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# **INTERNATIONAL JOURNAL OF SCIENCE ARTS AND COMMERCE**

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## **Adapting Biology Secondary Schools Curriculum to Motivate Students with Visual Impairment in an Inclusive Classroom to Catalyse their Interest in Biology and Science Career: The Case of Cameroon**

**Dr. Nsagha Sarah Mboshi,**

Department of Educational Psychology, Faculty of Education, University of Buea, P.O. Box 63, Buea, South West Region, Cameroon.

**Jitzi Samuel Ngala**

PG Student, Department of Curriculum Studies and Teaching, Faculty of Education, University of Buea, P.O. Box 63, Buea, South West Region, Cameroon.

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### **ABSTRACT**

*Today's Biology teachers of inclusive classrooms are facing difficulties in teaching learners with diverse educational needs. To meet the learners' needs, teachers of biology are required to adapt the curriculum and implement different teaching strategies. An inclusive classroom is therefore one that gives preference to equal teaching and learning to all students to maximise success and interest to all students irrespective of their disabilities without any bias or negative perception. When a biology classroom is made up of students from various intellectual, family, socio-economic and cultural backgrounds, in a nutshell with varied disabilities, effective teaching and learning becomes challenging in an inclusive classroom. One of the solutions to this kind of educational problem is the adaptation of the biology curriculum to meet the various challenges of the learners with special needs in an inclusive classroom. When this is done, emphasises is place on leaning but not teaching (eclectic) to meet up the challenges of every learner. Adapting biology curriculum will therefore serve as a spring board for students with visual impairment to be motivated and develop interest in choosing a career in biology. This is because biology forms the foundation of many science professions in the world today. The study of science and biology in particular to students with visual impairments in secondary schools is also a call for concern in Africa and Cameroon in particular because every learner needs to know the function and the care of the human body in order to handle issues that concern development. The methods used were a traditional structured literature review with regards to the main variable of the study using Google*

*scholar, reviewed of text books on the major themes, publications by foundations and institutions, technical and workshop reports, and conference proceedings were also consulted. The major findings of this study reveal that adapting the biology school biology in Cameroon motivates students with visual impairment to develop interest in the study of biology and science in general. The major recommendations are that all biology and science subjects' teachers in secondary schools should adapt their curricula to meet the needs of all the learners in an inclusive classroom secondly the government should provide all secondary schools with resource centres to promote inclusion in secondary schools.*

**KEYWORDS:** *Adapting biology curriculum, students with visual impairment, special needs, biology and science career and inclusive education.*

## INTRODUCTION

The teaching of biology to secondary school students in an inclusive classroom cannot be over emphasized. Teaching of any subjects depends on its curriculum. The curriculum of any subject enhances the acquisition of knowledge, skills and attitude of the learners. Teaching methods and leaning strategies should therefore be eclectic to bring about holistic learning of biology (Tchombe, 2004). In an inclusive biology classroom learners of different disabilities of both primary and secondary disabilities are found in the same classroom. Some of the students with disabilities in this classroom are students with visual impairments whose sense of sight have been affected. In this case the biology teacher must act as a panacea of managing and facilitating learning to every learner. However, biology is a life science subject that deals with human body and the environment. In this case biology is taught theoretically and practically. Biology is one of the core subjects in Cameroon secondary school curriculum as well as second cycle. Biology forms the back born of many science subject combinations at the advanced level. Furthermore, biology is also central to many science professions such as Medicine, Pharmacy, Nursing, Agriculture, Biochemistry, Microbiology, Conservators and so on. It is obvious that no student intending to study these disciplines can do without practical activities (Kareem, 2003).

Biology provides alternative and exciting approaches for engagement including opportunities for outdoor learning, supports essential cross-curricula activities and skills such as numeracy, literacy, communication, collaboration and interpersonal skills. Biology intrinsically motivates student's understanding and awareness as it is related to health and wellbeing of an individual such as healthy eating, personal hygiene, sex education, substance use and abuse just to name a few. Based on all these importance of biology, students with visual impairment seem not to be part of it due to their sense of sight which has been affected. This is because biology requires a lot of observation, experimentation and report writing as well as communication. In this regard, a normal biology curriculum cannot be able to meet up the challenges of students with visual impairment in an inclusive classroom due to its expectation. As such the biology curriculum needs to be adapted for the students with visual impairment in order for them to study biology effectively in an inclusive classroom. This adaptation is done these aspects of the curriculum in the instructional materials, practical, teaching strategies, methods, environment as well as evaluation/ assessment.

## Background

As enumerated by (Shey, 2018 ), as defined by Cameroon's Constitution of 1996, the Disability Law No. 2010/02 of April 13, 2010, the Prime Ministerial Decree of July 26, 2018 laying down the procedures for implementing Law No. 2010/02 of April 13, 2010 on the protection of persons with disabilities and older persons, and other legal provisions, the state offers protection and support in health, social welfare and educational services to people with different categories of special needs in Cameroon: ranging from disadvantaged minority groups; vulnerable women, men, elderly people and children; people at risk of developing or already living with a disabilities. However, prominence is placed on those with severe disabilities who are given official priority with few private organisations also giving support to people with different categories of disabilities and those from disadvantaged backgrounds. In addition, the Decree No. 77/495 of July 7 December 1977 outlines the official categorisation of disabilities in Cameroon, and makes provision for the creation of private social welfare services and specialised institutions like orphanages, private Rehabilitation centres, socio-professional/vocational training centres, day centres, respite care homes, among others (Constitution, 1996; MINAS, 1977, 1990, 2005) to support persons with disabilities in Cameroon. This law and degrees does not exclude students with visual impairments from pursuing a career in any field including biology. The challenges that biology teachers face in Cameroon in teaching students with visual impairment in an inclusive classroom are: is lack of resources, perception towards students with visual impairment, lack of professional knowledge and skills by many biology teachers, poor parent participation in the education of their visually impaired children, medium of instruction, rigid curriculum, lack of teacher collaboration, (Fraser, 2008).

A study conducted by (Fraser, 2008) revealed that rigid curriculum is also a big problem for implementation of inclusive education. According to Simon et al. (2010) as cited in Abdulwakil (2015), their study findings showed that; teachers do not have enough knowledge of inclusion and how to teach students with visual impairments in inclusive classrooms. This shows that, these factors will also hinder students with visual impairments to pursue a career in biology if the factors are not redressed. One of the major ways of addressing this phenomenon is adapting the biology curriculum to favour the teaching and learning of biology to the students with visual impairments in an inclusive classroom.

Biology learning started in Cameroon from the indigenous era where there was no formal curriculum. Biology learning ranges from human body, trees, grass just to name a few. Professions like medicine where also uphold through the use of herbs. Formal education came to Cameroon with the arrival of the London Baptist Missionaries (MacOjong, 2008). During this era there was a formal curriculum for education in Cameroon. Until date the secondary school biology curriculum has undergone a lot of innovations and revisions

## RELATED LITERATURE REVIEW

### Education

According to Amosa, James & Olubode (2013), education plays a pivotal role in maximizing individual's potentials and is a prerequisite for meaningful and sustained national economy. Tambo (2012) defined education as the process by which persons develop their intellectual, emotional, spiritual and physical powers and become more fully participating members of the community in which they belong. According to Shrivastava (2003) education is a purposive, conscious or unconscious, psychological, sociological, scientific and philosophical process which brings about the development of the individual to the fullest extent and also the maximum development of society in such a way that both enjoy maximum happiness and prosperity. This researcher sees education as the aggregate of all processes by means of which people develop abilities, attitudes and forms of behaviour that are of positive values for themselves and the society in which they live. It is therefore clear that these authors see education from the inclusive perspectives. In this regard, for biology students with visual impairment to achieve their dreams and job aspirations in biology, the curriculum needs to be adapted to meet the needs of the biology students with visual impairments. This will therefore set a solid platform for them to be able to choose a career in biology and sciences in general.

### Biology

Biology is a science subject that is taught theoretically and practically (Jitzi, 2018) in secondary schools in Cameroon. Biology helps the children to understand the growth and development of the human body and makes them better aware of the natural environment. More so, the learners of biology will be able to take care of their bodies, know and navigate the environment in which they live and finally are empowered through agricultural and economic skills through gardening, poultry and yogurt production (Shafack and Jitzi, 2019). These are biology professions among others that students with visual impairment can develop interest in even at the basic level of their studies. This will therefore boost their self-esteem to pursue a profession in biology and science in general as they study biology to higher level. They will not only motivate the learners with visual impairment to pursue a career in biology but they will be able to create jobs for themselves and other people in the society. This lofty dream can only be realized in Africa and Cameroon in particular if biology curriculum is adapted through its teaching materials, strategies, methods, teaching strategies, and evaluation strategies.

Due to the difficulty of the Cameroon General Certificate of Education (GCE) board had to test students with visual impairments since 1993, in 2010 the board had its difficulties in using braille machines to manually come up with biological and scientific diagrams for students with visual impairment. This was a major trait to students with visual impairment who were writing the GCE at the time. This narrowed their chances of studying biology and other science subjects like chemistry, physics and biology. This researcher realized that the adaptation of biology curriculum since inclusive education is being practiced now in Cameroon; this might motivate and arouse the interest of these students to study sciences and

biology in particular. The GCE administration will see the need of employing specialist and purchase equipment for this purpose. The practice of adapting curricula has been proven successful in Kenya, Ghana and Nigeria, why not Cameroon? (Lecturer of Special Education who is visually impaired in the University of Buea Experience).

Schiro (2013) pointed out that, general education is a foundation of many professions through its subjects. He went further and added that, professions are built from general education by the respective teachers through the 'meanings' that will inculcate and motivate the learners through a particular profession of aspiration by a learner(s). This means that biology teachers should be able to use vocational examples and strategies to inculcate vocational skills in the learners that will make them functional in the society (social efficiency) as they acquire skills. It is clear that students with visual impairments will not be left behind in science if all the teachers of biology adapt their curriculum bearing in mind that visual impairment is not an inability for that learner to pursue a career in science and biology in particular. However, they need that their educational need in every science subject including biology should be met to galvanize their aspirations in studying science to higher educational level.

### **Structure of the Biology Curriculum in Secondary Schools in Cameroon**

The curriculum designed for ordinary students is generally not appropriate for visually impaired students. As such some adaptations need to be made so that the learning needs of students with visual impairments can be met in an inclusive biology classroom. The curriculum needs to be balanced with due considerations given to the student's intellectual, personal, emotional and social developments (Tambo, 2012). This is because the curriculum is the live wire of every sound and quality education.

Many curricularists have different views and definitions of the term "curriculum". Many definitions of curriculum have been proposed by many scholars. According to Kauchak, Eggen & Carter, 2002 as cited in Tambo (2012) look at curriculum generally as all what people learn in school. Sadker and Sadker (2000, p 203) as cited in (Tambo, 2012) sees the curriculum as the organization of intended learning opportunities for which the school takes responsibility. In this case all learners need to be given the opportunity to learn effectively. Moreover, curriculum implementation takes place in the classroom by the teachers. The learners are given the opportunity to assimilate what biology content is through the organization of learning experiences. The curriculum according to this paper refers to the secondary school official biology syllabus and individual lesson note that is prepared and delivered by secondary schools biology teachers in the classroom. Most biology teachings in secondary schools in Cameroon today seems to favour more the so call "normal" students and relegating the students with visual impairments. This is simply due to the biology curriculum put in place to teach in an inclusive classroom. This has made the students with visual impairments wondering aloud whether biology which is a life science subject is not meant for them as any other student. They hear biology but hardly practice biology as required by the subject itself. Based on this approach visually impaired students turn their back on biology despite its importance in their lives. The result is that they decide to follow other art subjects and finally decide to choose a career in that direction despite their cognitive abilities. In

Cameroon there are visually impaired persons in professions like teaching, Journalism, Pastors, social workers and other vocational centres instructors and none is in any science profession (Cameroon Ministry of Social Affairs Achieves, 2019).

Inclusive education is a function of giving all the learners the opportunity to aspire for any field of study for his/her choice irrespective of his/her disability. A visually impaired student in the University of Buea openly declared to this researcher that he wanted to pursue a career in the science field but most of his science teachers especially biology teachers in his secondary school time did not encourage him to do so as he made biology attract through the choice of the teaching methods, materials and the perception the biology teacher had towards him as biology is not meant for him. This made him to develop a negative self-esteem in biology and science in general. Another added that, he was left behind to study alone despite the fact that he loved biology so much during his secondary school periods. He said they were never given the opportunity to involve in cooperative, project and collaborative learning that would have fostered their learning and interest in biology. This made biology so abstract and difficult for them. It is clear that the curriculum was not adapted to meet the challenges of the visually impaired students in an inclusive classroom by their biology teachers at the time. The importance of adapting secondary school biology curriculum to meet students with visual impairment to attain their career dreams in biology and sciences in life cannot be overemphasized in an inclusive classroom. This is the duty of the 21<sup>st</sup> century biology teachers. Thus it is a call for concern for all educators all over the world especial Africa and Cameroon in particular to see into it that students with visual impairment in an inclusive educational setting finds it suitable to study all subjects with ease and understanding during their learning process.

## **Inclusive Education**

The Republic of Cameroon like many other African countries like Nigeria, Ghana, Uganda, Kenya, Ethiopia, and the world at large have been practicing inclusive education. However, the practice of inclusive education in Cameroon is still at the infant stage when compared to other countries in the world that have been practicing inclusive education for decades. However, recent developments in national and international perspectives to promote inclusion under the UNESCO plan of Education for All (EFA) have brought changes in mainstream school practices. However “integration and inclusion”, as seen in Cameroon as two terms representing one concept, these terms are still used interchangeably in theory and practice in the Cameroonian educational system due to the influence of the “French Speaking” community that prefers the former and the “English Speaking” community that are familiar with the latter (Shey, 2018).

According to Tchombe (2015), learning requires social interaction, taking into consideration the diversity of learning needs, abilities and physical characteristics of all learners. In Cameroon teachers are trained to offer general education to persons with special needs. This only gives them a general approach for the teaching of an inclusive classroom goes beyond preliminary teaching skills. As such when these teachers are in the field they face a lot of challenges applying the knowledge they have gained simply because of the rigid curriculum

or lack of resources. One of the remedy to overcome these challenges teachers faced is for them to adapt the curriculum to meet these diversified learners when in school and not in school (Titanji, 2015) for effective learning. This will exonerate the competences in the learners that will equip and motivate them to choose a career in biology and sciences in general as they pursue their studies up the educational ladder.

The problem of not seeing person's with visual impairment in science professions in Cameroon today and Africa in general is a major concern for many scientists, special educators, educationists and science teachers despite the government of most African countries are doing their best to practice inclusive education in their respective countries. The government of Cameroon in collaboration with educational international organisations are leaving no stone unturned to foster and promote inclusive education. In 2008 the international bureau of education reported that only 10% of children with disabilities go to school in Cameroon. The process of inclusive education today has remain so much on paper as many schools in Cameroon from primary to tertiary level still find it difficult to see this as a reality. Curriculum, teacher factors, infrastructure and environment are among the front line factors hindering many public and private secondary schools from practicing inclusive education in Cameroon. It is due to these challenges that special need learners especially the visually impaired find it difficult to pursue a career in biology or sciences in Cameroon. This paper is to bring out the experience, techniques and strategies adapted by this researcher who is a secondary school biology teacher in Cameroon in adapting the biology curriculum. This paper suggests how and what biology teachers can do to arouse the interest of students with visual impairment to be able to choose a career in science and biology in particular. This paper goes further to add the empirical studies of other researchers in this area on how to equip students with visual impairment in an inclusive classroom with knowledge, skills and attitudes to be able to choose a career in biology and sciences.

According to Abdulwakil (2015), inclusion is geared in the provision of education that is anchored in improving the education systems that will benefit all children regardless of their differences or difficulties. In a nutshell, for this to be realistic and holistic the biology curriculum needs adapted to meet the aspiration of students with visual impairment as practiced by as trial tested by this researcher and some secondary school biology teachers in Cameroon.

## **Visual Impairment**

Sense of vision plays a critical role in the teaching and learning of biology. However, it is imperative for a biology teacher to carry along all the learners of biology to their respective aspirations pedagogically. A student with visual impairment (Nsagha, 2011) is one whose sense of sight has been affected partially or completely. The visually impaired learners will need to develop the other four senses; touch, hearing, smell, and taste to their maximum in order to cope in their environment. The learner therefore uses her fingers, feet, ear, nostrils and mouth to learn. This will eventually tell the learner about touch, smell, taste and the direction of the type sound that she hears. Biology is a science subject that requires a lot of observation and practical activities as such it is ought to be adapted to meet the learners with

visual impairment whose sense of sight has been impaired. When the sense of sight of a learner is defected it will affect the learning of biology negatively as biology is a subject of observation. It is therefore the responsibility of a biology teacher to work extra miles to make sure that students with visual impairment study effectively and choose their careers in biology and science like any other biology student. One of the ways of doing that is overcoming the challenges faced by visually impaired learners in the learning of biology is by adapting the curriculum; as biology teachers collaborate with each other and parents of these students, involve students with visual impairment in a lot of hands on activities; collaborative learning, cooperative and project learning.

Nsagha (2018) pointed out that visual impairment is severe enough to interfere with progress in normal educational programmes as such this is considered a visual handicap to the learning of biology by students with visual impairments in secondary schools. She reiterated that for biology teaching and learning to be effective, students should be able to see clearly, focus on objects far and near, be able to co-ordinate hand and eye, discriminate small differences and remember what they see. This is an unfortunate scenario to students with visual impairment because they do not have the sense of vision. This therefore poses a major hindrance for students with visual impairment in the teaching and learning of biology in the classroom, environment and the laboratory.

### **Types of Visual Impairments in a Classroom Setting**

**Totally blind:** The individual receives no useful information through the sense of vision and must use tactile and auditory senses for learning (severe impairment)

**Functionally blind:** The learners learn mostly through other senses but maybe able to use vision to supplement information receive from the other senses. They would need to use Braille to learn to read. Functional vision cannot be measured using visual field and visual activity tests.

**Low vision learners:** They primarily use vision as a means of learning and with magnifying devices. They may learn to use print (mild to moderate impairment)

**Visual efficiency** refers to how well a person uses whatever vision present. This includes the ability to control eye movements to discriminate objects from their background, and to pay attention to impairment details (Beatrice and Janet 2003, Yao and Prosper 2011 as cited in Nsagha, 2018).

### **Adapting Secondary Schools Biology Curriculum for the Visually Impaired Students in an Inclusive Classroom**

Adapting secondary school biology curriculum involves; first, identifying the needs of the various learners in an inclusive classroom, secondly, adapt the curriculum ranging from classroom arrangement, teaching materials, teaching methods, teaching strategies, environment, laboratory arrangement, above all lesson presentations. When this is done, this will pave the way for a balance teaching and learning in an inclusive classroom.

It was revealed that blind and partially sighted learners themselves have no volition to improve their circumstances, because their total learning environments fail to assist them optimally (Fraser and Maguvhe, 2008: p, 86). Blind and partially sighted learners need to be proactive to improve their interest in biology and sciences. The students with visual impairment need to be optimistic and develop a very high self-esteem, a positive locus of control in the study of biology to higher level and to choose a career in biology and sciences. The following important aspect of the curriculum needs to be adapted for the students with visual impairment to learn biology effectively like any other students and develop an interest in choosing a career in biology and sciences. Thus becoming producers of biological and science products rather than only being consumers of biological and science products. The following aspects of the curriculum are adapted for an inclusive biology classroom to meet up with the learning of biology by students with visual impairment:

### **Adapting the Instructional Materials**

The most important adaptation in an inclusive classroom is the instructional materials that the students with visual impairment can use during and after class time. Teaching based on instruction is very vital in the classroom. As the majority of the visually impaired students are weak in skills in note taking and have partially or completely lost the sense of vision. Based on Cryer (2013) biology teaching with students with visual impairment mostly involves students listening to the teacher but thereafter the learners forget what they learned soon after the teaching if practical is required since they did not see the illustrations and demonstration of the theoretical lesson. This is in line with the famous Confucian scholar who said that, “what I hear, I forget. What I see, I remember. What I do, I understand”. Due to this researcher’s observation and teaching experience, visually impaired students in secondary schools are always complaining about the lack of materials that they need to use in and out of classroom that will meet their need and challenges in the learning of biology and sciences in general. It is clear that having written notes are also important for students to carry out any kind of biological practical work by the students with visual impairment without relying on the biology teacher most of the time. By taking this point into account, all instructional design including teaching and learning materials to be used either during the classroom or after the classroom for revision purposes need also to be locally oriented so that the learners are able to make use of its environment in the learning of biology. Furthermore, these revision notes can be in the form of hard copies; audio or in prints gadgets. The learners through their reading skills and listening skills can use their radios, audio laptops or gadgets with the assistance of their friends, relatives and parents at home to study before they come to class or for a practical class. It should be noted that normal textbooks are written for sighted student and no brail biology textbooks have been seen by this researcher in Cameroon. However, some biology textbooks have audio compact discs which can favour students with visual impairment to study biology.

Nsagha (2011) opined that low vision students have to use technological aids or magnifying equipment in the learning of biology in secondary schools. However, these equipment are either not available or not accessible in and out of school time by the students with visual impairments as accounted by many factors. Therefore, a biology teacher need to prepare

hand-outs or audio tapes or summaries printed with enlarged fonts that are easy for the students with visual impairment to be able revise what they learned in school and keep it for future readings. According to Nsagha (2011), she buttressed this issues by pointing out that braille books are available for blind students, but they take too much space and therefore students cannot carry these books with them at all times. Another problem is the limitations of the biology braille books in available and the few are often expensive for an average student with visual impairment in Cameroon. In order to overcome this problem, biology teachers prepare design hand-outs printed in two different forms for low vision and blind students (brailled). This gives the teacher extra work to do for his students in an inclusive classroom Hand-outs for blind students are in the forms of audio taped while others are in normal typeset for partially sighted students but in enlarged fonts, and braille for the blind students. The biology teachers and parents of these learners need to work in collaboration to overcome these challenges. They have to contact specialist to braille materials for these students. This at times is very costly. Therefore, if these materials are printed in both formats, everybody can access them. Moreover, printing tactile figures is also a challenging task for biology teachers to meet the students with visual impairment thus the assistance of special educators and parents in the study of biology in secondary schools for the students with visual impairment cannot be overemphasized.

Biology concepts requires practical and diagrams thus posing a very big challenge for biology teachers to teach an inclusive classroom with students with visual impairments. If there is no necessary embosser printing system, the only option is preparing them by hand using a silicone gun which is scarce to find in an inclusive school in Cameroon since many schools lack resource rooms (Nsagha, 2011) as opposed to special centres. In order to overcome this difficulty an Imprint Spot Dot Colour Braille Printer, a braille and colour ink embosser, is used (Design Science , 2011). This printer prints figures with dots as well as in colour for low vision or sighted students. In the case of Cameroon ethno biological diagrams are used. That is, local teaching and learning materials such as beans, rice and maize grains, dress buttons and twigs and local real objects are used to raise the borders of biological diagrams as well as to teach biology. In this regards, artist are also called upon to do these adapted figures to be used by biology teachers and visually impaired students in teaching and learning to be neat, clear and motivational. The labels on the diagrams are also brailled. Figure 1 on the Appendix 1, presents the human Alimentary canal, parts of a tree and an apple locally adapted for the teaching of biology to students with visual impairment in an inclusive classroom. These diagrams help the students with visual impairment to be able to touch and feel the parts of the diagrams and make meaning from their tactile experience.

Classroom organization in a biology class is very important. Those students with partial vision should be sited in front (short sightedness students) of the classroom or behind (long sightedness students) the classroom. Furthermore, students with complete blindness should share their desks with bright students for brief class tutorials, directives as the teacher does general scaffolding. During practical, group members can be enlarged to a maximum of about five students heterogeneously to work together with the students with visual impairment. This will give them a sense of belonging and develop their personality in the learning of biology.

In order to be able to design biology practical activities for students with visual impairment, attention has to be given to the use of senses other than vision. In general, the most commonly used sense is hearing in a traditional teaching. However, students can benefit from materials that they can access through touching is a common practice with students with visual impairment. The materials that are based on sense of touching are called “tactile materials” as shown in figure 1 above. In order to develop tactile materials basically two approaches are adopted. The first and easy way is to use current materials for sighted students with some adaptations or develop some with everyday materials as shown above. This is particularly important to keep the cost low and make it accessible by everybody. However, it is not easy to make durable materials to teach every single biology concept and principles. The second approach is to use the emerging 3D printing technology. This technology is recently developed to solve this problem. However, it is also costly and not accessible by every visually impaired student (Nsagha, 2011 and 2018). Besides, it is also quite versatile and the materials developed are durable. In order to teach some abstract concepts or re-design the simple materials to the needs of students with visual impairments, in this study, 3D materials are designed and printed. Instructional materials developed and printed by 3D technology include models belonging to the concepts of the cell, reproduction, growth and development just to name a few (Fraser and Maguvhe, 2008). The general guidelines followed in designing of these materials for practical activities makes it possible for materials to be available for each student with visual impairment in an inclusive classroom to give them enough time for investigation. If the experimental setting materials are not enough for each student, carrying out biology practical work in an inclusive setting takes more time. The second issue the biology teacher should take into consideration is the simplicity of the biology practical materials. The majority of the instructional or everyday materials used in practical works include several different features which have nothing to do with the topics taught. Therefore, these are distracting to students with visual impairment from understanding the materials through touching. In order to overcome this problem, biology teachers should make practical materials as simple as possible and illustrate only the main ideas and avoid too much detail to ease understanding. Practical materials should include only the features that are important in terms of the particular topic and should follow the topic covered previously. Secondly, practical lessons should be organized immediately after every practical concept is taught to ease understanding. This researcher putting his experience in this form has equally observed a change in the interest of visually impaired students toward choosing a career in biology. The researcher also observed that many biology teachers in Cameroon find it difficult to teach biology in an inclusive classroom where visually impaired students are found. This observation corroborate with the findings of (Sahin and Yorek, 2009), who found out that many teachers do not have direct experience in teaching blind and partially sighted learners. Furthermore, they do not know what to do to improve the learning conditions of their learners in cases of marginal resources.

## Teaching Biology Practical for the Students with Visual Impairments in an Inclusive Classroom

In the laboratory, the biology laboratory technician orients the visually impaired students on accessibility as well as the location of the various specimens. Specimen names can be brailled and tacked on the specimens, reagents especially those that can be touched and feel with the hands such as corals, skeletons, bones, insects, maize, beans, birds just to name a few. The sense of smell is also important to identify those fresh specimens such as fish of all specie, flowers for instance hibiscus, sun flower and so on. Most of the specimens that are stored in formalin are described to the visually impaired and the students with the help of gloves are given the opportunity to touch to identify and describe the features. However, this is time consuming process and it requires patients. Experiments on osmoses, food test, dissections are audio taped and the compact discs given to the students with visual impairment as they can play at homes and listen using their radios and audio lap tops or desk tops. Figures below illustrating laboratory practical in an inclusive biology laboratory on osmosis (Government Bilingual High School Deido; Douala and diffusion (Government Bilingual High School Penja; Douala) in an inclusive biology class.



**Experiment on Osmosis**



**Cooperative learning for the experiment**



**Experiment on Diffusion (class)**



**Experiment on diffusion (laboratory)**

The pictures above illustrate practicals in class and the laboratory immediately the topic has been completed. This helps the students to understand the practical procedures correctly and how it operates in the real life situation. It should be noted that the laboratory technician and the teacher work in close collaboration as the teacher scaffolds the visually impaired students in the practical activities. The teaching learning strategies that is best exploited in practical activities both in the laboratory, classroom or environment for students with visual impairment are heterogeneous cooperative learning as shown above, collaborative learning, individual learning (to boost their self-esteem) as well as project learning thus an eclectic approach to teaching (Tchombe, 2004).

A study carried out by (Kumar et al., 2001; Sahin and Yorek, 2009) pointed out that the blind and partially sighted learners have the same mental capacity to comprehend mathematics and science as well as biology. They concluded that blind and partially sighted learners merely need to be appropriately accommodated to enable them to perform as well as their sighted counterparts in science classes. In this case, by implication, it shows that students with visual impairment can be motivated to choose a career in sciences and biology like any other sighted student if appropriate teaching strategies, methods and evaluation methods are used to teach an inclusive biology class in secondary schools as used by this researcher before.

### **Adapting the Teaching Methods in the Teaching of Biology in an Inclusive Classroom**

The following teaching methods are adapted in in the teaching of biology in an inclusive classroom. They includes; pure lecture, lecture illustration, lecture demonstration, discussion, laboratory method, discourse, discovery, group work and problem solving. In the same manner the biology teacher should be very reflective to enhance interaction, transaction and management of pedagogical principles (Tchombe, 2004). The biology teacher should also be able to move from teacher-centred, tasked-centred to student-centred teaching to facilitate learning and understanding. These methods favours all types of learning styles' Tchombe added. In addition to that these methods make teaching and learning eclectic and holistic and thus enhance apprehension, acquisition, retention and application or transferability of knowledge gained to solve real life problems by students with visual impairment.

### **Biology Lesson Presentation in an Inclusive Classroom**

In a biology class in an inclusive setting, a biology prepared lesson notes should be presented as follows to favour all learning styles:

- Be sequential and systematic.
- Break down the subject matter into sub topics to avoid monotony.
- Outline subject matter to demonstrate mastery of presentation.
- Use verbal communication and non-verbal to the different types of learners.
- Employ humour and jokes as the lesson is going on.
- Demonstrate competence skills in language use.
- Ensure subject matter is at the level of each learner.

- Use varied instructional materials to meet all learners and the materials should be well organized.
- Questioning, discussion should be involve in the presentation to enhance participation.
- State the learning outcomes to be achieved (Tchombe, 2004 and Tambo, 2012).
- Use practical examples and biology career and science profession examples to arouse interest and motivation towards those careers to the students with visual impairment.

### **Adapting the Learning Environment in an Inclusive Educational Setting**

According to Frenzel, Pekrun, and Goetz (2007), the learning environment includes school buildings, instructional materials, and teacher-learner and learner-learner interaction. Base on this view, the environment is adapted for the teaching of biology through orientation and mobility so that the students with visual impairment can be able to access these structures for effective learning of biology by individually. It is clear that most classrooms and biology laboratories as well as the school campus in Cameroon have master minded students with visual impairment with respect to classrooms, laboratories and general environment infrastructures. Orientation is about awareness of one's self in relation to one's spatial environment while mobility is the ability to move from one point to another in the environment (Bolchit and Ozoji, 2012). However, teachers of biology have very little knowledge on orientation and mobility in order to create time to give a clear practical picture of the school environment to the students with visual impairment. This is a big setback in the teaching of biology in an inclusive educational setting. Orientation involves the location of the laboratory and the various specimens and regents and the school campus as well as mobility which involves movement in the laboratory. However, cooperative and group activities should be highly encouraged to facilitate the adaptation of this hidden curriculum (orientation and mobility) in secondary schools. As the students with visual impairment move and work in heterogeneous group activities, they will find the learning biology easy and enjoyable. Therefore, they will become interested and intrinsically motivated in choosing careers in biology and sciences as they study further.

### **Adapting the Evaluation and Assessment strategies in an Inclusive Classroom**

Evaluation strategies are also adapted through the ways of posing oral and written questions that will make use of other active senses of the learners with visually impairment. The students with visual impairment should work with gloves during practical assessment with the biology teacher(s) and laboratory technicians and other experts (individualise education plan) who will guide them to navigate the practical process with ease during evaluation. Group evaluation is also remarkable. Visually impaired students portfolios analysis and individual presentations are all evaluation strategies to be used in a biology inclusive classroom. Test questions are brailed for the students with visually impairment and additional time is added to them to answer the test questions. These questions are also adapted to meet the understanding of the visually impaired students. Instead of asking them to observe in a

question, they can be asked to touch, feel and smell the specimen, or the specimen can be described comprehensively and questions asked from it.

Since students with visual impairment might not be able to draw biological diagrams manually during examinations, questions that require drawings should rather be written in the form of reading comprehension or diagrams should be presented to them to identify through the sense of touch and answer the questions that follow, questions digestive, system, the heart, insects, fish just to name a few. This research has done it and it has proven efficient for evaluating students with visual impairment in secondary schools around Cameroon.

Tamngwa (2017) pointed out that some students can be weak in one area and strong in another area, for that reason, it is of imperative importance that in carrying out evaluation in an inclusive biology classroom all these parameters should be taken into consideration to give each learner the opportunity to succeed. Biology teachers should not induce secondary disability in the students with visual impairment as low achievers or treat them as such, but biology teachers should perceive the students with visual impairment as high achievers and good future scientists. This will motivate the visually impaired learners to work hard succeed and will like pursue a career in biology or sciences in general as perceived by their biology teacher.

To favour learners with varied learning styles in an inclusive class, in secondary schools, biology needs to be evaluated in three perspectives such as written, oral and practical. The various types of assessments strategies that will catalyse students with visual impairment to choose a career in biology and sciences as observed by this research through the students' interest are; performance assessment (keeping track of visually impaired records), comprehensive assessment (information based on social, emotional, physical (fine and gross motor skills) and development (cognitive, affective and psychomotor) as well as self-assessment (learners are guided to ask questions to help self-oriented learning. For instance what career do I want to pursue in future? What are my personal strengths and challenges? What professional career will I really want to become? and so on and forth). These are questions that will always run in the minds of students with visual impairment in a balanced classroom they participate actively. Thus these questions need individual answers and personal effort with the support of the biology teacher.

### **Teaching Strategies in Teaching Students with Visual Impairment a Biology an Inclusive Classroom**

The role of a biology teacher is to teach these students on how to use these remaining senses to achieve learning of biology with ease. This will motivate the visually impaired learners to develop interest to choose a career in biology and sciences in general. There are so many ways a biology teacher can use to teach in an inclusive classroom that will not discriminate the students with visual impairment. These strategies include;

- Reach and Touch; put models or objects into the visually impaired hands, this will help the student to feel and get an image of what you are talking about.

- Link gestures and touch to actions and words that is to say, when you are explaining or describing something for instance the shape and functions of the heart, ear, digestive system, human skeleton, types of inserts, food chain etc look for images and object that has that shape so the students can feel it to have an image, and when making actions always say what you are doing so that the student can hear your voice.
- Develop their confidence when they are surrounded by unfamiliar noises which may cause their concern, by telling them what is happening.
- Biological models, charts and activities need to be big and colourful for the visually impaired students. Big: the larger the object or closer to the eyes, the easier it is for those with low vision to see. Bright: the more light there is the better, so ensure that classrooms and laboratory are well lit. Colourful: Eyes work best with contrast so develop this with colourful models and charts against contrasting background. Models, toys and charts, real objects chosen should have different textures, colour, sizes, shapes, weights, smells and sound, this would be more helpful for students who are visually impaired in a biology class. (Fraser and Maguvhe, 2008).
- Biology teacher should place the students with visual impairment (short sightedness) and long sightedness close or the back to the chalkboard or the classroom respectively. This will help the student to hear very well and also see what the teacher is writing.
- For special demonstration such as osmosis, or detailed note writing on chalkboard, partially visually impaired students should be allowed to move close to the presentation to enhance opportunity to see and hear.
- Biology teacher should make sure that obstacles are removed from classroom and the benches arranged well from to facilitate mobility.
- Consider the individual impairment (possibly extend a due date or a reading homework assignment) but do not let the disability be an excuse for a poor or unacceptable performance.
- Laboratory technicians together with the biology teacher should also orient the students with visual impairment about the laboratory settings and specimen location and arrangement.
- All visual impairments increase the time and effort related to their biology studies/activities. Be aware of this if a student is making requests such as extra time for the completion of essays and worksheets.
- Provide extensions to assignment deadlines if extensive reading has been set. Consider setting alternative assignments in which students have the opportunity to work intensively on a few selected texts rather than having to read widely.
- Pair the student with visual impairment with a seeing classmate who can assist him/her to organise their work. The partner can help find the correct page, repeat your instructions and so on (Nsagha, 2018). Biology teachers should encourage this kind of heterogeneous learning grouping both in schools and at home. The cited learners will indirectly act as sight to the students with visual impairment in the studying process.

- Biology teachers should consider the individual impairment (possibly extend a due date or a reading homework assignment) but do not let the disability be an excuse for a poor or unacceptable performance.
- Biology lessons can be taped using a cassette recorder for later playback at home or as revision. Learners who experience difficulties in writing can also provide information on audiotape. Taped versions of books are sometimes available in libraries and resource rooms.

### **Pedagogic Approaches in the Teaching of Biology to the Student's with Visual Impairment in an Inclusive Classroom**

Teaching methods are standard procedures of lessons delivery, communicating knowledge theoretically and practically through which educational goals are reached (Tambo, 2012 and Nekang, 2016). Some of the general learning strategies that literatures have suggested to be favourable in teaching and learning of biology in an inclusive classroom are those methods and strategies that are constructivism in nature as stated above. These strategies include; cooperative learning (collaborative learning), project based learning (inquiry based learning), integrated theme learning, as well as individualized learning.

These teaching and learning approaches encourage the learners to work in group, all members actively participate in the learning process as they contribute ideas, and peer tutoring is encouraged. The group members ask questions among themselves for clarification. These instil confidence of success and enhance competences in all the learners. This approach is in lined with Westwood (2011) who recommended that teachers should include visually-impaired learners in groups to facilitate their learning. These approaches are highly motivational to biology learners' in an inclusive classroom. The visually impaired learners indirectly make use of the sight of the other group members as their own as they work in group. These approaches should be used in the classrooms as well as in the laboratory or during field trips for the teaching and learning of biology in secondary schools. Theme teaching strategies encourages the involvement of the home and the community to the teaching and learning process of all the learners. This will bridge the gap between the school, home, nature and community. This makes the teaching of biology more realistic in context as to the traditional pedagogic approach.

The importance of the various teaching and learning approaches enumerated above cannot be overemphasize because it enhances competences in students with visual impairment, such as; methodological competences, intellectual competences, personal and interpersonal competences and communication competences (Ministry of Basic Education National Syllabus, 2018).

According to Nsagha and Ihenacho (2012), there are sensitive educational gadgets and services that are needed by learners with visual impairment for successful inclusion. These ranges from equipment/facilities to educational arrangement and provision of services which include:

- Orientation and mobility (Cane skill)
- Portable note taker
- Larger format books
- Slate and stylus
- Magnifying glasses
- Specialised computer software(Jaws, Zoom text etc)
- Electronic Braille writer
- Perkins Bailer

All these gadgets are also needed in a biology inclusive classroom by visually impaired students. This will enhance their success in learning of biology in secondary schools. More so, catalyse their morals and interest in choosing a career in biology and sciences in general. This is because students will always like to choose a career or profession in those areas that they like and have been performing and achieving better in them in their education ladder.

According to Disabil (2015), low vision children in inclusive classes follow the ordinary school curriculum. Since the children have different visual problems and learn at a different pace from that of their peers, individual attention from teacher is essential to learners with visual impairment in inclusive settings. This, Disabil meant that the various aspects of the curriculum need to be adapted to meet the needs of the students with visual impairment to learn effectively. In teaching these learners of varied disabilities the biology teacher should also take into consideration the teaching objectives, the different levels of ability of the learners and makes sure that learning materials suit the individual learning needs as well as the lesson delivery. The teaching and learning approaches should be flexible enough to meet the different levels of disabilities of the different learners in a biology inclusive classroom to foster all the students' success in biology.

## CONCLUSION

Conclusively, secondary schools biology teachers should adapt their biology curriculum (teaching methods, materials, classroom environment, laboratory, assessment strategies and learning strategies) to meet all the learners in an inclusive biology classroom especially students with visual impairment. This will promote inclusion. Furthermore, more students with visual impairments will be seen in biology and science professions in the nearest future in Cameroon. In a nutshell they will massively and scientifically contribute to the attainment of Cameroon emergence by 2035. This is because Cameroon emergence by 2035 involves the participation of every citizen. Secondly, secondary schools biology teachers should encourage students with visual impairment to overcome their inferiority complex biology, physics and chemistry is not meant for them so they cannot study it to higher level. If all these parameters are put in place in the teaching and learning of biology in secondary schools as the case of Cameroon, this will form a solid foundation for students with visual impairment to be interested and motivated in choosing careers in biology and sciences as they study biology to higher level.

## Recommendations

1. All biology and science subjects' teachers in secondary schools should adapt their curricula to meet the needs of all the learners in an inclusive classroom.
2. Individualise education plan should be set up in all secondary schools in Cameroon to facilitate the teaching and learning of learners with visual impairment so as to enhance inclusive education.
3. The government of Cameroon should motivate secondary schools biology teachers through scholarships, as they put in effort in teaching in an inclusive educational setting. Students with visual impairment should also be motivated through scholarships and provision of resource centres in all secondary schools allow them study biology and choose careers in biology and sciences.
4. More seminars and in-service training should be organized to train biology teachers on how to teach and manage inclusive classroom.
5. Teacher training colleges' curricula should be revised to equip biology graduates from these schools with professional skills and basic skills in braille and sign languages and other skills to be able to teach an inclusive classroom.
6. Biology infrastructures (laboratories) should be constructed bearing in mind of the practice of inclusive education at all level of education.
7. Cameroon General Certificate of Examination Board should include the evaluation of secondary schools students with visual impairment both orally and practically (project and presentations) as well as written examinations. Furthermore examination questions should be adapted to meet students with visual impairments.

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## **Appendix 1**

### **Adapted biological diagrams for students with visual impairment in an inclusive biology classroom**





