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## DEVELOPING ENTREPRENEURSHIP IN BIOLOGY: A TOOL FOR NATIONAL DEVELOPMENT

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### **Abstract**

*Prioritizing entrepreneurial skill acquisition is a catalyst for national development. In order to alleviate or reduce the level of unemployment among the several unemployed graduates that are flooding the job market, there is a need for wider campaign programs on the benefits of entrepreneurial skills acquisition. This study therefore sought to investigate and unveil the various entrepreneurial skills in biology that are profitable to reduce overdependence on the government for jobs, or, in other words, to reduce the level of unemployment. Many of these programs have been prioritized, while others are less explored or not given due attention. However, this study discussed, among others, the following entrepreneurial skills in biology for self-reliance and national development: These include: science education book writing and editing, SPSS, Python programming, and R programming learning, biogas learning and production, bio-fermentation, bioinformatics, solid waste and polythene recycling and re-utilization, and bio-remediation. As a consequence of the findings of this study, the following recommendations were made: preference should be given to practical in the curriculum; government at all levels should provide adequate instructional materials, laboratory equipment, and other facilities. Justice should be displayed during the recruitment process to appoint only qualified and competent teachers who can teach biology effectively. Biology teachers should be encouraged to use appropriate methods to improve their teaching through innovation.*

## **Background to the study**

The role of science education in the development of any nation cannot be underestimated. Science has played a significant role in the history of the world, especially in developed countries. There is nothing more to describe those countries that are termed "developing countries" today than the fact that they advanced in the aspect of science and technology. According to Ojiaku (2012), as cited by Abba (2010), those developed nations like the U.S.A., France, Japan, and the like that had acquired prosperity achieved this through advancement in science and technology; hence, they are leading in industrialization more than the rest of any other nation in the world.

Biology, which is taught at secondary schools and higher institutions of learning, is conceived with many opportunities. However, it is obvious that many science professions are making use of the knowledge of biology to thrive in their professions, especially those that are very important to man's life, such as breweries, agriculture, and human and veterinary medicines. This view is supported by Abubakar (2009), who stressed that biological science is more likely to have a more significant impact on man than the physical sciences. This is because most of our basic problems are biological in nature. Therefore, developing skills to tap these numerous opportunities would lead to a greater appreciation for the living world.

As stated in the national policy on education, one of the aims of education is to create a united, strong, and self-reliant nation. Biology contributes to the realization of the ultimate goals of education. This is dependent on how it is taught. When it is taught properly using activity-based instruction such as the inquiry method, it stands to contribute immensely to the general development of the students. To achieve this, both teachers in high institutions and secondary schools should do everything humanly possible to produce students devoid of parasitizing the nation's economy. Obiageli, (2012).

The term "biology" is a combination of two Greek words, "bios," meaning life, and "logos," meaning to study. Literally, biology is the study of life, or the study of plants and animals. Michael, (2015). According to the Oxford Science Dictionary (2005), biology is the study of living organisms, which includes structure (gross and morphological), functioning, origin and evolution, classification, interrelationship, and distribution. In the view of Nakano (2017), biology is the science that deals with the study of living things. Since it is the study of living things, there are certain recognizable characteristics of living things, which include movement, death, respiration, growth, excretion, irritability, reproduction, and nutrition. Chukunyeremuwa (2013) opined that biology remains one of the basic sciences whose teaching and learning are universally known to be efficient and successful if only undertaken simultaneously with the help of adequate instructional resources and facilities. Biology plays a vital role in the fields of biochemistry, genetics, physiology and anatomy, ecology, medicine, and molecular biology. Olutola, Daramola, and Bamidele (2016), and as such, biology has been made a central focus in some human activities, including being a solution to the problems of food scarcity, health, hygiene, family life, poverty eradication, management and conservation of natural resources, biotechnology, ethics, various social vices, and a lack of appropriate infrastructural materials. Aina (2013) stated that biology education is important to any growing economy like Nigeria. Many graduates of biology education are self-employed and employers of labor; many own schools for themselves where people work and earn their living, while some are in the fish business.

## **Biology of Entrepreneurship**

In history, entrepreneurship research has greatly neglected biological factors, and this has led researchers nowadays to seek means by which human biology has affected this natural process. The literature review on this by researchers has been shredded into pieces and spread across numerous outlets, making it cumbersome and arduous for entrepreneurship-erudite scholars to assemble findings and design an inclusive and detailed theoretical perspective to explain how biology relates to entrepreneurship (Nofal et al., 2018). A well-reviewed literature review could show connections and interconnections among some areas in biology, such as genetics, physiology, and neuroscience, and integration of these entrepreneurship programs could enhance understanding of various entrepreneurial outcomes. Research in genetics on entrepreneurship explained the influence of DNA on the tendency to key in on entrepreneurship, the tendency to identify opportunities in entrepreneurship, entrepreneurial intentions, and entrepreneurial performance (Nicolaou & Shane, 2009). Quantitative genetics and molecular genetics were the two methods adopted. Quantitative genetics talked about nature-nurture, where experiments on twins and adoptees were carried out to disconnect the influence of genes from the effects of environmental factors on an entrepreneurial phenotype, while molecular genetics talked about distinct genetic variants that influenced entrepreneurial propensities, adopting specific gene and genome-wide association studies. Even up until this moment, there have been numerous works on qualitative genetics rather than molecular genetics, as revealed by publication outlets. From this review, genetic factors explained 48% of the variance in self-employment (Nicolaou et al., 2008; Zhang et al., 2009), 40% of the variance in opening a new business, and 43% of the variance in processes to start a firm (Lindquist et al., 2015; Nofal et al., 2018; Zunino, 2016). In physiology, the influence of hormones was dissected, and the major hormone studied was testosterone, which has a strong propensity to engage people in self-employment (White et al., 2006; Greene et al., 2014), charging people for risk-taking to be self-employed (Bonte et al., 2015; White et al., 2006). The relationship between neuroscience and entrepreneurship was examined (De Holan, 2013; Nicolaou & Shane, 2013). Examination of the human brain by studying neural activity gives a better understanding of how human beings function (Hannah et al., 2013; Lee et al., 2008). This, according to Laureiro-Martinez et al. (2015), engaged humans in critical decision-making revealed by individual neuropsychological antecedents through the capture of neural activity. These three areas in biology showed how strongly they are interconnected to entrepreneurship programs, and the integration of these three can be harnessed for better outcomes.

## **Entrepreneurship and biology education**

An entrepreneur is someone who has an idea and works to create a product or service that people would buy, as well as an organization to support that effort. An entrepreneur takes on most of the risk and initiative for their new business and is often seen as a visionary or innovator. An entrepreneur is someone who has the ability to develop a new venture in business in order to make money, often in a way that involves financial risks. (Quirk, 2003), as cited by Obiageli (2012). According to Ezema (2000), an entrepreneur is defined as the owner of a business who is responsible for the initiation and organization of the enterprise out of a desire to maximize profits. An entrepreneur is therefore a person who has developed certain skills, attitudes, and behaviors that enable him to establish a business, thereby creating jobs for himself and others. Entrepreneurship education is education that provides training, experience, and skills that are suitable for entrepreneurial endeavors. Ovie, (2011). According to Ezema (2000), "entrepreneurship education" is the education given to an individual that will help him develop the skills needed for the management of any business

venture. From the various definitions earlier given, it can be inferred that entrepreneurship education provides individuals with insight into the numerous opportunities in all aspects of life for the benefit of man and the nation at large. This study is therefore carried out to unveil various entrepreneurial opportunities in biology and the skills to tap these opportunities for the development of our great nation, Nigeria.

### **Entrepreneurship opportunities in biology**

There are lots of entrepreneurial opportunities in biology; this depends on the fields and the topics. Nearly all subjects and topics in biology have their own opportunities that can help one develop entrepreneurial skills and become self-dependent. These topics and subjects, according to Nayah (2002), include apiculture, aquaculture, seaweed culture, floriculture, horticulture, ecotourism, mushroom culturing, aquariums, water conservation, poultry, insect and pest control, etc. Besides the aforementioned ones above, there are lots of emerging entrepreneurial programs to engage biology students during the course of study. These programs, if included in the course contents and well taught to students, could alleviate the problems of unemployment. The areas that could be explored include the following:

**Biology and science education Book Writing and Editing:** Book writing is the act of putting ideas together through extensive research and findings with logical arrangements and organization, while book editing involves reviewing and revising content written to enhance its quality, clarity, and overall effectiveness. In this work, grammar is corrected and punctuated, sentences are streamlined, and valuable suggestions for rewrites or reorganization are provided. This enhances creativity as it enables students with creative minds to transform their stories or information into readable books. Though this is a task as it requires time and mental energy, self-editing and rewriting, etc., experts in book writing and editing need to be invited for seminars and workshops in addition to what is enshrined in the course contents.

**SPSS, Python Programming, and R Programming Learning:** SPSS is a statistical software suite developed by IBM for data management, advanced analytics, multivariate analysis, business intelligence, and criminal investigation. It is also short for "Statistical Package for the Social Sciences." Python is a high-level, general-purpose programming language. It uses code readability with significant indentation. It could be used to build websites and software, automate tasks, and conduct data analysis. R programming is a language and environment for statistical computing and graphics. It's an open-source programming language often used as a data analysis and statistical software tool. R programming features a high-performance data storage and handling facility, a suite of operators for array calculations, a vast, easily understandable, integrated assortment of intermediate tools dedicated to data analysis, graphical facilities for data analysis, etc.

**Biogas and Biofuels Learning and Production:** This is a gaseous, liquid, or solid fuel that contains an energy content derived from biological sources. Biogas is a gaseous fuel (methane) produced by the fermentation of organic matter. The organic matter that makes up living organisms provides a potential source of trapped energy that is beginning to be exploited to supply the ever-increasing energy demand around the world. This is when food or animal waste is gradually broken down by microorganisms in the absence of oxygen. Thus, all the processes must be done in an enclosed environment and be used as renewable energy sources. The methane-carbon dioxide ratio differs, but the common ratio is known to be 60% CH<sub>4</sub> (methane) and 40% CO<sub>2</sub> (carbon dioxide), but one could think of methane in a measurement of 45% to 75% and carbon dioxide in a measurement of 55% to 25%. Materials needed are organic wastes such as agricultural wastes, plant materials, municipal waste,

manure, human feces, sewage, garden waste, or food waste. Examples are rapeseed methyl ester, biogas, gasohol, and others, according to the Oxford Science Dictionary (2005). Yahaya (2017) explained that Nigeria, as a developing country, may be considered a top destination for biofuel production in terms of cost-effectiveness.

**Bio-Fermentation:** This is a process by which food and organic products are produced through the process of fermentation in a bioreactor. The process includes organisms such as yeast, fungi, and algae. This process involves the selection of a suitable microbial culture that has the metabolic potential to produce the desired products. The medium in which the culture is fermented is carefully chosen. Production by bio-fermentation has been deemed advantageous as fermentation utilizes renewable feedstock instead of petrochemicals, some of which are agricultural waste (Yahya, 2017).

**Bioinformatics Learning:** This is the application of tools of computation and analysis to the capture and interpretation of biological data. This involves the collection, storage, and analysis of DNA and protein sequence data using computerized systems. This is an interdisciplinary field integrating biology, computer science, mathematics, and physics. It is related to genetics and genomics, but basically, computers are used to collect, store, analyze, and disseminate biological data and information, including DNA and amino acid sequences. Information from databases and indexes is used by scientists and clinicians to increase our understanding of health and diseases. The processes involve generating data through genome sequencing projects and protein studies, which is later held in various databanks and made available to researchers throughout the world via the internet. There are many computer programs developed to analyze sequence data that enable the user to identify similarities between newly sequenced materials and existing sequences. This allows predicting the structure and function of a protein from its amino acid sequence data or from the nucleotide sequence of its gene, according to the Oxford Science Dictionary (2005). Biological data that are commonly used in bioinformatics are transcriptomics, proteomics, phenomics, chemoinformatics, etc. Learning bioinformatics is not enough; adequate knowledge of Linux and programming languages such as Python, R, and Perl is also needed for large data sets. Careers in bioinformatics for students include bioinformatics scientist, research scientist, biostatistician, microbiologist, bio-informatician, zoologist or wildlife biologist, and molecular biologist.

**Solid Waste and Polythene Recycling and Re-utilization:** This is an area in applied biology where used solid waste could be used in the production of gasoline, bags, shoes, ceilings, fingernails, etc. So, recycling, according to the International Organization of Standardization (ISO), is the proportion, by mass, of recycled material in a product or packaging. So, to this end, only the pre-consumer and post-consumer materials are sorted by recycled content (ISO, 2016). Pre-consumer products are those wastes released during manufacturing, while post-consumer materials are those released by households or by commercial, industrial, etc. (Nakatani and Hirao, 2011). This is so cheap to do, as the costs of recycling are estimated from the costs of collection and sorting minus the value of materials in end-use markets (Kopsidas & Giakoumatos, 2021). According to Kellenberg (2012), in the past decade, the international trade of waste products has grown tremendously; by 2007, globally, more than 191 million tons of waste had been sold. According to the European Commission (2007), on employment and recycling, the EU possessed a 50% world tonnage proportion of waste and recycling industries, and their eco-industries sector gained a turnover of about 227 billion, which is approximately 2.2% of EU GDP in 2007 (including waste treatment and recycling). Though the EU recycling sector has over 60,000 companies with



percentages of 3% large, 28% medium, and 69% small, this is an opportunity for job creation and wealth creation for fresh graduates.

**Bioremediation:** It is very obvious that the world is facing challenges of environmental pollution due to the rapid increase in population, industrialization, and urbanization. In recent times, there has been the development of technology known as "bioremediation," which is capable of removing pollutants from the environment. According to Sharma (2012), "bioremediation is a process whereby contaminants or organic wastes are biologically degraded under controlled conditions to an innocuous state or to levels below concentration limits established by regulatory authorities." Bioremediation techniques are typically more economical than traditional methods such as incineration and others. Some of the microorganisms used in this technique include Nitrosomonas, Mycoccus, Xanthofacter, Norcardia, Pennicillium, Actinobacter, Rhizoctomia, and Mycobacterium, as well as others (Singh, Singh, and Sharma, 2014). The process of bioremediation involves biotransformation and biodegradation by converting the contaminants to non-hazardous or less hazardous substances. Singh et al. (2014) This technique is less expensive, more effective, and efficient, as well as environmentally friendly.

### **Strategies for Tapping Entrepreneurial Opportunities in Biology**

To explore these entrepreneurial opportunities in biology, it will require that the teachers of biology at various levels of education adopt good strategies that can foster better learning; hence, the students will be able to acquire the skills to become entrepreneurs in biology. However, it is imperative that teachers of biology adopt strategies such as:

**Teacher competency:** whoever is appointed to teach biology should be professionally competent, capable of handling practical skills, and well-grounded with the knowledge of business opportunities available in biology. The teacher is expected to know both the methodology and content of the subject matter in order to foster effective teaching and learning.

**Students-centered approach:** The teachers of biology should make their lessons student-centered by adopting teaching strategies such as field trips, demonstrations, inquiry, and guided discovery in teaching entrepreneurship education so that students will become entrepreneurially skilled people.

**Entrepreneurship Club and Exhibition** An entrepreneurship club should be established to promote and teach those topics in biology that create self-employment.

**Organization of Seminars and Workshops on Entrepreneurship in Biology:** Seminars and workshops are required for the teachers of biology to acquire new and adequate knowledge of entrepreneurship, which in turn impacts the students who become entrepreneurs through biology.

### **Challenges to Entrepreneurship Programs**

Poor awareness of the need for entrepreneurial skills

Population explosion of attendees

Insufficient funds are allocated for entrepreneurship programs.

Poor monitoring and feedback mechanisms

Poor examination and certification of the skills acquired are necessary for wide recognition.

## **Conclusion**

Entrepreneurship skills stand to be an integral part of national development. Many of these entrepreneurial skills are embedded in biology, though they have not been fully explored. In this regard, the importance of biology and biology education for sustainable national development cannot be overemphasized if entrepreneurship skills are not prioritized. So, biology and biology education find their way into agriculture, pharmacy, ethno botany medicine, biotechnology, and other related fields. Since entrepreneurship skills are not well explored in most of our secondary schools and tertiary educations. Hence, many graduates of biology and science-related courses would still search for government jobs that are scarce and competitive. However, it has therefore become imperative to unveil the numerous opportunities in biology education for national development.

## **Recommendations**

This paper recommends the following:

- Preference should be given to practical in the curriculum.
- The government at all levels should provide adequate instructional materials, laboratory equipment, and other facilities.
- Justice should be displayed during the recruitment process to appoint only qualified and competent teachers who can teach biology effectively.
- Biology teachers should be encouraged to use appropriate methods to improve their teaching through innovation.
- Seminars should be organized for the teachers of biology on the effective use of methodologies such as excursions, demonstrations, and practical methods of teaching.
- Learners should be motivated and made to put their attention into learning the subjects.

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