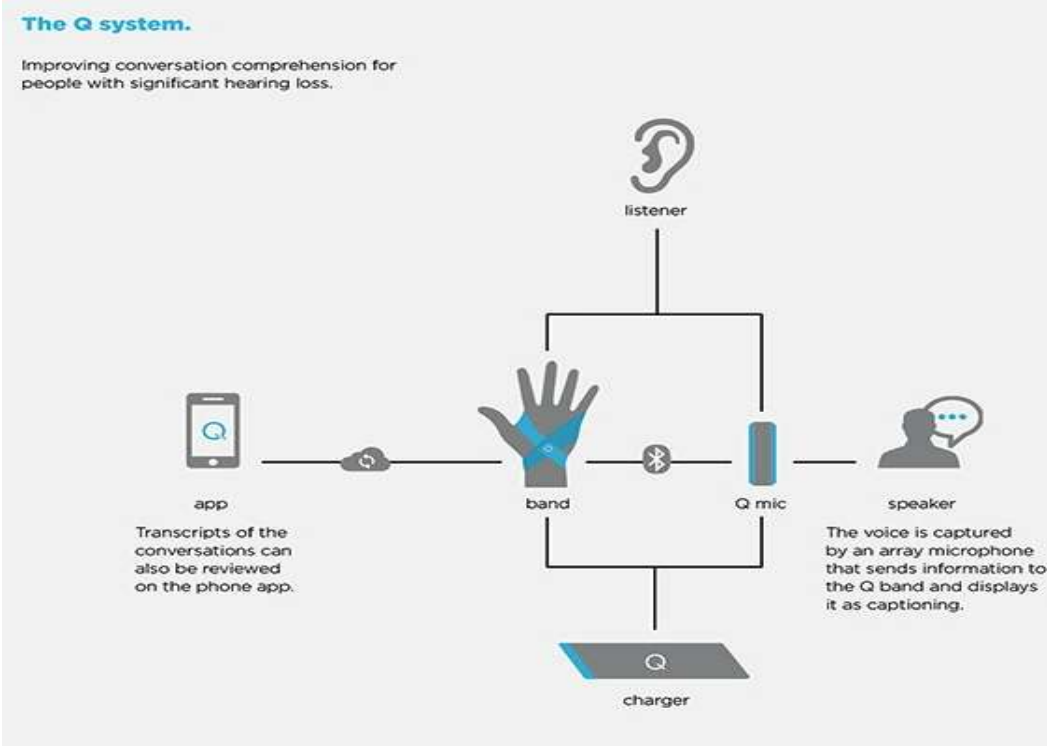

Figure 10: Digital Recorders

A Wearable Captioning Device for thestudent with Hearing Impairment.

Daniela, Jeff, Emin and Leah (2018)

Other equipment to assist people with hearing impairment

Infrared system

Infrared systems are commonly used in homes with television sets, but they can also be used in large settings such as theatres, similar to the FM system. The sounds are converted to infrared waves and then back to sounds by the listener's infrared receiver in this system.

Mobile phones and telephones

There are telephones and mobile phones with features that help users with hearing impairments. The following features may be present:

Amplified and adjustable ringtone—This is designed to increase the volume and pitch of a ring tone and can be purchased as a standard phone feature or as an external extension ringer that can be incorporated into an existing phone.

A handset amplifier is a device that increases the volume and clarity of the handset sound, i.e., the volume of the incoming caller's voice. A handset amplifier can be a built-in feature on a phone or a portable device that can be added to almost any phone. Another option is to increase the user's outgoing volume in order to make their voice louder for those to whom they are speaking.

Adjustable tone and pitch— Some people with hearing impairments can only hear certain frequencies of sound, such as low or high voices. Tone and pitch adjustments can aid in delivering the correct frequency of sound to the user.

Hearing aid compatible—People who use a telecoil (T-switch) hearing aid can use a phone or a mobile phone. A hearing aid compatible telephone directs the sound from the handset directly to the hearing aid, reducing background noise interference and improving sound clarity.

Hands-free speaker—This allows the sound from the handset to be projected to both ears and may include volume control.

Headset jack—A headset with two ear pieces directs and hears the handset sound through both ears at the same time. Additional amplification adjustments to the handset sound may be available on some headsets.

Flashing lights—As a standard feature or as a separate attachment, flashing lights provide a visual indication that the phone is ringing.

Vibration alert—This is a common mobile phone feature that causes the phone to vibrate to indicated an incoming call or text message.

Text messaging is a standard feature on mobile phones that allows people to

communicate via visual text rather than audible speech.

TTY (Teletypewriter) machines

People who are deaf or hard of hearing can use a Teletypewriter or text phone (TTY machine) to communicate via written text over the phone line. The device is made up of a phone, a keyboard, and an LCD display. A TTY machine allows you to type a message and have the conversation read to you from the display. A TTY machine can be used to communicate directly with another TTY machine or through the National Relay Service to communicate with voice users (NRS).

Communication Strategies on the Internet

On the internet, there are a plethora of free instant messaging (IM) programs. These allow communication through typed messages that are instantly displayed on the screens of others who are directly involved in the conversation. Another popular method of communication is email, which sends typed messages to the recipient's inbox when they check their email. While computers have traditionally been used to send and receive internet messages, mobile phone technology has advanced to the point where users can now frequently access, send, and receive internet messages through their phones.

Radio and television

Portable headsets can be used to watch television or listen to the radio. Hearing aid compatible headsets allow sound from the headset to be directed directly to the hearing aid, reducing background noise interference and improving sound clarity. Other headsets allow you to adjust the volume without affecting the sound quality of the television or radio. This could be useful if more than one person is listening, each with varying degrees of hearing loss.

Teletext (also known as subtitles) is a feature found on many DVDs and some television showed. At the bottom of the television, Teletext displays the sound as written text.

Clocks that sound the alarm

A visual flashing light or a vibrating alert are available on some alarm clocks. When a bedside clock alarm is activated, vibrating alert pads can be placed under a pillow to alert the user. Vibrating alarms are also available on some wrist watches and

mobile phones to indicated reminders or scheduled times.

Doorbells, smoke alarms, and baby monitors are all useful devices.

Flashing lights or a vibrating pager are available on doorbells, smoke alarms, and baby monitors to alert you when the alarm or doorbell has been activated. Some doorbells have a ringing volume and melody that can be adjusted.

2.2.4 Concept of Information and communication technology (ICT)

Mary (2021) defines Information and communications technology (or technologies) as the infrastructure and components that enable modern computing. Although there is no single, universal definition of ICT, the term is generally accepted to mean all devices, networking components, applications and systems that combined allow people and organizations (i.e., businesses, nonprofit agencies, governments and criminal enterprises) to interact in the digital world.

According to FOLDOC (2008), ICT refers to the convergence of audio-visual, telephone, and computer networks via a single cabling or link system. Murray (2011) defined information technology (IT) as an umbrella term that emphasizes the role of unified communications and the integration of telecommunications (telephone lines and wireless signals), computers, as well as necessary enterprise software, middleware, storage, and audio-visual systems, which allow users to access, store, transmit, and manipulate data.

Characteristics of Information Technology:

ESA (2018) stated some characteristics of Information and Communication Technology as follows;

1. Acquisition.
2. Storage is number two.
3. Manipulation is number three.
4. Management.
5. Data or information transmission or reception
6. Information is available in real time.
7. Updated data is readily available.
8. Connecting geographically dispersed regions is number eight.
9. A broader range of communication channels.

2.2.5 Relevance of ICT to students with hearing impairment

According to the British Educational Communications and Technology Agency (BECTA, 2000), ICT contributes significantly to the development of language experiences for learners with hearing impairment (HI). With pictures, signs, or texts on screen, ICT can be a very visual medium, allowing students to expand both their general knowledge and language use without relying on the spoken word. Learners with HI frequently require opportunities to expand their use of descriptive language in order to describe, compare, and contrast objects, all of which are essential skills for effective information management. As they plan and carry out their work, a group of students can be encouraged to extend their use of language and their understanding of concepts by collaborating on an ICT activity. According to BECTa (2000), the following types of technology are most beneficial to people with HI:

1. CD-ROM is number one.
2. Control software is number two.
3. Data archiving
4. Turtle graphics or a logo
5. Use of multiple media
6. Use of whiteboards. He went on to say:

- CD-ROM technology can provide students with hearing impairments with more immediate and visual access to information than was previously possible. Students can experiment with different methods of combining sound and vision by creating multimedia presentations that combine text, pictures, and sound. The sound output can be linked to the student's enhanced amplification when appropriate. When these sounds are combined with moving images on a screen, they become even more meaningful. ICT can provide first-hand experience to supplement and extend students' work without requiring them to structure their ideas using text. Control software, for example.
- Control software can be used to allow students to program and control a burglar alarm system using a computer-connected control box.
- Students can use data logging software to track the temperature of water in a beaker using sensors attached to the computer.
- Logo or turtle graphics allow a computer to send a series of instructions to a floor robot or turtle to guide them through a maze. There is less

chance of misunderstanding because all of these are ‘visual' rather than ‘aural.'

- The Smartboard, an interactive whiteboard that works with a computer and projector, is the highest-end hardware. To use the board, the user first instructs the computer to load the software, after which the user selects one of four different colored pens and draws on the board, which can then be erased with a magic eraser. You can drag pictures and other objects around the board using your fingernail as a mouse. Staff thought the board had a real "wow" factor and would impress students in recent trials. They liked how it was an excellent demonstration tool because students didn't have to listen to or interpret instructions because they could see what was going on. One advantage is that everyone is looking in the same direction, whereas if children are writing or using a computer, they are looking down and may miss important signs, body language, or explanations. You can tell that everyone is looking at the right piece of information thanks to the Smartboard. On the other hand, some staff members discovered that seeing the board in a light classroom without blackout facilities was not always easy. Furthermore, because the projector emits a beam that is all too easy to stand in front of, casting a shadow across the board, it may not be appropriate for use with young children. Furthermore, the board is so brightly lit that it may detract from the speaker, making lip-reading more difficult.
- Photographs are important to students with hearing impairments, but digital cameras have been expensive in the past, and teachers have been hesitant to hand them out to children who might not care for them. Everyone, including the teacher, can see the presentation when using PowerPoint. Furthermore, the teacher has control over what the students are looking at, whereas on paper, students will always be on different paragraphs.

2.3 Empirical Review

2.3.1a Onset of hearing loss and students' performance in Biology

Students with hearing impairment are heterogeneous group of people comprising different intra and interpersonal features. Hearing loss can be congenital, which is a condition that starts before birth or at the birth of child. It is known as prelingual deafness.This occurs before an individual has contact with language or acquires it (Mba, 1995). When a significant hearing loss begins is referred to as the onset of hearing loss. According to Okuoyibo (2006) 95% of all the children with hearing problem are with prelingual hearing problems. Those with postlingual hearing problem are those with hearing loss after they have learnt how to speak. Shemesh (2010) noted that hearing disability can occur either before or after the acquisition of speech and language. The most important distinction for distinguishing students with hearing disabilities is between prelingual and postlingual occurrences of hearing loss. Students who are born deaf or lose their hearing before learning to speak (prelingually deaf) differ more in many ways from those who lose their hearing after learning to speak (postlingual). The former cannot learn to speak in the same way that hearing people do. The latter, on the other hand, can use speech for learning and social purposes after developing speech prior to hearing loss. The length of time a person has been deafened has some bearing on how well he or she learns in school (Mba, 1995).

According to Ogundiran and Olaosun (2013), hearing loss that was not present at birth but develops later in life is known as acquired deafness. It's also been referred to as "the type of deafness that occurs after the acquisition of speech" for practical purposes (Hindley and Kiston 2000). The auditory system in congenital deafness has not been programmed for language and spoken communication in this type of deafness. Congenital deafness, on the other hand, is a condition that occurs at birth. Congenital deafness causes the auditory system to be unprogrammed for language and communication. The consequences of a hearing loss that occurs early in life are usually so severe that many people consider hearing loss to be one of the worst things that can happen to a person (Mba, 1995). Hearing loss early in life is more restrictive than hearing loss later in life, especially after speech development and personality development. The effects of early life hearing loss are felt throughout the victim's personality; for example, prelingually hearing disabled people have poor language skills. As a result, they have few opportunities to communicate meaningfully in

educational or social settings. As a result, the most significant impact of hearing loss is on communication, which is the foundation for cognitive and emotional development.

Students with hearing loss will undoubtedly struggle in school. In academic and interactive engagements, the person who acquired hearing loss later in life must have acquired some communicative skills (especially verbal signals) for which he or she could function relatively better than the prelingually hearing disabled person (Ademokoya, 2006), As a general rule, prelingual and postlingual learners with hearing impairments should be separated and taught separately (Bakare, 2013). Students with hearing loss may experience a variety of effects on their learning processes. In terms of educational disadvantage, students who have been deafened since childhod are very different from students who have lost hearing later in life. For example, their vocabulary may be limited, which may affect their reading ability. Deaf and hearing-impaired students are visual learners, which are difficult in an environment where much important information is delivered solely through word of mouth (Oyewunmi, 2008).

2.3.1b Onset of hearing loss and student's attitude towards Biology

Student attitudeare one of the most important aspects of learning science, and developing positive attitude towardsward science can encourage students to pursue science education and careers (George, 2006). Massie (2006) confirmed that attitudeof students with hearing impairment to learning are a major barrier to their full participation in learning. Nicolaidou and Philoppou (2003) reported that students have negative attitude towards basic science tasks and if these negative attitudesmay become relatively permanent are not taken care of. Usak, Holsterman, Grube and Bogeholzis (2009) found students' attitude towards Biology as being neutral.Movahedzadeh (2011) suggested that negative attitude towards sciences includes students' negative experiences in previous science classes and with instructors, a lack of necessary skills to learn and apply scientific concepts, a lack of motivation to work hard in science classes, students' home backgrounds, school and classroom environments, peer group biases, media portrayals of scientists, and students' perceptions of learning rewards (Koballa and Crawley 1988) stated that attitudeare regarded as both facilitators and outcomes of science education Students who perform well in a subject have more positive attitude towardsward that subject,

and students who have more positive attitude towards a subject perform better in that subject (Olatunde, 2009). According to Koch (2005), teachers' feelings and attitude about science can influence their students' interests and attitudes. This is supported by a study conducted by Bauer (2002), who found that teachers' enthusiasm, effectiveness in teaching, and presentation of experiments influenced students' positive attitudes. Ward, Roden, Hewlett, and Foreman (Warden, Roden, Hewlett, and Foreman) (2005), students' attitude towards science are formed at a young age, and parents and teachers can observe their attitude towardsward science which are formed at an early age.

2.3.2a Degree 0f hearing l0ss and students' performance in Biology

Heward (2013) noted that persons who have considerable levels of hearing loss usually encounter difficulty in understandin speech. Kelleher (2011) in his study found that there are more cases of moderate hearing impairment than profound hearing impairment in Beni, Bolivia. (2018) stated that prof0und hearing l0ss is a maj0r disability in Nigeria which affects all aspect 0f life. His study also suggests that there may be variations in degree of hearing loss across the globe. Acquired deafness is the loss of hearing that was not present at birth but develops sometimes during a person's life (Ogundiran and Olaosun, 2013). Unlike those who are congenitally deaf, persons who acquire deafness later in life had probably developed language skills which would enable them to perform relatively better in academic activities and in several social interactions (Ademokoya, 2006). Hence either a congenital or acquired hearing loss, the structure of teaching must take into consideration the ability of the individual and the capacity to hear and understand spoken instructions (Bakare, 2013). Consideration of the academic ability and learningstyles of both individuals with con genital and acquired hearing loss is necessary for effective planning in terms of teachi ng strategies, curriculum modification and application of teaching aids.

2.3.2b Degree of hearing loss and students with hearing impairment attitude towards Biology

Ogundiran and Olaosun (2013) conducted a study to compare the learning outcome_between students with congenital and acquired deafness in a Nigerian college and found no significant difference in the learning outcome between students with congenital and acquired deafness. The findings of

Ogundiran and Olaosun (2013) was in harmony with the study of DeLeon, Berg and Battin (1979), which found no significant difference in the reading level of twenty two (22) adults who were said to be equivalent in terms of intelligence quotients, educational level and had almost the same degrees of hearing loss. However, both studies noted a significant higher mathematics skill among respondents who are congenitally deaf. The higher mathematical scores in mathematics observed by Ogundiran and Olaosun (2013) and DeLeon, Berg and Battin (1979) among the group of congenitally deaf respondents might not be unconnected with the ability to switch from coding auditory signals to visual learners right from birth while those in the acquired group may yet to be suffering from the trauma experiencing deafness. Also, no significant difference was found by Ogundiran and Olaosun (2013) in the Mathematics performance between students with congenital and acquired deafness. It has however been noticed that there are characteristics exhibited by students with deafness which create problems with the teaching and learning of Mathematics. Olubela (2003) outlined the following problems: language communication and reading problems, inattention and distractibility, deficiency in arithmetic – learning strategies, lack of needed working materials, visual and psychological problems. Thus, special strategies and specialist teachers with a sound knowledge of mthematics and the cultural, linguistic, sociological, psychological, prosthetic and educational needs of the hearing impaired are necessary to meet the needs of these special students.

2.3.3a Academic Self-efficacy and students with hearing impairment performance in Biology

Self-efficacy is the belief in one's own ability to complete a task successfully (Bandura, 1977). These beliefs are domain-specific, rather than focusing on the individual judging himself as a whole. For example, one can have high self-efficacy for learning mathematics but low self-efficacy for learning science. Self-esteem is based on one's assessment of one's self-worth, whereas self-efficacy beliefs are based on one's assessment of one's personal capabilities. A person's self-esteem can be high while their self-efficacy for a particular task is low. Self-efficacy for self-regulated learning and perceived academic self-efficacy were identified by Pastorelli and colleagues (200I) as two self-efficacy domains that are relevant to academics. The

belief system about one's ability to self-regulate learning activities, such as using the library to obtain information or concentrating on school subjects, is known as self-efficacy for self-regulated learning. Perceived academic self-efficacy refers to a person's perceptions of his or her ability to master a particular academic subject, such as English grammar or general mathematics.

In science, Oliver and Simpson (I988) and Shrigley, Koballa, and Simpson (I988) found a strong link between performance and self-concept; however, they found no link between attitude and self-concept. According to Schruba (2006), the rise in positive attitudetoward science could be attributed to better instruction or a greater appreciation for the science material presented and discussed in class. The decrease in self-efficacy could be attributed to the assessment methods or the level of difficulty of the assessment instruments.

People's self-efficacy beliefs influence how they feel, think, motivate themselves, and act. These beliefs have a variety of effects on four major processes: cognition, motivation, affect, and selection (Bandura, 1982, 1997). According to Bandura, students are more likely to develop a strong sense of self-efficacy if they record multiple successes in a row, especially in difficult tasks. His theoretical framework reflects that in order to be successful, one must have a sense of self-efficacy, or the belief that one can perform well. Self-efficacy beliefs, for example, influence how a person chooses goals, invests effort, and persists in those efforts (Bandura, 1997). As a result, low self-efficacy can lead to low aspirations and perseverance, as well as low academic performance and goal performance in general. According to Pajeere (2002), students' self-efficacy beliefs not only improve academic performance but also promote intrinsic interest and reduce academic anxiety. People with low self-efficacy, according to Kumar and Lal (2006), may believe that things are more difficult than they are, which can lead to stress and a narrow vision of finding a perfect and timely solution to the problem. Kumar and Lal (2006) found that high self-efficacy (HSE) students scored higher on intelligence tests than low self-efficacy (LSE) students in a sample of 350 Chandigarh college students. As a result, their hypothesis proved that the high self-efficacy (HSE) group out performs the low self-efficacy (LSE) group on intelligence tests. Subjects with high self-efficacy (HSE) were more confident in their abilities. When compared to students with low self-efficacy (LSE), students with high self-efficacy view stressful situations as a challenge and believe in their ability to succeed, thus increasing their efforts to cope with them,

according to Kumar and Lal (2006).

2.3.3b Accademic Self-efficacy and students with hearing impairment attitude towards Biology

One of the fundamental concepts in social learning theory is self-efficacy. Self-efficacy belief is defined as an individual's assessment of his or her ability to complete a task (Bandura, 1986). In other words, it is a person's assessment of his or her ability to complete a task. Efficacy beliefs are made up of two structures: self-efficacy and the expectation of getting results. Individual skills have an impact on tasks, and the expectation to get results are the belief that certain actions will result in a specific way. Academic self-efficacy is positively associated with college grades, according to a large body of research (Bong, 2001). Researchers consider attitude and self-efficacy to be an integral part of the affective domain because of the emphasis on feelings and beliefs. The term "attitude" refers to how students feel about Biology, whether positively or negatively. Self-efficacy refers to a student's perception of how "good" or "bad" their abilities are in a given subject. Beliefs are regarded as "truths" by students (Baldwin 1999). “If a college student judges his or her ability to be lacking in science (belief), that lack of confidence may lead to a dislike for science (attitude) and a subsequent avoidance of science education (behaviour),” writes Baldwin (1999). Students' self-perceptions of their abilities have a big impact on how they act and make decisions throughout their school years. These decisions concern how much effort students will put into completing complex tasks, how much time they will devote to a course, and how persistent they will be when confronted with learning challenges (Baldwin, 1999). According to Bong and Skaalvik (2003), the ability to monitor one's own learning style has an impact on one's feelings about self-efficacy.

Furthermore, academic self-efficacy is crucial in comprehending students and their attitude towardsward science education. Students' evaluations of their own views, the effectiveness of teaching and learning strategies, and the development of a higher self-reported confidence in understanding and using biology are all important aspects of self-efficacy. The enrolment choices of students are influenced by their learning experiences (Farenga and Joyce, 1999). Students' concerns about the amount of coursework and homework required to study high level science, for example, will influence their decision to enrol in any of those courses (Dalgety et al., 2003). According to Bloom (I976), how students feel about science and their sense of self may

account for 25% of their performance.

Researchers consider attitude and self-efficacy to be an integral part of the affective domain because of the emphasis on feelings and beliefs. The term "attitude" refers to how students feel about biology, whether positively or negatively. Self-efficacy refers to students' perceptions of how "good" or "bad" they are at a given subject. Beliefs are regarded as "truth" by students (Baldwin et al., 1999). The following is what Baldwin et al. (1999) said about the relationship between belief, attitude, and behaviour. “If a college student believes that his or her ability in science is lacking (belief), that lack of confidence may lead to a dislike for science (attitude) and subsequent avoidance of science education (behaviour).” Students' self-perceptions of their abilities have a big impact on how they act and make decisions throughout their school years. These decisions concern how much effort students will put into completing complex tasks, how much time they will devote to a course, and how persistent they will be when confronted with learning challenges (Baldwin et al., 1999). Individual feelings about self-efficacy are influenced by one's ability to monitor one's own learning, according to Bong and Skaalvik (2003).

There are few studies linking the field of biology to attitudeand self-efficacy. In science, Oliver and Simpson (I988) and Shrigley et al. (I988) found a strong link between performance and self-concept, but no such link between attitude and self-concept. Thompson and Mintzes (2002) conducted a cross-age study and developed a shark questionnaire, which they distributed to students in elementary, middle, and high school, as well as undergraduate marine biology majors. The positive attitude was attributed to the marine biology majors' increased knowledge, as opposed to a decrease in knowledge as their grades dropped (Thompson and Mintzes, 2003). Another study on attitude was completed by Gogolin and Swartz in 1992. Gogolin and Swartz compared students' attitudetoward science in non-majors college biology courses to those of biology majors using the Attitude towardsward Science Inventory (ATSI). Biology majors' enjoyment and value of science decreased during the semester, while non-majors' enjoyment and value of science increased after instruction, according to Gogolin and Swartz (1992).

Schruba (2006) found a .23, significant correlation between self-efficacy and attitude in Biology for non-majors in their study of 128 students' attitudeand self-efficacy in a current issues in Biology course at an urban, private university in North Texas. This suggests that a student's attitude does influence his or her self-efficacy in

biology and vice versa. The rise in positive attitudetoward science could be due to better instruction or a greater appreciation for the science material presented and discussed in class. The decrease in self-efficacy could be attributed to the assessment methods or the level of difficulty of the assessment instruments.

2.3.4a Learning style and students with hearing impairment performance in Biology

Ugochi (2018) in his own study opined that learning styles of individuals have a significant positive relationship with academic performance. For instance, Abidin, Razaee, Abdullah and Singh (2011) found that there is a strong link between overall academic success and learning styles. More so, Vaishnav and Chirayu (2013) suggested that there exists positive high correlation between kinaesthetic learning style and academic performance. Similarly, Obiefuna and Oruwari (2015), based on a study, discovered that teaching methods which agree with the students'Learning styles influenced abetter performance. In the same vein, For trimodal learners, as well as male and female students, Mutua (2015) discovered a positive and statistically significant relationship between learning styles and academic performance. According to Al-Hebaishi (2012), learning style preferences did not appear to affect or predict any change in students' academic performance. Gappi (2013) also discovered that there was no statistically significant link between academic performance and students' preferred learning styles. Mumtaz (2013) expressed that viable studies have recommended that learning style of students should be considered by teachers in order to ensure higher performance.

Learning styles has a significant positive contribution to academic performance of the gifted students, this result is similar to the study conducted by Vaishnav and Chirayu (2013) where it was found that there was a significant main effect of the three variables of learning style – visual, auditory and kinaesthetic on academic performance. Findings showed that students with hearing impairment learn better from visual activities like demonstration teaching which are mostly supported by instructional materials (models, videos, charts and other concrete materials). They learn better when they watch demonstration, use visual aids to represent a subject, create mental picture of what they read and hear, solve problems or answer questions before anybody else can and prefer to work with other students. This supports the study of Ilcin, Tomruk, and Yesilyaprak (2018) which established a relationship

between the learning style and academic performance of students with hearing impairment. This also corroborate Qi and Mitchell (2012) in their own study which clearly stated that there is relationship between student learning styles of students with hearing impairment and their academic performancebecause of provision or availability of SignLanguage. It also supports Econlearningstyle (2020) which stated that most people are visual learners. Also, learning style (2020) opined that visual learners learn better by seeing what they need, to be able to see the whole concept they need to understand.This connotes that as adoption of a particular learning style could determine the academic performance of gifted students. (Ugochi, 2018) affirmed that learning styles has a significant positive relationship with and contribute significantly and positively to high academic performance of gifted students.

2.2.4b Learning style and students with hearing impairment attitude towards Biology

The characteristic, strength, and preference in the way people receive and process information is referred to as learning style. (Hsieh, Jang, Hwang &Chen, 2011). According to She (2005), teaching methods influence students' ability to store and structure information more effectively, while learning style influences only their ability to structure information effectively. Learning styles, according to Dunn and Dunn (1993), are methods used by students to process, internalize, and retain new and difficult information. Olatoye (2002) discovered that students' attitudetoward science have a direct impact on their academic performance in the subject. Despite the fact that Chemistry is recognized as a science subject, Esen (2007) claims that students still have a negative attitude towardsward science subjects, resulting in low performance and enrolment.

According to a study conducted by Lea (2003), students have generally positive attitude towardsward student-centred instruction. Students believed that student-centred instruction was primarily related to political intentions or for research purposes, according to Lea (2003). According to Kinchin, Hatzipanagos, and Turner (2009), student-centred instruction is beneficial to learning quality and the arousal of positive student attitudes. Students generally have positive attitude towardsward active learning, according to Jungst, Licklider, and Wiersema (2003) and Qualters (2001). This is especially true when students are aware of why active learning techniques are being used. In comparison to traditional lecture methods, some students' perceptions

of active learning/teaching methods were negative (Lake, 2001).

Yilmaz (2008) conducted a study on teachers' attitude towardsward student-centred teaching. Yilmaz (2008) used middle and high school social studies teachers as respondents. Those teachers, he discovered, had positive attitude towardsward student-centred instruction. They preferred student-centred instruction because it was appealing, engaging, challenging, and applicable to students' real-life situations. Teachers actively assumed different roles and responsibilities in line with active teaching, according to Drew and Mackie (2011). For some teachers, this shift in roles may be difficult. Promoter, examiner, leader, visionary, researcher, model producer, tutor, and collaborator are some of the roles. Active learning/teaching can be both challenging and fascinating for the teacher in this regard. Felder & Brent (1996) discussed non-cooperative students who develop negative attitude towardsward active learning when lecturers begin to use active learning methods and their course-end evaluation initially decreases. This showed that lecturers may be deduce to develop active learning but rather return to traditional teaching method which cause low performance to learning activity of learners.

2.3.5a Instructional supports (Human and Technical support) and performance of student with hearing impairment in Biology

The key to equal participation in the learning process' is education support services (Department of Education, 1997). As a result, their accessibility to students with hearing impairment in the context of equal learning participation is worth investigating (Magongwa 2008). Students with hearing impairment, according to Whyte, Aubrecht, McCullough, Lewis, and Thompson-Ochoa (20I3), are part of a cultural group, a linguistic minority, and that it is living in a non-signing world that is actually disabling, not the experience of being hearing impaired. Sign language interpreters, according to Mazoue (2011), play a critical role in assisting students with hearing impairments in overcoming some of the problems caused by their low literacy levels. According to Lang (2002), interpreters need to be more aware of the barriers that students with hearing impairment face, as many studies have shown. As a result of this awareness, they may be able to adjust their interpreting and provide appropriate advice to teachers and students. The literature on note taking and note review by hearing students assumes that students take their own notes, as Lang (2002) points out. Sign language interpreters, tutors and note-takers may be provided for students with

hearing impairment in order to facilitate their learning (Magongwa, 2008).This supports the view of Joel, Kochung, Kabuka, Charles and Oracha (2013) that schools with students with hearing impairment have inadequate learning support services and the available ones are not easily accessible by the students. Mazoue (2011) who Stated that sign language interpreters play a unique role in supporting students with hearing impairment in overpowering some of the problems caused by their poor literacy. Magongwa (2008) stated that sign language interpreters and note-takers are important in facilitating students with hearing impairment learning. This insufficient and non-availability of human support agrees with the findings of Bell, Swart and Carl (2016) who found that students with hearing impairment lack needed human support.

According to recent research, teachers of students with hearing impairments want more training on how to best handle students with learning disabilities (Soukup and Feinstien, 2007). Many deaf teachers do not believe they have enough tools to work effectively with children who have additional learning challenges in addition to being deaf or hard of hearing when they suspect a problem (Soukup and Feinstein, 2007). The deaf educator is responsible for writing the Individualized Education Program (IEP), which should include appropriate goals for the child in the areas of speech, language development, auditory skills development, and any academic areas affected by hearing loss (Berke, 2009). As previously stated, a child who is deaf or hard of hearing is more likely than a typically hearing child to have a learning disability (Soukup and Feinstein, 2007).

Students who have learning difficulties in addition to their hearing loss require as much sensory input as possible, and a visual and meaningful presentation provides a concrete way for these students to develop their understanding of the concepts (LDAA, 2004). Students are more likely to stay focused in class and achieve the given goal if they are highly motivated to learn and working toward a goal, according to Christine Perigoe (2005). The interpreter's location, the instructor's or speaker's location, and instructional visuals (for example, PowerPoint) can all lead to visual attention division, which is a challenge for and exhausting over time (Solomon, Braun, Kushalnagar, Ladner, Lundberg, Painter, Nuzzo, 2013). Taking notes while watching these various visual foci is also difficult for students; a note-taker may help to alleviate this problem (Solomon, Braun, Kushalnagar, Ladner, Lundberg, Painter, Nuzzo, 2013). The pace of instruction or discussion, the number of speakers, language and cultural differences, the interpreters' familiarity with the content and signing style, and

the use of space are all factors to consider (Lang, 2006).

2.3.5b Instructional supports (Human and Technical support) and attitude of student with hearing impairment in Biology

Students' attitudeare one of the most important factors in learning science, and developing positive attitudetoward science can motivate students' interest in science education and science-related careers (George, 2006). According to Donaldson (1994), it is biased and negative attitudethat prevent students with hearing impairments from fully integrating into society. Horne (1985) discovered that negative attitude of students without disabilities toward their classmates with disabilities were a major barrier to mainstreaming and/or inclusive education success. According to Yuker (1994), the influence of people with disabilities' behaviour on others' attitudeis a function of the perceiver's role relationship with the person with a disability. However, while the definition or concept of attitude towardsward science is nebulous and ambiguous, attitude is a concept that defines emotional trends in response to matters, people, places, events, or ideas. As a result, phrases like "I enjoy science" or "I enjoy science courses" are considered attitudes. (Simptom & Oliver, 1990). According to Adesoji (2008), students' positive attitudetoward science are highly correlated with their attitude towardsward the foundational sciences. According to Adesoji (2008), a number of factors have been linked to students' attitude towardsward science subjects, including biology. Teaching methods, teacher attitude, parental influence, gender, age, cognitive styles of students, career of interest, social view of science, social implication of science (Biology), and performance are examples of such factors. According to Osborne, Simon, and Collins (2003), studies have included a variety of components in their measures of attitude towardsward science, including: the perception of the science teacher; anxiety toward science; the value of science; self-esteem in science; motivation towards science; enjoyment of science; attitudeof peers and friends towards science; attitudeof parents towards science; the naiveté of science; the naiveté of science; the Students' attitude towardsward Biology are neutral, according to a study conducted by Usak, Prokop, Ozden, Ozel, Bilen, and Erdogan (2009). He concluded that improving their interest in studying Biology will lead to better learning outcomes in Biology. On the other hand, there was a gender gap in students' attitudetoward science education. Male students have more positive attitudethan female students (Osborne, Simon and Collins, 2003). Nasr and Soltani (2011) discovered no

significant differences in male and female attitudetoward biology. Prokop, Tuncer, and Chuda (2007) found that girls are more interested in Biology than boys in another study. Similarly, as students get older, their interest appears to wane. Thang, Ting, and Jaafar (2011) discovered that science students are more interested in learning English than art students. Yusuf and Bhutta (2012) found a significant difference in students' attitude towardsward environmental issues in favour of students in private schools. However, Abe (2014) discovered in a study conducted in Nigeria that while there was no significant difference in Ekiti State students' interest in studying Mathematics between private and public schools, there was a significant difference in male and female students' attitudes.

Kpolovie and Okoto discovered a significant link between students' interest in learning and their academic performance (2014). It is critical to determine how students in Nigeria perceive Biology in order to improve their academic performance.

2.3.6a ICT and student with hearing impairment performance in Biology

Students who have access to the appropriate information and communication technology solutions for their educational programs are more likely to succeed (Masson, 2000). ICT is defined by UNESCO (2002) as a set of technologies used in the collection, storage, editing, retrieval, and transfer of information in various forms. According to Salaudeen (2015), ICT helps people with hearing impairments by serving as a learning aid and increasing their learning potential. Through auditory and visual processes, ICT also aids students in reading and writing (Lasa, 2010). Teachers must strive to embrace new technological learning tools in order to effectively meet these expected results in schools (Handel and Harold, 2006; Jegbefume, 2006). (2013). The ability to communicate and interact in one's environment, according to Agomoh and Kanu (2011), is largely dependent on hearing. Quality teaching combined with innovative technology may help deaf students communicate more effectively (Lidström, Granlund, and Hemmingsson, 2014). According to MOE (2008), the ICT Policy is intended to promote inclusive education by addressing inequalities in gender, language, and disability.

According to Al-Alwani (2005), a lack of computers and hardware resources, as well as internet access, has hampered technology integration and use in schools. Lack of access has consistently been identified as a complex barrier to effective ICT use, particularly among students with disabilities, according to studies (Adebi-Caesar,

2012; Bingimlas, 2009; Sicilia, 2005). Incorporating ICTs, particularly computers and the Internet, into educational teaching and learning to improve deaf students' digital skills has become critical in all countries, including Ghana (Ciccarelli, Straker, Mathiassen, and Pollock, 2011; Li and Kirkup, 2007). Unfortunately, the implementation of ICT in education policy has been painfully slow; currently, the official curricula emphasize the development of students' skills in operating ICT rather than using technology to learn subjects other than ICT (Mereku, Yidana,Hordzi, Tete-Mensah and Williams, 2009). ICT can be used in schools by students with disabilities, including the deaf, to manipulate and communicate information through voice and sound, or images, such as computers, computer-based assistive technology, special software, and communication aids, to facilitate their participation in learning (Hakkarainen, Ilomäki, Lipponen, Muukkonen, Rahikainen, Tuominen 2003; Lei and Zhao, 2007). The use of Computer Assisted Instruction improves the impact of ICT on students with hearing impairments' academic performance. Brummer (2004) talked about how they used Computer Assisted Instruction (CAI) to get interesting positive results in teaching and learning activities in a variety of science and science-related courses. The importance of using computers and CAI software in the classroom cannot be overstated. The use of computers as a teaching tool has proven to be effective in piqueing students' interest and providing individualized instruction at the students' own pace and direction. Computers have proven to be useful in engineering and, more importantly, as an excellent teaching tool (Ogu, 2003).

When literatures had so many benefits of Computer-Assisted Instruction (CAI), such as motivation, transfer of knowledge, problem-solving, and individualization of instruction, Sowunmi and Aladejana (2013) remarked that teachers still retain the conservative approach by acting as repertoires of knowledge while learners remain as dormant recipients. ICT looms larger in the teaching of concept and terms in science and technology as if it is only this area of human endeavour that has a monopoly of ICT. This trend has therefore circumscribed the rich language resources provided by ICT in spite of the fact that English Language remains mostly the only available look twentieth century learning (Ero, 2005). Kptyug (2006) declares that using the ICT really motivates the students to develop independent learning strategies most especially in the study of vocabulary, presentation and report writing. Oliver (2003) posit further the positive contributions of ICT to English Language learning and teaching with his submission that the English Language teacher and his students

can influence the effectiveness of instructional programme through creative use of variety of media especially ICT as students learn more, retain better what they learn, and improve their performance of the skills they are expected to develop. Oliver (2003) adds that the teacher's role is streamlined to guiding learners, setting them tasks leading specified solutions, setting the time limits etc. rather than presenting themselvesas the sole repertoire of knowledgeFakeye (2001), Anoma (2003) and Sanusi (2009) have pointed out the vital role played by the learners' home background in second language learning.

The result of study of Imhanlahimi and Inhanlahimi (2008) showed that both computer-assisted learning strategy and expository or traditional methods of instruction are effective in enhancing students' performance in biologyMuraina, Adeleke and Rahman (2011) exposed one group to conventional teaching and found that using computer – assisted instructional method had significant effect on students' performance than the conventional teaching method. Anyamene, Nwokolo, Anyachebelu and Anemelu (2012) examined the significance of retention performance scores of students taught using computer- assisted and conventional method with sample of forty senior secondary school students. Anyamene, Nwokolo, Anyachebelu and Anemelu (2012) added that students taught using CAI package performed significantly better than their counterparts taught using the conventional method of instruction and the control group in retention tests. Adeyemi (2012) examined the effect of computer assisted instruction (CAI) and the conventional method on students' performance in social studies. The result of Adeyemi (2012) indicated that there was no significant main effect of treatment (computer – assisted instruction and conventional method) on students' performance in social studies.

2.3.6b ICT and students with hearing impairments attitude towards Biology

Attitude is a concept that describes emotional patterns in response to things, people, places, events, or ideas. For example, the phrase "I like science" or "I enjoy science courses" is an example of attitude (Simpson and Oliver, I990). According to Osborne (2003), studies have included a variety of components in their measures of attitude towardsward science, such as the science teacher's perception; anxiety toward science; the value of science; self-esteem in science; motivation towards science; enjoyment of science; attitudeof peers and friends towards science; attitudeof parents towards science; the nature of the classroom e.g. Attitude studies in science education

are mostly concerned with the attitude of elementary, middle, and high school students, as well as college students in some cases (Turkmen, 2007). As science has become more deeply embedded in our daily lives, social scientists, as well as scientists, have become increasingly interested in how ordinary people perceive science (Bak, 2001). Students' attitudeare one of the most important factors in learning science, and developing a positive attitude toward science can motivate students' interest in science education and science-related careers (George, 2006). The importance of interest, goals, and motivation for learning and academic performance has been identified (Hidi and Harackiewicz, 2000). The attitudeof students toward science and science education have also been studied (Osborn, 2003). Many students find science to be boring (Delpech 2002); it is difficult, unrelated to people's lives, more appealing to boys, and less so to older students (Ramsden, 1998).

According to Abdul, Noor, and Kamaliah (2005), computer technology is thought to aid special students in improving their learning effectiveness, particularly in developing new attitudeand adding value to reading, writing, and mathematics skills. Students' attitude towardsward science learning may be influenced by years of habitual patterns of participation, attitudes, and expectations (Baseya and Francis, 2011). Measures of student satisfaction such as changes in interest in course material, relevance of course material to long-term goals, seeing the course as stimulating and exciting, and course difficulty are sometimes used to conceptualize attitude towardsward science. (Basey, 2008). Abimbade (2014) stated that computers are not basically designed for schools' teaching and learning but they are have been introduced into the school as a real world resources. Hence the computer has to be adapted to the educational setting. Computers have found its way into the school management and administrative purposes inform of computer manages instruction such as – worksheets, stastical analysis package, symbolic manipulation system have been proved valuable, educational tools.

2.4 Appraisal of literature

The review of literature in the area of study showed that various attempts have been made and many strategies have been used by researchers to enhance students with hearing impairment biology learning outcomes in Senior Secondary School, but low level of the research findings was utilised. Evidence from literatures has also shown that hearing impairment does not have effect on the acquisition of literacy

skills because students with hearing impairment have the same intellectual potentials as their hearing peers. The primary and obvious effect of hearing impairment is on spoken communication and the use of sign language interpreter and amplification as early and as often as possible are extremely important to the future language and academic performance of students with hearing impairment. Factors such as onset of hearing loss, degree of hearing loss, self-efficacy and learning styles were considered as type of factors that may contribute to poor performance of students with hearing impairments in Biology.

It is also revealed from literatures that the use of instructional supports (human support such as sign language interpreter, note takers, lip – speakers, communication support workers and technical supports such as radio microphone system, induction loop, and digital recorder) would help to support and facilitate learning in students with hearing impairment. So far, the findings of studies have also shown that teachers use conventional teaching methods in teaching Biological contents, whereas students with hearing impairment require the use of Information Communication Technology as well to benefit from educational programmes and to be able to perform excellently in their academic endeavours. Therefore, this study looked at the relationship between personal factors, instructional supports, ICT use and biology learning outcome of students with hearing impairment in Oyo State, Nigeria.

CHAPTER THREE
METHODOLOGY

This chapter focuses on the methodology that was adopted for this study. It is organised under the following headings: research design, population of study, sample and sampling techniques, instrumentation, validation of instruments, procedures for data collection and methods of data analysis.

3.1 Research Design

This research work adopted the survey research design of correlational type. Some of the variables considered in the study were inherent in the participants and no intervention was provided.

3.2 Variables of the study

The following variables were involved in this study

Independent variables:

(a) Personal Factors (Onset of hearing loss, Degree of hearing loss, Self-Efficacy and learning style)

(b) Instructional Supports (Human Support and Technical Support)

(c) ICT use

Dependent Variables: These are the learning outcomes

(a) Students' performance in Biology

(b) Students' attitude towards Biology

3.3.1 Population

The population comprised all students with hearing impairments offering biology in Senior Secondary Schools in Oyo State, Nigeria.

3.3.2 Sample and Sampling Techniques

A sample of two hundred and twenty four (224) students were used for the study comprising the senior secondary class II. One hundred and ninetyone (191) from

public school and thirty-three (33) from private schools were used. The average age of the participants was 16 years. A purposive sampling technique was used to select students with hearing impairment from seven schools that offered biology in West Africa Senior Secondary School Certificate Examinations. The schools are located in Eruwa, Ibadan, Iseyin, Ogbomoso and Oyo.

3.4 Instrumentation

The study used the following instruments:

1. Students'Audiological and Audiometric Screening Report (SAASR)
2. Grasha-Riechmann Student Learning Style Scale (GRSLSS)
3. Students' Self Efficacy Formative Questionnaire Scale (SSEFQS)
4. Students' Biology Performance Test (SBAT)
5. Students' Attitude towards Biology Scale (SABS)
6. Students' Inventory on Instructional Supports (SIIS)
7. Students' Inventory on ICT (Utilisation, Availability,Accessibility) (SIICT)

3.4.1 Students' Audiological and Audiometric and Screening Report (SAASR)

The instrument was made up of medical files and audiometric screening report of students that were engaged in the study on onset and degree of hearing impairment.

3.4.2 Grasha-Riechmann Student Learning Style Scale (GRSLSS)

This is an adapted scale. The scale was developed by Grasha and Riechmann (1974). It had an internal consistency of 0.83 using Cronbach alpha. The scale is in two parts, (a) Visual (b) Kinaesthetic, each part contains 10 items with a four-point likert scale of Strongly Agree (SA), Agree (A), Disagree (D) and Strongly Disagree (SD). The items were modified to suit the purpose of the study. A pilot study was carried out on 30 SSII students with hearing impairment who were not part of the study to determine its reliability index as 0.85 using Cronbach Alpha.

3.4.3 Student's Self Efficacy Formative Questionnaire Scale (SSEFQS)

The self-efficacy formative questionnaire was an adapted scale for this study. It was developed in 2015 by Research Collaboration. The questionnaire was in two parts, (a) believe in personal ability (b) believe that ability grow with effort. This scale contained 18 items, part (a) 13 items and part (b) 5 items with a four-point likert scale

of Very True (4), True (3), Not quite sure (2), Untrue (1). The initial items had a reliability index of 0.88. A pilot study was carried out on 30 SSII students with hearing impairment who are not part of the study to ascertain the reliability of the instrument. The reliability coefficient of the students' self- efficacy scale was determined using Cronbach Alpha and it was found to be 0.78.

3.4.4 Students' Biology Performance Test (SBAT)

The test was self-constructed by the researcher. The questionnaire was set based on some topics in NERDC Biology curriculum. The instrument was used to examine students with hearing impairment knowledge in Biology on Living and Non – living things, Cell, Tissue and supporting system, Nutrition, Ecology, Reproduction, Micro – organisms and relevance of Biology to Agriculture. The initial test items of students' Biology Performance Test (SBAT) consisted of 60 multiple choice items. It was given to experts in Biology education for face and content validity. Each item on the multiple choice section had options A-D and attracts 1 mark for correct response. In order to carry out the reliability coefficient, a pilot study was carried out on 30 SSII students with hearing impairment who were not part of the study to ascertain the reliability of the instrument. The reliability coefficient was established using Kudar-Richardson formular (KR_{20}). The reliability index of 0.77 was obtained. The average difficulty index of 0.52 and the discriminative index of 0.27 were also obtained. 40 multiple choice objective test items that were within these indices were found good enough. The table of specification is presented below based on Anderson and Krathwohl (2001) revised bloom taxonomy.

Table 3.1: Table of Specification (SBAT)

Concept	Knowledge	Comprehension	Application	Analysis	Evaluation	Creativity	Total
Living things and Non living things	26	14	-	2	-	-	3
Cell	15,33,39	27	-	1	-	-	5
Tissue and supporting system	3,16,28	-	34	-	-	-	4
Nutrition	4,17,29	-	-	-	35	-	4
Ecology	30,36	5	-	18	-	-	4
Relevance of Biology to Agriculture	19,37	-	-	6,31	-	-	4
Micro – organisms	32	-	-	20	7,38	-	4
Reproduction	11,40	21	-	-	8	-	4
Excretory System	22	-	-	-	9	-	2
Respiratory System	23	-	-	-	10	-	2
Digestive System	-	12	24	-	-	-	2
Transport System	25	13	-	-	-	-	2
Total	**20**	**06**	**02**	**06**	**06**	**-**	**40**

3.4.5 Students' Attitude towards Biology Scale (SABS)

This is an adapted scale. Students' Attitude towards Biology Scale (SABS) was developed by Ige (1998) with a reliability co-efficient of 0.71 which was also used by Adigun (2016). They contained 40 items which were designed on a four – point Likert scale ranging from Strongly Agree (SA), Agree (A), Disagree (D) to Strongly Disagree (SD). The Scale covered area of attitude towards Biology. The questionnaire was administered to 30 SSII students with hearing impairment. The Students' Attitude towards Biology Scale was given to experts in Biology Education for face and content validation. It was revalidated through a pilot study carried out on 30 SS II students with hearing impairment who were not part of the study. A reliability coefficient of 0.91was obtained using Cronbach Alpha.

3.4.6 Students' Inventory on Instructional Supports (SIIS)

This is an inventory constructed by the researcher. The researcher used articles on special education, which included supporting the performance of deaf young people, National Deaf Children's Society(NDCS, 2017) and information for staff working with deaf or hearing-impaired students, Royal National Institute for the deaf people, RNID, 2017). The inventory had two parts, which consisted of seven items. The Inventory included items on availability, accessibility and utilization of human support and technical support. The first four items were on Human Support; while the other three questions were on technical support. A pilot study was carried out on 30 SSII students with hearing impairment who were not part of the study in order to ascertain reliability of the inventory. The reliability of the instrument was determined using Cronbach Alpha and it was found to be reliable at 0.77.

3.4.7 Students' Questionnaire on ICT (SQICT)

The inventory was constructed by the researcher for this research. The researcher used article on ICT, British Educational Communications and Information agency (BECTa, 2000). The inventory consisted of 10 items. The inventory covereed availability, accessibility and utilization of ICT in schools. Respondents were rated on a six point Likert scale based on availability, non-availability, accessibility, non-accessibility, utilisation and non-utilisation of some items like: CD- ROM, control software, computer, and power point. To ensure the reliability of the inventory, a pilot study was carried out on 30 SSII students with hearing impairment who were not part

of the study. Cronbach Alpha was used to determine the reliability of the instrument and it was found to be reliable at 0.88.

3.5 Research Procedure

Administration of Instrument

3.5.1 Visit to Schools used for the study

The secondary schools selected for the study were visited by the researcher with the letter of introduction from the Department of Science and Technology Education (STE), Faculty of Education, University of Ibadan. The researcher introduced herself as a post graduate student of the University of Ibadan; she explained the purpose of the research work and familiarized herself with the students. Parental consent letter was given to the students to give their parents to indicated their approval of their wards to participate in the research. The researcher consulted audiologist from Special Education Department, University of Ibadan to help in screening and identifying onset of hearing loss of the students who participated in the study. The, sign language interpreters in various schools for the study were consulted for the administration of the questionnaire and the inventories. Sign language interpreter interpreted and explained that the responses will be used for research purpose alone. Thereafter, copies of the questionnaire and the inventories were collected immediately.

3.6 Method of Data Analysis

The Data collected were analysed using descriptive statistics (frequency counts, percentages analysis, means, and standard deviation) inferential statistics of Pearson's Product Moment Correlation and Multiple Regression. The descriptive statistics was used to explain participants' demographic variables while Pearson Product Moment Correlation was used to test the relationships between each of the independent variables and dependent variables. Multiple Regression analysis was used to determine composite and relative contribution of the independent variables to the dependent variables. Descriptive statistics of frequency counts, percentages, mean, standard deviation, were used to analyse research question 1, 2, 3and 4. Pearson Product Moment Correlation was used to provide answers to research questions 5, 6 and 7 while Multiple Regression analysis was used for research questions 8 and 9.

CHAPTER FOUR
RESULTS AND DISCUSSION

This chapter presents, interprets and discusses results as well as summarised findings of this study.

4.1 Presentation of Results

The seven hypotheses formulated were tested at α=0.05 level. The presentation therefore followed the order in which the research questions were stated in Chapter One.

Table 4.1 revealed that 99 (44.2%) of the respondents (students with hearing impairment) indicated that their age of onset of hearing loss started before birth. While the remaining 125 (55.8%) indicated after birth. This implies that majority of the students with hearing impairment have their hearing loss after birth. This is referred to as post-lingual hearing loss.

Table 4.2 revealed that 78 (34.8%) of the respondents (students with hearing impairment) indicated that their degree of hearing loss was moderate while 146 (65.2%) indicated that their degree of hearing loss is profound. This implies that majority of the students with hearing impairment have profound hearing loss.

Table 4.3 showed the responses 0f students with hearing impairment to self-efficacy. It indicated the grand weighted mean of 3.12 0ut of the 4.00 maximum 0btainable score, which was higher than the Standard Mean of 2.50. This showed that self-efficacy of the students with hearing impairment in Biology was high. Thus, self-belief of students with hearing impairment in Biology as a subject was high. The results revealed that the belief that ability grows with effort (3.26>3.12) was the major one that contributed to this high self-efficacy in Biology among the students. The results further showed that 10 items out of the 18 items contributed to this high self-efficacy in Biology recorded among the students. The 10 items were rated as follow: I will succeed in whatever career path I choose (3.51>3.12) was ranked highest among the mean scores, followed by I will succeed in whatever course I choose (3.40>3.12), My ability grows with effort (3.38>3.12), I usually understand my homework

(3.34>3.12), I belief hard work pays off (3.32>3.12), I think no matter whom you are, you can significantly improve on your talent (3.30>3.12), When I am struggling to acc0mplish something difficult, I focus on my progress instead of feeling discouraged (3.30>3.12), I belief the brain can be developed with much task (3.21>3.12), I could get the best grade in class if I try (3.16<3.12), lastly, It is not hard for me to get good grades in school (3.15>3.12).While the remaining 8 items did not contribute to this high self-efficacy in Biology among the students with hearing impairment.

Table 4.1: Distribution of Students with Hearing Impairment According to Onset of Hearing loss

Onset of hearing loss	Frequency	Percentage
Before birth	99	44.2
After birth	125	55.8
Total	**224**	**100.0**

Research question 1b: What are the descriptive indices of students with hearing impairment with respect to degree of hearing loss?

Table 4.2: Distribution of Students with Hearing Impairment According to Degree of Hearing loss

Degree of hearing loss	**Frequency**	**Percentage**
Moderate	78	34.8
Profound	146	65.2
Total	**224**	**100.0**

Research question 1c: What are the descriptive indices of students with hearing impairment with respect to self-efficacy?

Table 4.3: Self-efficacy of Students with Hearing Impairment

S/N	Items	SA	A	D	SD	Mean	STD.D
Belief in personal ability							
1	I can learn what is being taught in class	56 25.0%	64 28.6%	54 24.1%	50 22.3%	2.56	1.10
2	I will get better grades if my teacher likes me more	39 17.4%	58 25.9%	54 24.1%	73 32.6%	2.28	1.09
3	I can figure out anything if I try enough	73 32.6%	66 29.5%	41 18.3%	44 19.6%	2.75	1.11
4	I will graduate from secondary school	92 41.1%	70 31.3%	38 17.0%	24 10.7%	3.03	1.01
5	If I practice every day, I can develop any skill	60 26.8%	56 25.0%	43 19.2%	65 29.0%	2.50	1.17
6	Once I have decided to accomplish something that is important to me, I keep trying to accomplish it, even if it is harder than I thought	67 29.9%	44 19.6%	63 28.1%	50 22.3%	2.57	1.14
7	I am confident that I will achieve the goals that I set for myself	96 42.9%	49 21.9%	40 17.9%	39 17.4%	2.90	1.14
8	When I am struggling to accomplish something difficult, I focus on my progress instead of feeling discouraged	139 62.1%	38 17.0%	21 9.4%	26 11.6%	3.30	1.03
9	I will succeed in whatever career path I choose	149 66.5%	49 21.9%	18 8.0%	8 3.6%	3.51	0.79
10	I will succeed in whatever course I choose	140 62.5%	49 21.9%	19 8.5%	16 7.1%	3.40	0.92
11	I could get the best grade in class if I try	101 45.1%	75 33.5%	31 13.8%	17 7.6%	3.16	0.93
12	It is not hard for me to get good grades in School	97 43.3%	79 35.3%	32 14.3%	16 7.1%	3.15	0.92
13	I usually understand my homework	106 47.3%	96 42.9%	15 6.7%	7 3.1%	3.34	0.74
Weighted mean = 2.97							
Belief that ability grows with effort							
14	I belief hard work pays off	108 48.2%	90 40.2%	16 7.1%	10 4.5%	3.32	0.79
15	I think no matter whom you are, you can significantly improve on your talent	106 47.3%	90 40.2%	18 8.0%	10 4.5%	3.30	0.80
16	My ability grows with effort	125 55.8%	66 29.5%	27 12.1%	6 2.7%	3.38	0.80
17	I belief the brain can be developed with much task	105 46.9%	69 30.8%	43 19.2%	7 3.1%	3.21	0.86
18	I can change my basic level of ability Considerably	93 42.5%	76 34.7%	32 14.6%	18 8.2%	3.11	0.94
Weighted mean = 3.26							
Grand weighted mean = 3.12							

Research question 1d: What are the Descriptive Indices of Students with Hearing Impairment with Respect to Learning Style?

Table 4.4: Learning Style of Students with Hearing Impairment

S/N	Items	SA	A	D	SD	Mean	STD.D
		Visual					
1	I prefer to learn by reading textual materials	111 49.6%	71 31.7%	19 8.5%	23 10.3%	3.21	0.98
2	I learn better when I watch educational programmes	53 23.7%	98 43.8%	40 17.9%	33 14.7%	2.76	0.98
3	I create mental picture of what I want to study	53 23.7%	61 27.2%	57 25.4%	53 23.7%	2.51	1.10
4	I learn better when my teacher uses instructional materials in class	75 33.5%	65 29.0%	53 23.7%	31 13.8%	2.82	1.05
5	I create mental picture of what I read	104 46.4%	79 35.3%	25 11.2%	16 7.1%	3.21	0.91
6	I learn better when someone presents information in a pictorial form (e.g., pictures, flow chart)	60 26.8%	79 35.3%	48 21.4%	37 16.5%	2.72	1.03
7	I enjoy watching other students discussion about issues raised in the class with the help of interpreter	39 17.4%	95 42.4%	32 14.3%	58 25.9%	2.51	1.06
8	I learn better when someone uses visual aids (e.g., white board, power point) to represent a subject	90 40.2%	58 25.9%	36 16.1%	40 17.9%	2.88	1.13
9	I learn better when I watch demonstration	169 75.4%	34 15.2%	20 8.9%	1 0.4%	3.66	0.66
10	I make lists and notes because I remember things better if I write them down	66 29.5%	102 45.5%	29 12.9%	27 12.1%	2.92	0.95
Weighted mean = 2.92							
		Kinaesthetic					
11	I prefer to work with other students in the laboratory during practicals	96 42.9%	78 34.8%	32 14.3%	18 8.0%	3.13	0.94
12	I learn practical tasks better than theoretical ones	71 31.7%	97 43.3%	34 15.2%	22 9.8%	2.97	0.93
13	I learn better when I manipulate learning materials on my own	75 33.5%	65 29.0%	53 23.7%	31 13.8%	2.82	1.05
14	Most of my free time is spent doing physical activities or making things	151 67.4%	48 21.4%	23 10.3%	2 0.9%	3.55	0.71
15	I enjoy discussing my ideas about course content with other students	112 50.0%	69 30.8%	28 12.5%	15 6.7%	3.24	0.92
16	I learn better through seminal and training	46 20.5%	97 43.3%	52 23.2%	29 12.9%	2.71	0.94
17	I learn better when I am involved in a task	51 22.8%	38 17.0%	56 25.0%	79 35.3%	2.27	1.17
18	I like to solve problems or answer questions before any body else can	121 54.0%	49 21.9%	34 15.2%	20 8.9%	3.21	1.01
19	When I am in the class, I learn better when my teacher asks me to practise	61 27.2%	80 35.7%	48 21.4%	35 15.6%	2.75	1.03
20	When I am reading I move my lips.	88 39.3%	82 36.6%	33 14.7%	21 9.4%	3.06	0.96
Weighted mean = 2.79							
Grand weighted mean = 2.94							
Standard mean = 2.50							

Table 4.4 showed the responses of students with hearing impairment to their learning styles. The results indicated the grand weighted mean of 2.92 and 2.79 for visual and kinaesthetic learning style respectively which are higher than the standard mean of 2.50. This showed that most of the students with hearing impairment are visual leaners, while the remaining ones were kinaesthetic learners. The results also showed that most of them preferred the following visual activities; learn better when they watched demonstration (3.66>2.50), prefer to learn by reading textual materials (3.51>2.50), create mental picture of what they read (3.21>2.50), make lists and notes because they remember things better if they write them down (2.92>2.50), learn better when someone uses visual aids (e.g., white board, power point) to represent a subject (2.88>2.50), learn better when their teacher uses instructional materials in class (2.82<2.50), learn better when they watched educational programmes (2.76>2.50), I learn better when someone presents information in a pictorial form (e.g., pictures, flow chart) (2.72>2.50), I enjoy watching other students discussion about issues raised in the class with the help of interpreter (2.51>2.50). Table 4.4 further revealed that the remaining students preferred the following kinaesthetic learning styles: Most of their free time they spent doing physical activities or making things (3.55>2.50) they enjoyed discussing their ideas about course content with other students (3.24>2.50), they like to solve problems or answer questions before anybody else can (3.21>2.50), they preferred to work with other students in the laboratory during practicals (3.13>2.50), When I am reading I move my lips (3.06>2.50), I learn practical tasks better than theoretical ones (2.97>2.50), I learn better when I manipulate learning materials on my own (2.82>2.50I learn better through seminal and training (2.71>2.50).

Research question 2a: What are the level of availability, accessibility and utilization of instructional supports with respect to students with hearing impairment in biology?

Table 4.5: Availability, Accessibility and Utilization of Instructional Supports for Students with Hearing Impairment

S/N	Items	A	NA	AC	NAC	U	NU
Human support							
1	Sign language interpreter	90 40.2%	134 59.8%	22 24.4%	68 75.6%	22 100%	- -
2	Notetakers	74 33.0%	150 67.0%	21 28.4%	53 71.6%	21 100.0%	- -
3	Lip speaker	- -	224 100.0%	- -	224 100.0%	- -	224 100.0%
4	Communication support workers	- -	224 100.0%	- -	224 100.0%	- -	224 100.0%
Technical support							
5	Radio microphone system	- -	224 100.0%	- -	224 100.0%	- -	224 100.0%
6	Induction loop	- -	224 100.0%	- -	224 100.0%	- -	224 100.0%
7	Digital recorder	- -	224 100.0%	- -	224 100.0%	- -	224 100.0%
8	Science laboratory	90 40.2%	134 59.8%	90 40.2%	- -	90 40.2%	- -

KEY

A- AVAILABILITY

NA- NON AVAILABILITY

AC- ACCESSIBILITY

NAC- NON ACCESSIBILITY

U- UTILIZATION

NU- NON UTILISATION

Table 4.5 revealed that 90 respondents (40.2%) agreed that sign language interpreters were available, out of which 22 (24.4%) agreed that Sign Language Interpreters were accessible and utilised. 74 (33.0%) of the respondents indicated that note takers were available, 21 (28.4%) of the 74 respondents agreed that they were accessible and utilised. 90 (40.2%) agreed that science laboratories were available, accessible and utilised 224 (100.0%) indicated that lip speaker, communication support workers, radio microphone system, induction loop and digital recorder were not readily available. This implies that sign language interpreters were available but not sufficient and those that were available were not readily accessible, few science laboratories were available, and the available ones were readily accessible and utilised, note takers were not sufficient and out of the available ones, only few were utilized, while lip speaker, communication support workers, radio microphone system, induction loop and digital recorder were not available at all.

Table 4.6 indicated that 74 (33.3%) of the respondents agreed that CD-ROM, Control software, Multimedia, Computer and Video tape player were available but not sufficient. 30 (40.5%) out of the 74 respondents who indicated that CD-ROM were available, agreed that they were utilised. 19 (25.8.3%) of the 74 respondents indicated that control software were accessible while only 7 out of the 19 respondents indicated that they were utilised. 30 (40.5%) of the 74 respondents indicated that multimedia were accessible and 13 (43.3%) of these 30 respondents indicated that they were utilised.18 (24.3%) of the 74 respondents agreed that computers were accessible and utilised. 26 (35.1%) of the 74 respondents who indicated availability of video tape player, only 17 (65.4%) agreed that they were utilised. It further revealed that data logging, logo or turtle graphics, overhead projector and power point were not available.

Research question 2b: What is the level of availability, accessibility and utilization of information communication technology (ICT) with respect to students with hearing impairment in biology?

Table 4.6 Availability, Accessibility and Utilization of ICT

S/N	Items	A	NA	AC	NAC	U	NU
1	CD-ROM	74 33.0%	150 67.0%	30 40.5%	44 59.5%	30 40.5%	- -
2	Control software	74 33.0%	150 67.0%	19 25.8%	55 74.3%	7 36.8%	12 63.2%
3	Data logging	- -	224 100.0%	- -	224 100.0%	- -	224 100.0%
4	Logo or turtle graphics	- -	224 100.0%	- -	224 100.0%	- -	224 100.0%
5	Multimedia	74 33.0%	150 67.0%	30 40.5%	44 59.5%	13 43.3%	17 57.7%
6	Whiteboards	149 66.5%	75 33.5%	149 66.5%	- -	149 100.0%	- -
7	Overhead projector	- -	224 100.0%	- -	224 100.0%	- -	224 100.0%
8	Computer	74 33.0%	150 67.0%	18 24.3%	56 75.7%	18 100.0%	- -
9	Power Point	- -	224 100.0%	- -	224 100.0%	- -	224 100.0%
10	Video tape player	74 33.0%	150 67.0%	26 35.1%	48 64.9%	17 65.4%	9 34.6%

KEY

A- AVAILABILITY

NA- NON AVAILABILITY

AC- ACCESSIBILITY

NAC- NON ACCESSIBILITY

U- UTILIZATION **NU**- NON UTILISATION

Research question 3: What is the performance of students with hearing impairment in biology?

Table 4.7: Performance of Students with Hearing Impairment in Biology

Level	**Range**	**Frequency**	**Percentage**
Low	0-10	138	61.60
Medium	11-20	65	29.00
High	21-40	21	9.40
Total		224	100.00
Mean = 18.31			

The above table 4.7 showed that 138 students (61.60%) scored between 0 and 10 marks. 65 (29%) of students scored between 11 and 20 marks, while 21 students scored between 21 and 40 marks. This indicated that students that scored between 0-10 had low scores, those scored between 11 and 20 had medium scores while students that scored between 21 and 40 had high scores.

Table 4.7 indicated that the mean performance (18.31) of students with hearing impairment in Biology was below the Standard Mean (20.00). This is because 203 (90.60%) of the participants had low (0-10; 61.60%) and medium (11-20; 29.00%) performance, while 21 (9.40 %) had high level of performance (21-40) in the subject. Therefore, the performance of students with hearing impairment in Biology was poor.

Table 4.8 presents the attitude of students with hearing impairment as revealed from their responses to Biology learning. It indicated the weighted mean of 2.46 out of the maximum obtainable score of 4.00, which was lower than the standard mean of 2.50. This indicated that students with hearing impairment had fairly moderate attitude towards Biology learning. It further revealed that 15 items out of the 30 items contributed to these fairly moderate towards Biology learning. The contributing items were rated as follow: Biology gives me an opportunity to work as a scientist (1.46<2.46), followed by Biology helps me to understand the human body system (1.96<2.46), I enjoy studying Biology even without the teacher teaching me (1.96<2.46), I think the society needs more biologists because of its importance (2.05<2.46), I believe the knowledge of Biology will keep our health stable (2.07<2.46), I have to work harder in studying Biology than in other areas of science (2.09<2.46), I find studying natural phenomena an exciting part of Biology (2.09<2.46), I find Biology class very boring due to abstract nature of some concepts (2.11<2.46), Studying Biology improves one's manipulative skill (2.13<2.46), I love topics related to environmental issues (2.17<2.46), I am excited when I am taught in the laboratory (2.30<2.46), I prefer to tell everyone the advantage one could get from Biology (2.30<2.46), I like Biology because it takes me outside the classroom (2.34<2.46), Knowledge of Biology makes it easier for me to solve simple problems in my environment (2.46 = 2.46), lastly, I am interested in issues that affect the quality of my environment (2.46= 2.46). While the remaining 16 items were above the weighted mean, which implies that they were not contributing to the fairly moderate attitude of the students with hearing impairment to Biology learning.

Research question 4: What is the attitude of students with hearing impairment towards biology learning?

Table 4.8: Attitude of Students with Hearing Impairment Towards Biology Learning

S/N	Items	SA	A	D	SD	Mean	STD.D
1	I love Biology as a subject	65 29.0%	64 28.6%	41 18.3%	54 24.1%	2.63	1.14
2	Biology helps me to understand the human body system	22 9.8%	47 21.0%	56 25.0%	99 44.2%	1.96	1.02
3	I enjoy studying Biology even without the teacher teaching me	28 12.5%	39 17.4%	52 23.2%	105 46.9%	1.96	1.07
4	Biology is very difficult to understand	48 21.4%	36 16.1%	55 24.6%	85 37.9%	2.79	1.17
5	I do not like Biology	50 22.3%	38 17.0%	38 17.0%	98 43.8%	2.82	1.21
6	I think the knowledge of 5Biology makes me understand my life	83 37.1%	40 17.9%	37 16.5%	64 28.6%	2.63	1.26
7	I like Biology because it takes me outside the classroom	48 21.4%	36 16.1%	61 27.2%	79 35.3%	2.34	1.15
8	I find studying natural phenomena an exciting part of Biology	46 20.5%	29 12.9%	47 21.0%	102 45.5%	2.09	1.19
9	I prefer to tell everyone the advantage one could get from Biology	53 23.7%	37 16.5%	57 25.4%	77 34.4%	2.30	1.17
10	The study of Biology makes man understands himself better	85 37.9%	43 19.2%	41 18.3%	55 24.6%	2.71	1.21
11	I believe the knowledge of Biology will keep our health stable	25 11.2%	62 27.7%	41 18.3%	96 42.9%	2.07	1.07
12	I find Biology class very boring due to abstract nature of some concepts	95 42.4%	34 15.2%	71 31.7%	24 10.7%	2.11	1.09
13	Studying Biology improves one's manipulative skill	30 13.4%	68 30.4%	26 11.6%	100 44.6%	2.13	1.13
14	Biology gives me an opportunity to work as a scientist	60 26.8%	53 23.7%	40 17.9%	71 31.7%	1.46	1.19
15	Knowledge of Biology makes it easier for me to solves simple problems in my environment	65 29.0%	52 23.2%	29 12.9%	78 34.8%	2.46	1.24
16	I have to work harder in studying biology than in other areas of science	27 12.1%	54 24.1%	55 24.6%	88 39.3%	2.09	1.06
17	I think the rate at which the knowledge of Biology is growing in the country will bring about increase in population	166 74.1%	35 15.6%	21 9.4%	2 0.9%	3.63	0.69
18	Biology will be useful to me when 1 leave school	143 63.8%	65 29.0%	13 5.8%	3 1.3%	3.55	0.67
19	I hope to specialise in Biology or any biological related field	56 25.0%	54 24.1%	93 41.5%	21 9.4%	2.65	0.96
20	Education will not be complete for any science students who do not have a good knowledge of Biology	54 24.1%	50 22.3%	84 37.5%	36 16.1%	2.55	1.03
21	I will like students to learn conservation of resources in Biology	61 27.2%	48 21.4%	86 38.4%	29 12.9%	2.63	1.02
22	Biology gives room for me to develop my creativity	24 10.7%	44 19.6%	83 37.1%	73 32.6%	2.09	0.97
23	I think the society needs more biologists because of its importance	18 8.0%	59 26.3%	62 27.7%	85 37.9%	2.05	0.98
24	I tend to become easily discouraged when 1 do not understand Biology topics	63 28.1%	62 27.7%	46 20.5%	53 23.7%	2.60	1.13
25	There will be healthier environment if most people are exposed to Biology knowledge areas	108 48.2%	53 23.7%	30 13.4%	33 14.7%	3.05	1.10
26	When you know a lot about your environment, you can control it better	92 41.1%	55 24.6%	46 20.5%	31 13.8%	2.93	1.08
27	I am interested in issues that affect the quality of my environment	56 25.0%	65 29.0%	46 20.5%	57 25.4%	2.46	1.12
28	I love topics related to environmental issues	38 17.05	50 22.3%	49 21.9%	87 38.8%	2.17	1.13
29	I am excited when am taught in the laboratory	42 18.8%	52 23.2%	61 27.2%	69 30.8%	2.30	1.10
30	I enjoy biology practical than theory	56 25.0%	67 29.9%	48 21.4%	53 23.7%	2.56	1.11
Weighted mean = 2.46							

Research question 5a: What is the relationship of personal factors (onset of hearing loss, degree of hearing loss, self efficacy and learning style) to performance of students with hearing impairment in Biology? This relationship is captured in Table 4.9A - 4.9C

Table 4.9a: Correlation Matrix Showing the Relationship between Onset of Hearing Loss and Performance of Students with Hearing Impairment in Biology

Variables	Mean	S.D.	df	r	P-value	Remark
Performance	24.96	4.35	222	-0.047	0.517	N.S.
Onset of hearing loss	1.54	0.50				

N.S means not significant at p<0.05 level of significance

Table 4.9b: Relationship between Self-efficacy and Performance of Students with Hearing Impairment in Biology

Variables	Mean	S.D.	df	r	P-value	Remark
Performance	24.96	4.35	222	0.460*	0.000	Sig.
Self-efficacy	54.71	7.85				

* denotes significant at p<0.05 level of significant

Table 4.9c: Relationship Between Learning Style and Performance of Students with Hearing Impairment in Biology

Variables	Mean	S.D.	df	r	P-value	Remark
Performance	24.96	4.35	222	0.576*	0.000	Sig.
Learning style	85.09	14.43				

* denotes significant at p<0.05 level of significant

Table 4.9a showed a negative and low non-significant relationship ($r = -0.05$; $p>0.05$) between onset of hearing loss and performance of students with hearing impairment in Biology. This showed that onset of hearing loss of students with hearing impairment was not related to their performance in Biology.

Table 4.9b revealed that there was a positive and moderate significant relationship ($r = 0.46$; $p<0.05$) between self-efficacy and performance of students with hearing impairment in Biology. This showed that self-efficacy is one of the personal factors that is positively related to the performance of students with hearing impairment in Biology. This implies that as the self-efficacy of students with hearing impairment in Biology improves, there will also be a significant improvement in their performance in Biology.

Table 4.9c revealed that there was a positive and moderate significant relationship ($r = 0.58$; $p<0.05$) between learning style and performance of students with hearing impairment in Biology. This implies that learning style was related to performance of students with hearing impairment in Biology. This implies that learning style is necessary for an improvement in the performance of students with hearing impairment in Biology.

Table 4.10a revealed a positive, but low non-significant relationship ($r = 0.06$; $p>0.05$) between onset of hearing loss and attitude of students with hearing impairment to Biology.

Table 4.10b showed that the relationship ($r = 0.49$; $p<0.05$) between self-efficacy and attitude of students with hearing impairment to Biology was moderate and positively significant. This implies that self-efficacy of students with hearing impairment was significantly related to their attitude towards Biology. This indicated that as the self-efficacy of students with hearing impairment in Biology is improving, there will be a significant development of positive attitude towards Biology.

Table 4.10c revealed that there was a positive and moderate significant relationship ($r = 0.58$; $p<0.05$) between learning style and attitude of students with hearing impairment to Biology. This indicated that learning style of students with hearing impairment was significantly related to their attitude towards Biology. This implies that as the learning style of students with hearing impairment in Biology is enhanced, there will be a significant development of positive attitude towards Biology.

Table 4.11. It revealed that there was a negative and low non-significant relationship ($r = -0.02$, $p>0.05$) between use of instructional supports and performance of students with hearing impairment in Biology. This indicated that there was no significant relationship between the use of instructional supports and performance of students with hearing impairment in Biology.

Table 4.12 showed a negative and low not-significant relationship ($r = -0.06$, $p>0.05$) between Instructional supports and attitude of students with hearing impairment in Biology. This implies that Instructional supports almost did contribute to improvement on the attitude of students with hearing impairment to Biology. This implies that if instructional supports are made available in the teahing of students with hearing impairment, it will change their attitude to biology because this set of students are visual learners. They belief in their ability to perform better if sign language interpreters, lipspeakers, note takers communication supports are available. Also, if environmental noise are eliminated or reduced through induction loop, radio microphone system and other technical support gardgets, it will improve their performance in biology.

Table 4.13 indicated that there was a positive and moderate significant relationship ($r = 0.40$, $p<0.05$) between ICT use and performance of students with hearing impairment in Biology. This implies that there was a relationship between ICT use and performance of students with hearing impairment in Biology. This implies that with consistency in the use of ICT tools, the performance of students with hearing impairment in Biology will be enhanced.

Table 4.14 showed a positive and high significant relationship ($r = 0.81$, $p<0.05$) between ICT use and attitude of students with hearing impairment to Biology. This indicated that ICT use has high positive correlation to the attitude of students with hearing impairment to Biology. This implies that for students with hearing impairment to have high positive attitude towards Biology, ICT must be used in the teaching and learning process.

Research question 5b: What is the relationship that exists between personal factors and attitude of students with hearing impairment in biology? This relationship is captured in Table 4.10A -4.10C

Table 4.10a: Correlation Matrix Showing the Relationship between Onset of Hearing loss and Attitude of Students with Hearing Impairment to Biology

Variables	Mean	S.D.	df	r	P-value	Remark
Attitude	74.64	18.73	222	0.055	0.448	N.S.
Onset of hearing loss	1.54	0.50				

* denotes not significant at p>0.05 level of significant

Table 4.10b: Relationship between Self-efficacy and Attitude of Students with Hearing Impairment to Biology

Variables	Mean	S.D.	df	r	P-value	Remark
Attitude	74.64	18.73	222	0.485*	0.000	Sig.
Self-efficacy	54.71	7.85				

* denotes significant at p<0.05 level of significant

Table 4.10c: Relationship between Learning Style and Attitude of Students with Hearing Impairment to Biology

Variables	Mean	S.D.	df	r	P-value	Remark
Performance	24.96	4.35	222	0.576*	0.000	Sig.
Learning style	85.09	14.43				

* denotes significant at p<0.05 level of significant

Research question 6a: What is the relationship between the use of instructional supports and performance of students with hearing impairment in biology?

Table 4.11: Relationship between the Use of Instructional Supports and Performance of Students with Hearing Impairment

Variables	Mean	S.D.	df	r	P-value	Remark
Performance	24.96	4.35	222	-0.016	0.817	N.S.
Instructional support	9.33	0.47				

N.S denotes not significanct at $p<0.05$ level of significance

Research question 6b: What is the relationship between the use of instructional supports and attitude of students with hearing impairment in biology?

Table 4.12: Relationship between the Use of Instructional Supports and Attitude of Students with Hearing Impairment

Variables	Mean	S.D.	df	r	P-value	Remark
Attitude	74.64	18.73	222	-0.06	0.924	N.S.
Instructional support	9.33	0.47				

* denotes significant at p>0.05 level of significant

Research question 7a: What is the relationship between ICT use and performance of students with hearing impairment in biology?

Table 4.13: Relationship Between ICT use and Performance of Students with Hearing Impairment

Variables	Mean	S.D.	df	r	P-value	Remark
Performance	24.96	4.35	222	0.377*	0.000	Sig.
ICT use	9.25	3.77				

* denotes significant at p<0.05 level of significant

Research question 7b: What is the relationship between ICT use and attitude of students with hearing impairment to biology?

Table 4.14: Relationship between ICT Use and Attitude of Students with Hearing Impairment to Biology

Variables	Mean	S.D.	df	r	P-value	Remark
Attitude	74.64	18.73	222	0.807*	0.000	Sig.
ICT use	9.25	3.77				

* denotes significant at p<0.05 level of significant

Table 4.15 indicated that the composite contribution of the independent variables (personal factors, instructional supports, and ICT use) to the prediction of the performance of students with hearing impairment in Biology was significant ($F_{(5,188)} = 23.32$; Adj $R^2 = 0.37$; $p<0.05$). This implies that when the personal factors, instructional supports, and ICT use are taken together, they predict performance of students with hearing impairment in Biology. It further showed a multiple regression coefficient (R = 0.62), that is, there was a high positive significant relationship between the independent variables and performance of students with hearing impairment in Biology. It also showed a multiple regression adjusted ($R^2 = 0.37$). This implies that 37.0% variation in the performance of students with hearing impairment in Biology was accounted for by the composite contribution of the independent variables while the remaining 63.0% may be due to other factors and residuals not under investigation in this model.

Table 4.16 showed that there was a significant composite contribution of the independent variables (personal factors, instructional supports, and ICT use) to attitude of students with hearing impairment to Biology ($F_{(5,188)} = 128.35$; Adj $R^2 = 0.77$; $p<0.05$). This implies that when the independent variables (personal factors, instructional supports, and ICT use) are taken together they jointly predict attitude of students with hearing impairment to Biology. It revealed a multiple regression coefficient (R = 0.88), this implies that the relationship between the independent variables and attitude of students with hearing impairment to Biology was positive, strong and significant. It further revealed that there was a multiple regression adjusted (R^2) of 0.77 which implies that 77.0% of the variations in the attitude of students with hearing impairment to Biology was due to the composite contribution of the independent variables while the remaining 23.0%% may be due to other factors and residuals not under investigation in this model.

Table 4.17 showed that the relative contribution of onset of hearing loss ($\beta = -0.08$; $t = -1.37$; $p>0.05$) and use of instructional supports ($\beta = 0.02$; $t = 0.39$; $p>0.05$) on performance of students with hearing impairment in Biology were not significant. The relative contributions of learning style ($\beta = 0.43$; $t = 5.13$; $p<0.05$), self-efficacy ($\beta = 0.16$, $t = 2.01$; $p<0.05$) and ICT use ($\beta = 0.13$, $t = 2.03$; $p<0.05$) on performance of students with hearing impairment in Biology were significant. This showed that learning style, self-efficacy and ICT use were the independents variable that relatively predicts performance of students with hearing impairment in Biology. It also revealed

the prediction power of the independent variable to students with hearing impairment in Biology at different levels and ranks as expressed by the β-values. Learning style ($\beta = 0.43$; $p<0.05$) >ICT use ($\beta = 0.13$, $p<0.05$)> self-efficacy ($\beta = 0.16$, $p<0.05$). This indicated that the strongest predictor of performance of students with hearing impairment in Biology is learning style, followed by ICT use, while self-efficacy is the least. This implies that for performance of students with hearing impairment in Biology to improve, learning style, ICT use and self-efficacy needed to be considered during the teaching and learning of Biology.

Research question 8a: What is the composite contribution of independent variables (personal factors, instructional supports, and ICT use) to performance of students with hearing impairment in biology?

Table 4.15: Multiple Regression Analysis Showing the Composite Contribution of Independent Variables on Performance of Students with Hearing Impairment

Sources of Variance	Sum of Squares	df	Mean Square	F	Significant
Regression	22573.096	5	4514.619	23.319	0.000*
Residual	36397.590	188	193.604		
Total	58970.686	193			
R = 0.619 R Square = 0.383 Adjusted R Square = 0.366 Std. Error of the Estimate = 13.91417					

Research question 8b: What is the composite contribution of independent variables (personal factors, instructional support, and ICT use) to attitude of students with hearing impairment towards biology?

Table 4.16: Multiple Regression Analysis Showing the Composite Contribution of Independent Variables on Attitude of Students with Hearing Impairment Towards Biology

Sources of Variance	Sum of Squares	df	Mean Square	F	Significant
Regression	55669.653	5	11133.931	128.351	0.000*
Residual	16308.290	188	86.746		
Total	71977.943	193			
R = 0.879 R Square = 0.773 Adjusted R Square = 0.767 Std. Error of the Estimate = 9.31377					

Research question 9a: What is the relative contribution of independent variables (personal factors, instructional supports, and ICT use) to performance of students with hearing impairment in biology?

Table 4.17: Multiple Regression Analysis Showing the Relative Contribution of Independent Variables to Performance of Students with Hearing zImpairment

Model	Under standardized Coefficients	Standardized Coefficient		Rank	t	Sig.
	B value	Std. Error	Beta (β)			
(Constant)	-21.497	22.087			-0.973	0.332
Onset	-2.762	2.009	-0.079		-1.374	0.171
Learning style	0.505	0.098	0.429	1st	5.130	0.000*
Self-efficacy	0.358	0.178	0.162	3rd	2.014	0.045*
Use of instructional support	0.832	2.132	0.023		0.390	0.697
ICT use	0.587	0.290	0.129	2nd	2.026	0.044*

Research question 9b: What is the relative contribution of independent variables (personal factors, instructional supports, and ICT use) to attitude of students with hearing impairment towards biology?

Table 4.18: Multiple Regression Analysis Showing the Relative Contribution of Independent Variables to Attitude of Students with Hearing Impairment Towards Biology

Model	Under standardized Coefficients	Standardized Coefficient		Rank	T	Sig.
	B value	Std. Error	Beta (β)			
GG (Constant)	-18.776	14.784			-1.270	0.206
Onset	0.173	1.345	0.004		0.128	0.898
Learning style	0.412	0.066	0.316	2nd	6.244	0.000*
Self-efficacy	0.156	0.119	0.064		1.309	0.192
Use of instructional	1.981	1.427	0.049		1.388	0.167
support				1st		
ICT use	3.337	0.194	0.661		17.195	0.000*

Table 4.18 showed that the relative contributions of onset of hearing loss (β = 0.004; t = 1.13; p>0.05), self-efficacy (β = 0.06, t = 1.31; p>0.05) and use of instructional supports (β = 0.05; t = 1.39 p>0.05) to attitude of students with hearing impairment to Biology were not significant. While the relative contributions of learning style (β = 0.32; t = 6.24; p<0.05) and ICT use (β = 0.66, t = 17.20; p<0.05) to attitude of students with hearing impairment to Biology were significant. This implies that learning style and ICT use were the independent variables that relatively predict attitude of students with hearing impairment to Biology. It also showed the extent of prediction of the independent variables to attitude of students with hearing impairment to Biology at different levels and ranks as expressed by the β-values. ICT use (β = 0.66; p<0.05) >learning style (β = 0.32, p<0.05). ICT use was a stronger predictor of attitude of students with hearing impairment to Biology than learning style. This implies that for students with hearing impairment to develop positive attitude towards Biology, ICT use and learning style need to be considered during the learning of Biology.

4.2 Summary of Findings

1a. Majority of the students with hearing impairment had post- lingual hearing loss.

1b. Majority of the students with hearing impairment had profound hearing loss.

1c. **S**elf-efficacy of the students with hearing impairment to Biology was high.

1d. Most of the students with hearing impairment were visual learners, while the remaining ones were kinaesthetic learners.

2a. **S**ign language interpreters were available but not sufficient and those that were available were not readily accessible while Note takers and science laboratory were not sufficient.

2b. Most of information communication technologies (ICT) with respect to the students with hearing impairment in Biology were not available and those that were available were not accessible and utilised.

3. Performance of the students with hearing impairment in Biology was poor.

4. The students with hearing impairment had fairly moderate negative towards Biology.

5ai. A negative and weak non-significant relationship between onset of hearing loss and performance was observed. This indicated that onset of hearing loss of students with hearing impairment was not related to their performance in Biology.

5aii. There was a significant relationship between self-efficacy and performance of the student in Biology.

5aiii. A positive, moderate significant relationship between learning style and performance of students was recorded. That is, learning style was related to performance of students with hearing impairment. Thus, learning style of students is important for students with hearing impairment performance in Biology.

5bi. A positive and weak non-significant relationship ($r = 0.06$; $p>0.05$) between onset of hearing loss and attitude of students with hearing impairment to Biology was obtained.

5bii. Self efficacy of students with hearing impairment was to Biology was moderate, positive and significant ($r = 0.49$; $p<0.05$). This implies that self-efficacy of students with hearing impairment was significantly related to their attitude towards Biology.

5biii. There was a positive, moderate significant relationship ($r = 0.61$; $p<0.05$) between learning style and attitude of students with hearing impairment to Biology. This implies that as the learning style of students with hearing impairment in Biology is enhanced, there will be a significant development of positive attitude towards Biology.

6a. A negative and weak non-significant relationship between use of instructional support and performance of students was observed. This indicated that there was no relationship between the use of instructional supports and performance of students with hearing impairment in Biology.

6b. A negative and weak non-significant relationship between instructional supports and attitude of students was obtained. This implies that instructional supports had no effect on the attitude of students with hearing impairment to Biology.

7a. A low positive, significant relationship between ICT use and performance of students was recorded. This implies that the consistency in the use of ICT tools will enhance Biology learning of students with hearing impairment.

7b. A high positive, significant relationship between ICT use and attitude of students was observed. This implies that students had positive attitude towards Biology and the use of ICT tools.

8a. A composite contribution of the independent variables (personal factors, instructional supports, and ICT use) to the prediction of the performance of students with hearing impairment in Biology is significant. Findings showed that there was a positive, moderate significant relationship under investigation in this study.

8b. A significant composite contribution of the independent variables (personal factors, instructional supports, and ICT use) on attitude of students with hearing impairment to Biology was observed.

9a. Onset of hearing loss on performance of students with hearing impairment in Biology is not significant.

9b. Contributions of Self-efficacy and ICT use on performance of students with hearing impairment in Biology were significant.

9c. Contributions of onset of hearing loss, self-efficacy and use of instructional support to attitude of students were not significant while, the relative contributions of learning style to attitude of students with hearing impairment to Biology were significant.

4.3 Discussion of Findings

4.3.1 Descriptive indices of students with hearing impairment with respect to onset of hearing loss

The result showed that majority of the students with hearing impairment had their hearing loss after birth. This implies that they have post natal impairment which could be either prelingual or post lingual in nature. The results of the findings supports the result of Ogundiran and Olaosun (2013) who reported that acquired deafness is a condition of hearing which was not present at birth but develops sometimes during the person's life time in Nigeria. Ademokoya (2006) stated that the person who sustains hearing loss later in life must have acquired some communicative skills (especially verbal signals) for which he or she could function relatively better than those with prelingual hearing disability in academic and interactive engagements in Ibadan. ASLHA(2021) emphasized that prelingual hearing impairment affects the entire personality of the person and little opportunity to communicate meaningfully in educational context also that loosing hearing early in life is more limiting than loosing hearing later in life especially after speech must has been acquired in America.

4.3.2 Descriptive indices of students with hearing impairment with respect to degree of hearing loss

The results of this study revealed that majority of the students with hearing impairment have profound hearing loss. This implies that profound hearing loss is the predominant hearing loss among these students with hearing impairment (respondents) in Oyo State. This was contrary to the findings of Kelleher (2011) who in his study found that moderate hearing impairment was more prevalent than profound hearing impairment in Beni, Bolivia. This finding also was contrary to the findings of Beria, Raymann and Gigante (2007) who in their study revealed that moderate hearing loss was the most common or predominant degree of hearing loss among respondents with hearing impairment in Brazil. This supports the assertion of Jaiyeoba and Adeyemo (2018) that profound hearing loss is a major disability in Nigeria which affects all aspect of life. They also suggested that variations may exit according degree of hearing loss across the globe.

4.3.3 Descriptive indices of students with hearing impairment with respect to self-efficacy

The outcome of this research revealed that the self efficacy of students with hearing impairment was high as indicated in the study. This finding implies that respondent's self-belief in Biology triggered higher performance in the subject. The study was contrary to the findings of Adigun (2016) who affirmed that there was no significant main effect of self efficacy on students with hearing impairment performance in Biology in Ibadan. Aderoke, Amos, Tawakalitu and Adenike (2020) discussed that students with hearing impairment need more than ability and skills in order to perform successfully well in their academics; they also need the sense of efficacy to use them well and to regulate their learning in Oyo.

4.3.4 Descriptive indices of students with hearing impairment with respect to Learning style

This study showed that students with hearing impairment learn better from visual activities like demonstration teaching which are mostly supported by instructional materials (models, videos, charts and other concrete materials). They learn better when they watch demonstration, use visual aids to represent a subject, create mental picture of what they read and hear, solve problems or answer questions before anybody else can and prefer to work with other students. This supported the study of Ilcin, Tomruk, and Yesilyaprak (2018) which stated that relationship exists between the learning style and academic performance of students with hearing impairment in Turkey. This also corroborate Qi and Mitchell (2012) who clearly stated that there was relationship between student learning styles and the academic performance of students with hearing impairment because of provision or availability of Sign Language or Sign Language Interpreters in Nigeria. It also supported Econlearningstyle (2020) which stated that most people are visual learners in Cebu Technological University- Danao. Also, Cecilia, Cornelius U, Edoho , Richard. (2019) opined that visual learners learn better by seeing what they need in Calabar.

4.3.5 Level of availability, accessibility and utilization of human support with respect to students with hearing impairment in Biology.

The results showed that sign language interpreters were available but not sufficient and those that were available were not readily accessible, note takers were

not sufficient and out of the available ones, only few were utilized, science laboratory was available but not sufficient, while lip speaker, communication support workers, radio microphone system, induction loop and digital recorder were not available at all. This supported the view of Joel, Kochung, Kabuka, Charles and Oracha (2013) that schools who have students with hearing impairment on their enrolment had inadequate learning support services while the available ones were not easily accessible by the students in Zimbabwe. Mazoue (2011) who Stated that sign language interpreters play a unique role in supporting students with hearing impairment in overpowering some of the problems caused by their poor literacy in Durban. Magongwa (2008) stated that sign language interpreters and note-takers are important in facilitating learning by students with hearing impairment learning in Johannesburg. This insufficient and non-availability of human support agrees with the findings of Bell, Swart and Carl (2016) who found that students with hearing impairment lack needed human support in South Africa

4.3.6 Level of Availability, accessibility and utilization of information communication technology (ICT) with respect to students with hearing impairment in Biology

Information and Communication Technology (ICT) with respect to students with hearing impairment in Biology was not completely available, accessible and utilised in the teaching of students with hearing impairment as revealed by this study. It was further shown that data logging, logo or turtle graphics, overhead projector and power point were not available. This supported the findings of Mereku, Yidana, Hordziand, Tetemensah and Williams (2009) who found that some schools had computer laboratories and few computers were available in Ghana. The finding supports the findings of Dadzie-Bonney and Hayford (2017) who reported that students with hearing impairment lacked access to functional ICT toolsin Ghana. A good number of these students might not have handled these necessary equipments. This finding is in agreement with the findings of Adebi-Caesar (2012) and Bingimlas (2009) who in their separate studies revealed lack of access to ICT tools as a complex barrier to its utilization, especially among students with hearing impairment in Ghana.

4.3.7 Performance of students with hearing impairment in Biology

The findings revealed that performance of students with hearing impairment in Biology was poor. Majority of this category of students had low grades and very few of them had high grades. This finding was a fall out of the effect of their hearing impairment. This supported the report of Ogunbowale (2014) who indicated that students achieved poorly in secondary school science especially in Biology in Nigeria. This also supported the reports of Ogundiran and Olaosun (2013) that academic performance of students with hearing impairment was poor in Nigeria. Qi and Mitchell (2011) reported that academic performance of students with hearing impairment continues to be lagging behind their hearing peers in Nigeria. Adigun (2016) affirmed that learning outcome of students with hearing impairment in Biology has not been satisfactory in Ibadan. Nwagbo (2015) was of the view that one subject most students opt for in their final examination is Biology, yet performance has not been encouraging in Nigeria.

4.3.8 Attitude of students with hearing impairment to Biology learning

Findings from this study revealed that students with hearing impairment' attitude towards Biology learning indicated fairly moderate negative attitude. This implies that students with hearing impairment had fairly moderate negative attitude towards biology. These fairly moderate towards Biology may be due to the facts that they do not belief that biology could give them an opportunity to work as scientists. They found biology class very boring due to the abstract nature of some concepts and that they were not interested in issues that affect the quality of their environment. This fairly moderate negative attitude towards biology corroborated the findings of Massie (2006) that attitude of students with hearing impairment to learning is the major barrier to their full participation in learning. Nicolaidou and Philoppou (2003) reported that students have negative attitude towards basic science tasks and if these negative attitude are not taken care of, it may become relatively permanent in Europe. This is in contrast with the findings of Usak, Holsterman, Grube and Bogeholzis (2009) who in their study found students' attitude towards Biology was neutral in Japan.

4.3.9 Relationship between personal factors and performance of students with hearing impairment in Biology

Results from the study indicated a negative, weak non-significant relationship between onset of hearing loss and performance of students with hearing impairment in Biology. This implies that onset of hearing loss of the students was not related to their performance in Biology. This supports the findings of Ogundiran and Olaosun (2013) that there was no significant relationship between onset of hearing loss and performance of students with hearing impairment in mathematics and English language in Nigeria. Also, Adigun (2016) reported that there was no significant effect of onset of hearing loss on students with hearing impairment performance in Biology in Ibadan.

The result also showed that there was a positive, moderate significant relationship between self-efficacy and performance of these students in Biology. This implies that as the self-efficacy of students with hearing impairment in Biology improves, there will also be a significant improvement in their performance in Biology. This may be due to the fact that students with hearing impairment believe they could perform a given task in Biology class by utilising their own abilities. They belief they will succeed in whatever career path they choose; understand their homework no matter whom they are; they can significantly improve on their talent and that they could get the best grade in class if they try. This finding supports the findings of Ekeh and Oladayo (2015) who found that self-efficacy was positively related to academic performance among special needs students in Nigeria. This finding corroborates the findings of Capara, Vecchione, Alessandri, Gerbino and Barbaranelli (2011) that self-efficacy beliefs of students with hearing impairment contribute significantly to their academic performance and decisions in Britain. This finding also corroborated the work of Ogunmakin (2013) who found that there was positive association between self-efficacy and academic performance in Ondo. Awoyale and Keshinro (2013) affirmed that students' self efficacy/beliefs enhanced academic performance in Ogun State.

This study revealed that there was a positive, moderate significant relationship between learning style and performance of students with hearing impairment in Biology. This implies that learning style was related to students with hearing impairment performance in Biology. This may be due to the fact that they learn better when they watch demonstration, uses visual aids to represent a subject, create mental

picture of what they read and hear, solve problems or answer questions before anybody else can and prefer to work with other students. This finding supported the findings that learning styles play an important role in student's ability to structure information successfully in New York (She, 2005). This also agrees with the findings of Mutua (2015) who discovered a positive and statistically significant relationship between learning styles and academic performance for the trimodal learners Kenya. This finding was contrary to the findings of Abidin, Razaee, Abdullah and Singh (2011) who in their study found that there was no significant relationship between overall academic performance and learning styles in Jambi. Al-Hebaishi (2012), found that learning styles preferences did not seem to affect or predict academic performance of students Saudi. Also, Gappi (2013) found that there was no significant statistical correlation between the academic performance and the learning style preferences of the students in Chile.

4.3.10 Relationship between personal factors and attitude of students with hearing impairment in Biology

The study revealed that self efficacy of the students with hearing impairment to Biology was moderate and positively significant. This implies that self-efficacy of these students was significantly related to their attitude towards Biology. This supported the findings of Kundu and Ghose (2016) that there was a significant positive relationship between self-efficacy and attitude of students with hearing impairment to mathematics in Kulkata. This was contrary to the findings of Adigun (2016) that there was no main significant effect of self efficacy on the attitude of students with hearing impairment in Biology in Ibadan.

Results from the study revealed that there was a positive, moderate significant relationship between learning style and attitude of the students with hearing impairment to Biology in Oyo state, Nigeria. This implies that as the learning style of students with hearing impairment in Biology is enhanced, there will be a significant development of positive attitude towards Biology. This supported the finding of Caliskan and Kilinc (2012) that there was a positive significant relationship between learning styles and students' attitude towards social studies in Kenya. This was contrary to the findings of Azizoglu and Cetin (2009) who found that learning styles did not affect the attitude of students towards their course of study in Kenya.

The findings of this study revealed that the relationship between onset of hearing loss and attitude of students with hearing impairment to Biology was not significant. This implies that the onset of hearing loss is not related to attitude of students with hearing impairment to Biology.. Bakare (2013) showed that onset of hearing loss had no influence on the attitude of students with hearing impairment towards Biology in Nigeria. It also corroborates the study of Adigun (2016) that there was no significant effect of onset of hearing loss and attitude of students with hearing impairment towards Biology in Ibadan.

4.3.11 Relationship between the use of instructional supports and performance of students with hearing impairment in Biology

Result of the study showed that there was a negative, low non-significant relationship between use of instructional supports and performance of students with hearing impairment in Biology. This indicated that there was no significant relationship between the use of instructional supports and performance of students with hearing impairment in Biology. This supported the findings of Antia, Reed and Kreimeyer (2005) who found that the use of instructional supports such as sign language interpreter was not related to performance of students with hearing impairmenin US. This was contrary to the findings of Mazoue (2011) who reported that instructional supports such as sign language interpreters have no significant relationship with students with hearing impairment poor literacy in Durban University. LDAA (2004) reported that instructional supports such as visual and meaningful presentation were related to students with hearing impairment understanding of the concepts in United State of America.

4.3.12 Relationship between the use of instructional supports and attitude of students with hearing impairment in Biology

Result showed that there was a negative, low significant relationship between Instructional supports use and attitude of students with hearing impairment in Biology. This implies that use of instructional supports had no effect on the attitude of students with hearing impairment to Biology. This was contrary to the findings of Michael, Lisa and Roland (2009) that note takers, sign interpreters and other instructional supports services influence students with hearing impairment factual attitude towards a particular subject in US. This was contrary to the findings of George (2006) who

reported that key factors in learning science was students' attitude and the development of positive attitude was related to instructional aids provided in Ghana (George, 2006). Adesoji (2008) who reported that a number of factors such as teaching methods and instructional supports, teachers' attitude and influence of parents have been identified as related to students' attitude towards science and performance in Nigeria.

4.3.13 Relationship between ICT use and performance of students with hearing impairment in Biology

Findings of the study indicated that there was a positive, low significant relationship between ICT use and performance of students with hearing impairment in Biology. This implies that with consistent use of ICT tools, the performance of students with hearing impairment in Biology will be enhanced. This may be due to the fact that ICT assists people with hearing impairment by providing them modern technology for learning and students with hearing impairment academic performance in Portharcourt (Salaudeen, 2015). ICT helps students with hearing impairment in reading and writing through the hearing and seeing processes in UK (Lasa, 2010). This finding of positive correlation between ICT use and students with hearing impairment performance in Biology corroborates the findings of Boniface (2013), Dike (2015) which in their separate studies found a positive correlation between the use of ICT and academic performance of students with hearing impairment in school subjects. This also supports the findings of Adigun (2016) that ICT use has positive relationship with hearing impairment students' performance in Biology in Ibadan.

4.3.14 Relationship between ICT use and attitude of students with hearing impairment to Biology

Result showed a positive, strong significant relationship between ICT use and attitude of students with hearing impairment to Biology. This implies that for students with hearing impairment to have positive attitude towards Biology, the use of ICT must be considered. The above result supports the findings of Kptyug (2006) who found that the use of ICT really motivates the students to develop independent learning strategies most especially in the study of vocabulary, presentation and report writing in Britain. This also supports the findings of Trans (2009) who found a significant impact on students' attitude through internet in Britain. This supported the

findings of Muraina, Adeleke and Rahman (2011) who in their separate studies reported that both ICT assisted strategy instruction is effective in enhancing students' attitudein learning Biology in Nigeria.

4.3.15 Composite contributions of independent variables (personal factors, instructional supports, and ICT use) to performance of students with hearing impairment in Biology

The result of the study indicated composite contributions of independent variables (personal factors, instructional supports, and ICT use) to prediction of performance of students with hearing impairment in Biology was significant. This implies that personal factors, instructional supports, and ICT use jointly predict performance of students with hearing impairment in Biology. According to Qi and Mitchell (2012) in their own study which clearly stated that there is a relationship between students' learning styles and the academic performance of students with hearing impairment due to the provision or availability of sign in Nigeria. Geni (2014) also found out that students with hearing impairment performed well in subjects that were taught by specialist than in those subjects taught by non – specialist in Tanzania. Mlimina (2009) and Mosha (2011) noted that availability and use of teaching and learning materials as well as specialised equipment is important in facilitating learning in students with hearing impairment in Nigeria. This supported the report of St Joseph University (2019) that teachers should use modern techniques and materials for instruction when working with children with hearing impairments in Kenya.

4.3.16 Composite contribution of independent variables (personal factors, instructional supports, and ICT use) to attitude of students with hearing impairment to Biology

The result revealed that there was a significant composite contribution of the independent variables (personal factors, instructional support, and ICT use) to attitude of students with hearing impairment. This implies that personal factors, instructional supports, and ICT use jointly influence attitude of students with hearing impairment to Biology when their joint contribution to attitudeare taken together. This is in line with the findings of Pajeere (2002) who affirmed that students' self-efficacy believes not only enhance academic performance; they promote intrinsic interest and reduce academic anxiety in Spain.

4.3.17 Relative contributions of independent variables (personal factors, instructional support, and ICT use) to performance of students with hearing impairment in Biology

The findings of the study revealed that onset of hearing loss did not predict performance of students with hearing impairment in Biology. The relative contributions of learning style, self-efficacy and ICT use on performance of students with hearing impairment in Biology were significant. The findings further revealed that learning style was the most potent variable that predicts performance of students with hearing impairment in Biology followed by ICT use and self-efficacy respectively. Learning style as the most potent predictor of performance of students with hearing impairment in Biology supports the findings of Ugochi (2018) and Mutua (2015) that learning styles significantly predict academic performance in Nigeria.

This also support the findings of Ekeh and Oladayo (2015) who found that self-efficacy positively predicted academic performance among special needs students in UK. This supports the findings of Egaga and Aderibigbe (2015) found in their study that the use of ICT has a major significant effect on students with hearing impairment's performance in economics in Nigeria. Adigun (2016) Stated that there was no main significant effect of self efficacy on the performance in and attitude of students with hearing impairment in Biology in Ibadan Nigeria.

4.3.18 Relative contributions of independent variables (personal factors, instructional support, and ICT use) to attitude of students with hearing impairment towards Biology

Result revealed that the relative contributions of onset of hearing loss, self-efficacy and use of instructional supports to attitude of students with hearing impairment to Biology were not significant. While the relative contributions of learning style and ICT use to attitude of students with hearing impairment to Biology were significant. This implies that learning style and ICT use relatively predicts students' attitude towards hearing impairment to Biology. It further showed that ICT use was the potent factor while learning style was the least predictor. This implies that for students with hearing impairment to develop positive attitude towards Biology, ICT use and learning style need to be considered during teaching –learning process.

This is in line with the view of Ndirika (2015) who affirmed that over reliance on traditional methods in Biology has tended to affect students' performance in the subject in Nigeria. This supports the findings of Caliskan and Kilinc (2012) that learning styles can determine to a great extent the kind of attitudestudents will develop towards the learning of social studies. This finding supports the findings of Egaga and Aderibigbe (2015) that ICT use is a relevant factor in predicting the attitudestudents with hearing impairment have towards economics in Nigeria. Adigun (2016) in his own study also affirmed that the use of computer was effective in enhancing performance of students with hearing impairment in Biology in Ibadan, Nigeria.

CHAPTER FIVE
SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents the discussion of the findings which is based on the result reported, conclusion, implication of the finding, contribution to knowledge, limitation of the study, recommendation and Suggestions for Further Studies.

5.1 Summary

This study extensively examined the relationships of Personal Factors, Instructional Supports, Information Communication Technology and Biology Learning Outcomes of Students with Hearing Impairment in Oyo State, Nigeria**.** The study adopted the survey research design of correlation type method. The seven schools and two hundred and twenty four (224) students with hearing impairment used for the study were purposefully selected. Seven instruments were also used for data collection. Data collected were analysed using descriptive statistics (frequency counts, percentages, means, and standard deviation), inferential statistics of Pearson Product Moment Correlation (PPMC) and Multiple Regression. The descriptive statistics was used to explain participants' demographic variables while Pearson Product Moment Correlation (PPMC) was used to test the relationship between each of the independent variables and dependent variables. Multiple Regression Analysis was used to analyse composite and relative contribution of the independent variables to the dependent variables. Descriptive statistics of frequency counts, percentages, mean, standard deviation, were used to analyse research questions 1, 2, 3and 4. Pearson Product Moment Corelation was used to analyse research questions 5, 6 and 7 while multiple Regression analysis was used for research questions 8 and 9.

The study was guided by nine (9) research questions which were measured descriptively and the inferential part was tested at 0.05 level of significance. The major findings of the study showed that students with hearing impairment self-efficacy to Biology and self-belief as a subject is high, sign language interpreters were available but not sufficient and those that were available were not readily accessible, note takers were not sufficient, lip speakers and communication support workers were

not available at all while few science laboratories that were available were not functioning. More so, it was stated that performance of students with hearing impairment in Biology was poor and finally, students' attitude towards Biology was fairly moderate and was contributing to poor Biology learning outcome of students with hearing impairment. The result indicated a composite contribution of the independent variables to the prediction of the performance of students with hearing impairment in Biology. It was revealed that there was a positive, moderate significant relationship in this model, significant composite contribution of the independent variables on attitude of students and the onset of hearing loss on performance of students with hearing impairment in Biology was not significant. It was further showed that the relative contributions of onset of hearing loss, self-efficacy and use of instructional support to attitude of students were not significant.

5.2 Conclusion

The study determined the effect of personal factors, instructional supports, and ICT use on Biology learning outcomes of students with hearing impairment in Oyo State, Nigeria. It measured learning outcomes from two different views which were the independent indicators and Biology learning outcomes of students with hearing impairment. It was also concluded that personal factors, instructional supports and ICT use should not be neglected in the school settings especially in the education of students with hearing impairment.

5.3 Implication of Findings

The study emphasised personal factors, instructional supports, ICT use and Biology learning outcomes of students with hearing impairment in Oyo State, Nigeria.

The findings of this study have implications for Biology teachers of students with hearing impairment in the senior secondary schools. With these findings, there is need of availabilities, accessibility and utilisation of instructional supports in Biology classroom to facilitate improved Biology learning outcome of students with hearing impairment. It has also become obvious that the current conventional strategies used by science teachers should be replaced with the use of ICT; this will no doubt enhance students' performance in science, particularly in Biology as a subject in the secondary schools especially with the peculiarities of the hearing problems of the participants.

5.4 Contributions to Knowledge

The study has contributed to the body of existing knowledge in the following ways:

1. The study established that self-efficacy and ICT utilization predicted better academic performance in Biology among students with hearing impairment.
2. The study indicated that learning style is a potent personal factor that predicts the attitude of students with hearing impairment to Biology.
3. The study established that few instructional supports for students with hearing impairment were available but not sufficient, and some of those that were available were not utilised.
4. Findings from this study would add to the pool of existing empirical literature in the field of education of student with hearing impairment.

5.5 Limitation of the study

This study was limited in scope to students with hearing impairment in Oyo State, Nigeria. More data would have been retrieved if a wider scope was used for the study. Also, lack of uniform sign language in scientific concept is a limitation. Some schools do not have sign language interpreters and some of the students did not understand sign language. Also, it took time for the teachers and sign language interpreters in some of the schools to get the attention of students with hearing impairment.

5.6 Recommendations

The following recommendations were made based on the findings of this study:

1. Students with hearing impairment should improve their attitude towards Biology learning for better academic performance through the use of digital technology.
2. Teachers and school authority should encourage the use of appropriate digital technology to enhance students with hearing impairment learning outcomes in Biology.
3. School principals should organize sign language workshops and seminars to improve academic performance among students with hearing impairment in Biology.

4. Ministry of education and school administrators need to employ more of the instructional supports to provide a variety of options for learners to learn and perhaps keep the pace with their hearing counterparts in regular schools.
5. Students with hearing impairment should improve their attitude towards Biology learning for better academic performance through the use of digital technology.
6. The period of teaching ICT to individuals with hearing impairment should be increased.
7. In ICT field, more personnel should be employed in the field, to make teaching and learning easier.
8. Parents should support individuals with hearing impairment in the aspect of encouragement, materially and financially to enhance their learning outcomes in Biology.
9. Government should provide adaptive and latest tools for secondary school students with hearing impairment to understand the concept of ICT and other methods to instil positive disposition to Biology learning in this group of learners.

5.7 Suggestions for Further Studies

This study has generated insights for further researchers into the effects of personal factors, instructional supports, information communication technology and Biology learning outcomes of students with hearing impairment in Oyo State, Nigeria, Further researchers should endeavour to replicate the study in junior secondary schools involving both public and private schools for the hearing impairment in Southwest Nigeria so that the generalizations could be made better. With improved technology, appropriate experiments can be undertaken to investigate the effectiveness of computer technology in teaching learners with hearing impairment. Similar studies should be conducted in Biology learning outcome to find out the effects of improvised instructional materials on the performance of students with hearing impairment among varied ability levels and their retention. Additional research works could investigate the impact of personal factors, instructional supports, information communication technology and Biology learning outcomes of students with hearing impairment in other locations and in other subjects.

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APPENDIX I

UNIVERSITY OF IBADAN
FACULTY OF EDUCATION
DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION (S.T.E)

GRASHA-RIECHMANN STUDENTS' LEARNING STYLE SCALE (GRSLSS)

Dear Respondent,

This questionnaire is meant for research purpose. Your response has nothing to do with you or your school. Be honest in your response as absolute confidentiality is assured.

SECTION A

Demographic Information

Name of school: _____

Class: _____

Instruction: please, tick () the appropriate box.

1). Age: 13-15 ( ) 16 -19 ( ) 20-25 ()

2). Religion : Christianity ( ) Islam ( ) Others ( ) (Specify)

3). Gender : Male ( ) Female ( )

4). Onset of hearing loss: Before Birth () After Birth ()

SECTION B

These items intend to investigate the style at which students with hearing impairment learn. Please, tick the appropriate options that best reflect your agreement or disagreement with the statement.

KEY: Strongly Agree =SA, Agree =A, Disagree = D, Strongly Disagree = SD.

Table 4:4 Learning style of students with hearing impairment

S/N	Statements	SA	A	D	SD	Mean	STD.D
	Visual						
1	I prefer to learn by reading textual materials						
2	I learn better when I watch educational programmes						
3	I create mental picture of what I want to study						
4	I learn better when my teacher uses						

	instructional materials in class						
5	I create mental picture of what I read						
6	I learn better when someone presents information in a pictorial form (e.g., pictures, flow chart)						
7	I enjoy watching other students discussion about issues raised in the class with the help of interpreter						
8	I learn better when someone uses visual aids (e.g., white board, power point) to represent a subject						
9	I learn better when I watch demonstration						
10	I make lists and notes because I remember things better if I write them down						
Kinaesthetic							
11	I prefer to work with other students in the laboratory during practicals						
12	I learn practical tasks better than theoretical ones						
13	I learn better when I manipulate learning materials on my own						
14	Most of my free time is spent doing physical activities or making things						
15	I enjoy discussing my ideas about course content with other students						
16	I learn better through seminal and training						
17	I learn better when I am involved in a task						
18	I like to solve problems or answer questions before any body else can						
19	When I am in the class, I learn better when my teacher asks me to practise						
20	When I am reading I move my lips.						

APPENDIX II

STUDENT SELF EFFICACY SCALE (SSES)

These items intend to investigate the academic self efficacy of students with hearing impairment. Please tick (v) the appropriate column.

Rating Scale: Very True = 4 True = 3Not quite true = 2Untrue = 1

	ITEMS	Very True	True	Not quite true	Untrue
	PART A- BELIEF IN PERSONAL ABILITY				
1.	I can learn what is being taught in class.				
2.	I will get better grades if my teacher likes me more.				
3.	I can figure out anything if I try enough.				
4.	I will graduate from secondary school.				
5.	If I practice every day, I can developany skill.				
6.	Once I have decided to accomplish something that is important to me, I keep trying to accomplish it, even if it is harder than I thought				
7.	I am connfident that I will achieve the goals that I set for myself.				
8.	When I am struggling to accomplish something difficult, I focus on my progress instead of feeling discouraged				
9.	I will succeed in whatever career path I choose				
10.	I will succeed in whatever course I choose.				
11.	I can get the better grade in class if I try enough.				
12.	It is not hard for me to get good grades in school.				
13.	I usually understand my homework.				
	PART B- BELIEFTHAT ABILITY GROWS WITH EFFORT				
14	I believe hard work pays off.				
15.	I think no matter whom you are, you can significantly improve on your talent.				
16.	My ability grow with effort				
17.	I believe the brain can be developed with much task.				
18.	I can change my basic level of ability considerably.				

APPENDIX III

STUDENTS' INVENTORY ON INSTRUCTIONAL SUPPORT (SIIS)

The following statements are developed to measure the level of availability, accessibility and utilization of Instructional support (Human and Technical support). Please, tick (v) the appropriate options that best reflect your agreement or otherwise with the statement.

KEY:

Available =A Not- available = NA Accessible = A Not Accessible= NA Utilized: U Not– Utilized = NU.

	ITEMS	Available (A)	Not Available (NA)	Accessible (A)	Not Accessible (NA)	Utilized (U)	Not Utilized (NU)
	A. HUMAN SUPPORT						
1.	Signlanguage Interpreter						
2.	Notetakers						
3.	Lip speakers						
4.	Communication Support Workers						
	B. TECHNICAL SUPPORT						
5.	Radio Microphone System						
6.	Induction Loop						
7.	Digital Recorder						
8	Science Laboratory						

APPENDIX IV

STUDENT INVENTORY ON INFORMATION COMMUNICATION TECHNOLOGY (SIICT)

The inventory is to measure availability, accessibility and utilization of Information Communication Technology (ICT). Please, tick (v) the appropriate options that best reflect your agreement or otherwise with the statement.

KEY:Available =A Not- available = NA Accessible = A Not Accessible= NA Utilized: U Not– Utilized = NU.

	ITEMS	**Available (A)**	**Not Available (NA)**	**Accessible (A)**	**Not Accessible (NA)**	**Utilized (U)**	**Not-utilized (NU)**
1.	CD-ROM						
2.	Control software						
3.	Data logging						
4.	Logo or turtle graphics						
5.	Multimedia						
6.	Whiteboards						
7.	Overhead projector.						
8.	Computer						
9.	Power Point						
10.	Video tape player						

APPENDIX V

STUDENTS' ATTITUDE TOWARDS BIOLOGY SCALE (SABS)

These items intend to investigate the attitude of students with hearing impairment towards Biology. Please, tick (v) the appropriate options that best reflect your agreement or otherwise with the statement.

Please, tick (v) the appropriate options.

KEY: Strongly Agree =SA Agree =A Disagree = D Strongly Disagree = SD.

	Remark	**Strongly Agree (SA)**	**Agree (A)**	**Disagree (D)**	**Strongly Disagree (SD)**
1.	I love Biology as a subject.				
2.	Biology helps me to understand the human body system.				
3.	I enjoy studying Biology even without the teacher teaching me.				
4.	Biology is very difficult to understand				
5.	I do not like Biology				
6.	I think the knowledge of Biology makes me understand my life.				
7.	I like Biology because it takes me outside the classroom				
8.	I find studying natural phenomena an exciting part of Biology				
9.	I prefer to tell everyone the advantage one could get from Biology.				
10.	The study of Biology makes man understands himself better.				
11.	I believe the knowledge of Biology will keep our health stable				
12.	I find Biology class very boring due to abstract nature of some concepts				
13.	Studying Biology improves one's manipulative skills.				
14.	Biology gives me an opportunity to work as a scientist.				
15.	Knowledge of Biology makes it easier for me to solve simple problems in my environment.				

16.	I have to work harder in studying biology than any other science subject.				
17.	I think the rate at which the knowledge of Biology is growing in the country will bring about increase in population.				
18.	Biology will be useful to me when I leave school.				
19.	I hope to specialise in Biology or any biological related field				
20.	Education will not be complete for any science student who does not have a good knowledge of Biology.				
21.	I will like students to learn conservation of resources in Biology				
22.	Biology gives room for me to develop my creativity.				
23.	I think the society needs more biologists because of its importance.				
24.	I tend to become easily discouraged when I do not understand Biology topics				
25.	There will be healthier environment if most people are exposed to Biology knowledge areas.				
26.	Biology helps me to understand my environment and control it.				
27.	I do not like biology because the scope is very wide.				
28.	I love contributing to discussions on biology concepts.				
29.	I am excited when am taught biology in the laboratory				
30.	I enjoy biology practicals more than theory.				

APPENDIX VI

UNIVERSITY OF IBADAN
FACULTY OF EDUCATION

DEPARTMENT OF SCIENCE AND TECHNOLOGY EDUCATION (S.T.E)
STUDENTS BIOLOGY PERFORMANCE TEST (SBAT)

Dear Respondent,

This questionnaire is meant for research purpose. Your response has nothing to do with you or your school. Be honest in your response as absolute confidentiality is assured.

Demographic Information

SECTION A:

Demographic information

Name of school: _____

Class:_____

Instruction: please, tick (v) the appropriate box.

1). Age: 13-15 ( ) 16 -19 ( ) 20-25 ( )

2). Religion: Christianity ( ) Islam ( ) Others ( ) (Specify)

3). Gender: Male ( ) Female ( )

4). Onset of hearing loss: Before Birth ( ) After Birth ( )

SECTION B

Below are some items to examine students on Living and Non – living things, Cell, Tissue and supporting system, Nutrition, Ecology. Reproduction, Micro – Organisms and Relevance of Biology to Agriculture.

Read the questions and carefully choose the right options. Please, do not write on the question paper.

STUDENTS' BIOLOGY PERFORMANCE TEST

1. A collection of cells of the same origin performing a specific function is called _____ (a) organ (b) tissue (c) system (d) organism
2. The study of plants is called _____ (a) botany (b) zoology (c) ecology (d) parasitology
3. Muscles are attached to bones by means of _____. (a) ligament

(b) tendons (c) cartilage (d) synovial membrane

4. Micro-organisms, which breakdown dead organisms and absorb their contents are called _____. (a) decomposers (b) consumers (c) commensals (d) parasites.
5. In a food chain, the position occupied by an organism is called _____. (a) the tropic level (b) energy level (c) habitat level (d) ecological niche
6. Cassava mosaic is a crop disease caused by a _____. (a) virus (b) fungus (c) bacterium (d) nematode
7. The following are useful effects of micro – organisms except _____. (a) production of vaccines (b) curing of tobacco (c) training of leather (d) decay of meat
8. Artificial methods of vegetative propagation include the following except _____ (a) budding (b) bulbing(c) layering (d) grafting.
9. Which of the following definitions best describes excretion? The (a) liberation of energy from food (b) release of faeces from the body (c) breakdown of food molecules (d) removal of waste product of metabolism
10. Which of the following is responsible for the rapid increased heartbeat of a boy who saw a python? Increased production of _____. (a) adrenaline (b) insulin (c) pituitrin (d) thyroxin
11. The _____ receives the yolk released by the ovary of female domestic fowl. (a) magnum (b) infundibulum (c) isthmus (d) uterus
12. In mammals, digested food is absorbed in the _____. (a) stomach (b) ileum (c) colon (d) duodenum
13. The function of the red blood cells is to _____. (a) engulf invading bacteria (b) aid in protein formation (c) transport oxygen to the cells (d) control blood glucose level
14. The basic unit of classification is the ____ (a) genus (b) class (c) species (d) kingdom
15. _____ was proposed by Matthias Schleiden and Theodor Schwann as a result of their discoveries in1839. (a) Cell theory (b) Cell law (c) Cell hypothesis (d) Phylum theory
16. Which of the following vertebrate is located in the upper abdomen? (a) Thoraic (b)Caudal (c) Sacral (d) Lumber
17. During which of the following processes is food for plants produced? a) Respiration (b) Photosynthesis (c) Digestion (d) Transpiration

18. Change in energy flow between organisms in habitat can be represented by a _____ (a) pyramid of biomass (b) food chain (c) pyramid of numbers (d) pyramid of energy
19. _____ are plants which complete their life cycle in one season. (a) Annuals (b) Biennials (c) Food crops (d) Perennials
20. Trypanosomiasis is associated with _____. (a) mosquito (b) cockroach (c) housefly (d) tsetsefly
21. The type of reproduction that occurs in Amoeba is _____. (a) budding (b) binary fission (c) spore formation (d) fragmentation
22. In which of the following organisms is ammonia excreted as a waste product? (a) man (b) bird (c) amoeba (d) spirogyra
23. Which of the following does not occur during inhalation in mammals? (a) rib cage is raised up (b) diaphragm contracts and becomes dome shaped (c) intercoastal muscle contracts (d) volume of the thoracic cavity increases
24. The deficiency disease that results from the lack of vitamin B due to frequent eating of rice is _____. (a) ricket (b) night blindness (c) scurvy (d) beri – beri
25. _____ help to defend the body against diseases by ingesting the bacteria and virus that causes. (a) Thrombocytes (b) Leucocytes (c) Erythrocytes (d)Plasma
26. Which of the following is not a characteristic of living organism? (a) Feeding (b) Reproduction (c) Expansion (d) Growth
27. The presence of a large member of mitochondria in a cell indicated that _____. (a) it has little cytoplasm content (b) the cell is very active (c) the cell is dormant (d) the respiration is poor
28. Which of the following will ease the friction between the ends of bones in a movable joint? (a) Serum (b) Tissue (c) Blood plasma (d) Synovial fluid
29. Which of the following is a saprophyte? (a) Spirogyra (b) Mushroom (c) Hydra (d) Fein
30. An instrument used to measure wind speed is _____ (a) hygrometer (b) barometer (c) thermometer (d) anemometer
31. The following are cereal plants except _____ (a) rice (b) oats (c) groundnut (d) maize
32. Which of the following causes typhoid? (a) Meningoloceus (b) Entamoeba (c) Salmonella (d) Clostridium

33. _____ is the movement o gaseous or liquid molecules from a region of higher concentration to a region of lower concentration through the air or water. (a)Osmosis (b)Haemolysis (c) Diffusion (d)Turgidity
34. The following are the functions of skeleton in man except _____ (a) support (b) excretion (c) respiration (d) muscles attachment
35. Endoparasites include the following except ____. (a) tapeworm (b) lice (c) hookworms (d) live fluke
36. The secchi disk is used to measure _____ (a) speed of flow water (b) specific gravity of water (c) turbidity of water (d) depth of water
37. _____ is an example of leguminous plant. (a) Maize (b) Groundnut (c) Guinea corn (d) Rice.
38. The following are examples of diseases caused by bacteria except _____. (a) pneumonia (b) trizteza (c) onion rot (d) gonorrhoea
39. _____ serves as power house of all cells where cellular respiration takes place to provide energy. (a) Vacuole (b) Mitochondrion (c) Nucleus (d) Cytoplasm
40. Which of the following is absent in the reproductive system of a male tilapia? (a) Dorsal fin (b) Right testis (c) Ovarian duct (d) Cloaca.

ANSWERS

1.	B	21. B
2.	A	22. B
3.	B	23. B
4.	A	24. D
5.	A	25. B
6.	A	26. C
7.	D	27. B
8.	B	28. D
9.	D	29. B
10.	A	30. D
11.	B	31. C
12.	B	32. C
13.	C	33. C
14.	C	34. B
15.	A	35. B
16.	D	36. C
17.	D	37. B
18.	D	38. B
19.	A	39. B
20.	D	40. C