**ENTREPRENEURIAL OPPORTUNITIES AND CHALLENGES FOR MICROBIOLOGY GRADUATES IN NIGERIA**

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**ABSTRACT**

Unemployment among university graduates is a problem that has steadily worsened over the last two decades in Nigeria. The root of this socio-economic problem is the fact that university graduates in Nigeria all want to be employees in the public and private sectors, and there are just not enough jobs to accommodate them all. Previous studies on graduate entrepreneurship in Nigeria have been descriptive in nature seeking to understand the relationship between entrepreneurship education, self-employment intentions and actions and obstacles hindering graduate entrepreneurship. This paper provides a different perspective by providing a prescriptive and normative step-by-step approach which Microbiology graduates can utilize to actualize their entrepreneurship dreams after graduation. This involved identifying entrepreneurial opportunities in the field of Microbiology such as academia, food, agriculture, laboratory services, water quality services, the pharmaceutical industry and public health. The paper also identified the main obstacles hindering microbiology graduates from achieving self-employment such as limited access to funding, lack of business management skills, limited access to technology, limited access to markets and difficulties navigating different regulatory hurdles. Practical steps which microbiology graduates can adopt to overcome these challenges were presented, and the paper concludes by suggesting policy recommendations in the form of targeted policies and programs that promote entrepreneurship and support self-employment ventures which create a more enabling environment for graduates to establish and grow their businesses, thereby creating employment opportunities for others.

**Keywords:** Microbiology, Entrepreneurship, Graduates, Self-reliance, Nigeria.

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**INTRODUCTION**

Unemployment among university graduates is a problem that has steadily worsened over the last two decades in Nigeria (Olubusoye et al., 2022). The root of this socio-economic problem is the fact that university graduates in Nigeria all want to be employees in the public and private sectors, and there are just not enough jobs to accommodate them all (Joshua-Omoregie & Olubor, 2022). For Microbiology graduates, the story is not different. According to Aishat (2019), due to lack of job opportunities immediately after graduation, Microbiology graduates either continue to further their studies to obtain a postgraduate degree in Microbiology or leave the field of Microbiology to venture into non-Microbiology fields such as Agriculture, Banking or even the Military. Scholars have opined that a sustainable way of solving this growing problem is to encourage graduates to embrace entrepreneurship (Ogar et al., 2022). The premise is that if more Nigerian graduates started their own businesses rather than looking for jobs, they would be able to earn a sustainable livelihood and even become employers of labour, thus reducing the number of unemployed graduates in the country (Adebakin & Ajadi, 2022).

The Nigerian government subscribed to this premise by mandating that entrepreneurship education be inculcated into the Nigerian university curriculum so that all students would be equipped with the necessary knowledge and skills to be able to start their own business upon graduation (Ajah, 2022). Theoretically, the policy makes sense as studies have shown that entrepreneurship education has a positive impact on the entrepreneurial intentions and new venture creation aspirations of university students (Nurwahyunani, et al., 2021). However, the reality of these mandated entrepreneurship courses is that they are very general in nature, simply introducing university students to the basic principles of entrepreneurship as well as the characteristics of an entrepreneur such as risk-taking, creativity and innovativeness. They also include accounting, marketing and management concepts needed for running a business. They do not actually focus on entrepreneurship opportunities available for graduates *specific* to their disciplines and thus do not offer *practical strategies* as to how these opportunities can be taken advantage of by these graduates.

Additionally, previous studies that have investigated the impact of entrepreneurship education on self-employment practices of Nigerian graduates have been descriptive in nature seeking only to determine the relationship between entrepreneurship education and the entrepreneurial intentions of Nigeria graduates, without actually providing a prescriptive guide as to how Nigerian graduates can actually establish new businesses after graduation (e.g., Oluseye et al., 2017; Faloye & Olatunji, 2018; Anosike, 2019; Mamman, 2019; Otache et al., 2020). This paper seeks to address this significant limitation of previous studies by identifying entrepreneurial opportunities in the field of Microbiology and offering practical strategies which Microbiology graduates can utilize to actualize their entrepreneurship dreams after graduation. In addition, the paper also identifies specific challenges these graduates will face and offers practical steps and strategies that they can take to overcome them.

The rest of the paper proceeds as follows: First a literature review section is presented that addresses a conceptual review of entrepreneurship, presents a theoretical review of relevant theories as well as a description of this study’s theoretical framework and provides a review of relevant empirical literature. Second, the entrepreneurial opportunities available to Microbiology graduates in Nigeria is presented via a step-by-step approach and third, the challenges likely to hinder these graduates from fulfilling their entrepreneurial aspirations are presented alongside practical steps they can adopt to overcome these challenges. The paper ends with a conclusion that summarizes the key contributions of the paper and outlines policy recommendations for the relevant for the Nigerian government and institutions of higher learning alike that will help create an enabling environment whereby microbiology graduates can thrive as self-employed individuals with the potential to become employers of labour in the near future.

**LITERATURE REVIEW**

**Conceptual review**

Entrepreneurship can be defined in different ways, but some common themes are evident in many definitions. According to Stevenson (2021), entrepreneurship is a process of creating or seizing an opportunity and pursuing it regardless of the resources currently controlled. Forbes (2021) defines entrepreneurship as the ability to identify a need in the marketplace and fulfil it with a product or service that generates revenue and profit. Investopedia (2021) describes entrepreneurship as the art of starting and growing a business by identifying and seizing opportunities in the market while navigating inherent risks. Entrepreneur (2021) defines entrepreneurship as a mindset and a set of skills that involves taking calculated risks, being innovative, and creating value for customers and stakeholders. The Small Business Administration (2021) characterizes entrepreneurship as the process of developing, organizing, and managing a business venture in a competitive environment with the aim of generating profits.

Despite their differences, these definitions share some commonalities. They all emphasize the identification of opportunities, taking calculated risks, and creating value for customers and stakeholders. However, they differ in their focus, with some placing greater emphasis on revenue generation or the ability to navigate risks.

In the context of graduates of microbiology in Nigeria which is the focus of this paper, a suitable definition of entrepreneurship would be the following: "Entrepreneurship is the process of identifying and creating opportunities in the market by taking calculated risks, being innovative, and creating value for customers and stakeholders, with the aim of starting and growing a business venture in the microbiology field, generating profits, and contributing to the development of the industry and the Nigerian economy." This definition highlights the specific context of microbiology graduates in Nigeria while emphasizing the importance of innovation, value creation, and profit generation.

The process of identifying and taking advantage of entrepreneurial opportunities in the context of newly graduated microbiology students in Nigeria would involves several steps. The first step is to identify a problem or need in the microbiology field that can be addressed through entrepreneurship. This may involve conducting market research to identify areas where there is a demand for products or services related to microbiology, or identifying gaps in the existing market that can be filled with innovative ideas (Morris, 2022).

Once a problem or need has been identified, the next step is to develop a business idea that can address it. This may involve brainstorming ideas with a team, conducting further research to refine the idea, and developing a business plan that outlines the goals, strategies, and financial projections for the venture (Dholiya et al., 2023).

The third step is to secure funding to support the venture. This may involve applying for grants, seeking investments from angel investors or venture capitalists, or securing loans from financial institutions. In some cases, it may be necessary to bootstrap the venture by using personal savings or leveraging personal networks to raise initial capital (Kochuvilayil et al., 2023).

Once funding has been secured, the next step is to launch the venture and start implementing the business plan. This may involve developing and marketing the product or service, hiring employees, and managing the day-to-day operations of the business (Oliveira & Cardoso, 2023).

Throughout the process, it is important to remain flexible and adaptable to changes in the market and to learn from failures and mistakes. It is also important to network and collaborate with other entrepreneurs, industry experts, and potential customers to gain insights and support (Freiberg & Matz, 2023).

**Theoretical review**

The fundamental premise underlying this paper is that the mandatory entrepreneurship education provided to Microbiology students in Nigerian tertiary institutions should provide them with the requisite knowledge and competencies to identify and take advantage of entrepreneurial opportunities after graduation, rather than competing with millions of other graduates for limited public and private sector employment opportunities. In this section of the paper, five theories that connect the two variables of entrepreneurship education and new venture creation are reviewed, and the theory that most fits this paper’s context is selected to serve as the theoretical underpinning for this paper.

1. Human capital theory: The Human Capital Theory was postulated by Theodore Schultz, an American economist in 1961 (Djelassi, 2023). The theory suggests that individuals who possess human capital, including knowledge, skills, and education, are more productive and earn higher incomes (Mengesha & Singh, 2023). The Human Capital Theory assumes that individuals can increase their productivity and earning potential by investing in education and training (Lee et al., 2023). Critics argue that the theory fails to account for the role of other factors such as social networks and institutional factors that can affect an individual's earning potential (Haq et al., 2023). The theory establishes a direct relationship between entrepreneurship education and new venture creation, as it suggests that individuals who possess human capital are more likely to start new ventures (Ali et al., 2023). Entrepreneurship education can provide individuals with the knowledge and skills necessary to identify and exploit entrepreneurial opportunities, leading to new venture creation (Bendickson et al., 2023).
2. Social cognitive theory: The Social Cognitive Theory was postulated by Albert Bandura, a Canadian-American psychologist in 1986 (Yin & Zhou, 2023). The theory emphasizes the role of learning and observation in shaping behavior (Imron et al., 2023). The Social Cognitive Theory assumes that individuals learn through observation and imitation of others (Harb et al., 2023). Critics argue that the theory oversimplifies the complex process of learning and behavior change (Murimbika & Urban, 2023). In the context of entrepreneurship education, the Social Cognitive Theory suggests that entrepreneurship education can provide individuals with opportunities to learn from successful entrepreneurs, observe their behaviors, and develop the necessary skills and knowledge to start a new venture (Yang et al., 2023). This can lead to new venture creation as individuals learn from successful entrepreneurs and apply their knowledge to starting and managing their own ventures (Baber et al., 2023).
3. Resource-based view theory: The Resource-Based View (RBV) theory was postulated by Jay Barney, an American professor of strategic management in 1991 (Adhiatma et al., 2023). The theory suggests that firms can achieve a competitive advantage by possessing and exploiting unique resources and capabilities (Syariati et al., 2023). These resources are often costly to imitate and difficult to replicate, leading to a sustainable competitive advantage (Nguyen et al., 2023). The RBV theory assumes that firms must develop unique and valuable resources that are rare, inimitable, and non-substitutable to achieve a competitive advantage (Ahsan et al., 2023). It also assumes that resources and capabilities must be properly aligned with the firm's strategy to achieve a competitive advantage (Mai & Do, 2023). Critics argue that the RBV theory overlooks the role of external factors such as market conditions and government policies that can affect a firm's competitive advantage (Khan et al., 2023). Additionally, it has been criticized for its inability to provide guidance on how to identify and develop valuable resources (Chion et al., 2023). In the context of entrepreneurship education, the RBV theory suggests that entrepreneurship education can equip individuals with the necessary competencies and resources to start and manage a new venture (Alalwan et al., 2023). Entrepreneurship education can provide individuals with the knowledge and skills necessary to develop unique resources and capabilities, leading to a sustainable competitive advantage in their new venture (Mai & Do, 2023).
4. Theory of planned behaviour: The Theory of Planned Behavior was postulated by Ajzen, an Israeli psychologist in 1991 (González-Serrano et al., 2023). The theory posits that an individual's intentions to engage in a behavior are determined by their attitudes, subjective norms, and perceived behavioral control (Marabesi et al., 2023). The Theory of Planned Behavior assumes that individuals are rational decision-makers who consider the consequences of their actions before engaging in a behaviour (Mihut et al., 2023). Critics argue that the theory overlooks the role of emotions and social context in shaping behaviour (Le et al., 2023). In the context of entrepreneurship education, the Theory of Planned Behaviour suggests that entrepreneurship education can influence an individual's intentions to engage in entrepreneurial behaviour (Olutuase et al., 2023). By changing an individual's attitudes, subjective norms, and perceived behavioural control, entrepreneurship education can increase an individual's intention to start a new venture (Sousa-Filho et al., 2023). However, the theory also suggests that there are factors beyond an individual's control that can influence their behaviour, such as external barriers to new venture creation (Rippa et al., 2023). Therefore, entrepreneurship education should also focus on providing individuals with the resources and support necessary to overcome these barriers and facilitate the successful creation of new ventures (McLarty et al., 2023).
5. Opportunity recognition theory: The Opportunity Recognition Theory was postulated by Shane and Venkataraman, American professors of entrepreneurship in 2000 (Englis & Frederiks, 2023). The theory suggests that individuals who are able to recognize and exploit entrepreneurial opportunities are more likely to succeed in new venture creation (Cortes & Kiss, 2023). The Opportunity Recognition Theory assumes that individuals with prior knowledge and experience in a particular industry or market are more likely to recognize and exploit entrepreneurial opportunities (Cavalcante & Sousa-Filho, 2023). Critics argue that the theory overlooks the role of serendipity and luck in opportunity recognition (Steininger et al., 2022). In the context of entrepreneurship education, the Opportunity Recognition Theory suggests that entrepreneurship education can help individuals develop the ability to identify and assess entrepreneurial opportunities (Lehtimaki et al., 2022). This can lead to new venture creation as individuals are better equipped to recognize and exploit entrepreneurial opportunities (Uhlbach et al., 2022).

In the context of this paper which focuses on microbiology graduates in Nigeria, the Resource-Based View (RBV) theory may best explain the impact of entrepreneurship education and graduates' ability to establish new ventures amidst opportunities and challenges. Microbiology graduates in Nigeria possess a unique set of skills and knowledge that they can leverage to start new ventures in the biotechnology and healthcare industries. The RBV theory suggests that entrepreneurship education can provide these graduates with valuable resources and capabilities, such as knowledge of biotechnology and healthcare markets, access to funding and support networks, and the ability to innovate and create new products and services.

Furthermore, the RBV theory emphasizes the importance of sustainable competitive advantage in new venture creation. Microbiology graduates who have received entrepreneurship education may be better equipped to identify and exploit opportunities in the market, as well as create products and services that are unique and difficult to replicate by competitors. However, the RBV theory also acknowledges that external barriers to new venture creation, such as limited access to funding, lack of infrastructure, and regulatory challenges, can pose significant challenges for entrepreneurs. Therefore, entrepreneurship education should also focus on providing graduates with the resources and support necessary to overcome these barriers and facilitate the successful creation of new ventures.

Overall, relative to the other four theories reviewed in this section, the RBV theory provides a strong framework for understanding the impact of entrepreneurship education on graduates' ability to establish new ventures amidst opportunities and challenges in various industries in Nigeria.

**Review of empirical literature**

In this section of the paper, a review is provided on the existing empirical literature of the last decade, that investigated the impact of entrepreneurship education on the career potentials of graduates of tertiary institutions from different countries across the globe. The primary aim of the review was to identify research gaps in the extant scholarship which this paper aimed to address.

\Hamzah et al. (2016) focused on investigating this relationship among real-estate graduates in Malaysia. Adopting a similar mixed methods research design as that used by Owusu-Mintah (2014), Hamzah et al. (2016) relied on survey data from 95 respondents as well as interview data from nine graduates, and the study found that although EE positively impact the entrepreneurial intention of the real-estate graduates, it did not have a significant impact on actual entrepreneurial behaviour in terms of the establishment of new real-estate ventures after graduation. This is the third study in a row, one from Norway, one from Ghana and this study from Malaysia that indicates that EE does not translate into actual new venture creation by graduates of higher educational institutions.

Premand et al. (2016) provided a second African perspective on the impact of EE on the entrepreneurial careers of higher education graduates, with a focus on Tunisian university graduates. A survey was conducted of 1,506 graduates who had taken part in a newly introduced entrepreneurship track in Tunisian universities, and the study found that one year after graduation, participants of the programme have a slight but insignificant advantage in the establishment of their own businesses relative to other graduates who did not take part in the entrepreneurship track in university. The study concluded that although EE significantly improve the business skills of participants, it did not translate into significant instances of new venture creation by these graduates. This finding corroborates those of Ann Storen (2014), Owusu-Mintah (2014) and Hamzah et al. (2016).

Jones et al. (2017) also provide a Western European perspective of the EE-graduate entrepreneurship nexus, but with a specific focus on the United Kingdom, rather than Norway. A survey of 80 graduates from two UK higher education institutions revealed that 36% of the respondents were self-employed as compared with 39% of the respondents who were working for private sector companies. Relative to the four studies previously reviewed, this is the first study that provides positive evidence that EE does in fact translate into a significant level of new venture creation among university graduates.

South Africa served as the next port of call with a review of the study by Nwokolo (2017) who investigated the EE-graduate entrepreneurship nexus (EE-GE nexus) by surveying 374 graduates from the University of Fort Hare located in the Eastern Cape. The study found that EE improved the level of self-reliance of the graduates. However, unlike the previous studies reviewed, this study did not extend the research focus to determine whether or not EE actual led to new venture creation by these graduates, and this serves as a significant limitation of this study. Previous studies have already established that EE improves the entrepreneurial competencies of university graduates; the next frontier of this research interest is to understand if it actually translates into the establishment of new businesses by these graduates.

Relative to this paper, the study by Oluseye et al. (2017) carries great significance as it provides the first Nigerian perspective of EE-GE nexus which is also the focus of this paper, albeit from a very different dimension which will be highlighted later on in this section. Oluseye et al. (2017) surveyed 205 science and technology graduates from Gateway Polytechnic in Ogun State and found that a majority of these graduates agreed that EE had positively impacted their entrepreneurial competencies. Similar to the study by Nwokolo (2017), this study was extremely limited in that it did not investigate the extent to which EE actually led to new venture creation by these graduates, making its findings of very limited value relative to extant scholarship on the same phenomenon.

Just like Oluseye et al. (2017), the study by Faloye and Olatunji (2018) also took place in Nigeria, and suffered the same limitation as the prior study in that it only focused on determining if EE impacts the entrepreneurial intentions of graduates of tertiary institution in the country. To fulfil its objective, the study surveyed 230 National Youth Service Corp (NYSC) members serving in Ondo State, and found that EE had a significant impact on the entrepreneurial intentions of these graduates. As alluded to, this is an already established relationship and thus the findings of this study has very limited value in advancing the current knowledge of the impact of EE on new venture creation among higher education graduates.

Yusuff (2018) represented the third of a hat-trick of Nigerian studies reviewed in this section. However, unlike Oluseye et al. (2017) and Faloye and Olatunji (2018) who only established that EE positively impacts the entrepreneurial intentions and competencies of Nigerian graduates, this study took the research process an important step further by surveying 200 university graduates in order to identify the barriers preventing them from utilizing these improved competencies to actually establish their own businesses. The study found that limited access to finance, fear of risk and a weak economic environment were the three main obstacles preventing Nigerian graduates from venturing into self-employment ventures. Lack of access to capital was also the main obstacle hindering graduate entrepreneurship in Ghana (Owusu-Mintah, 2014).

Anosike (2019) focused on the conflict-ridden Northern parts of Nigeria in their investigation of the EE-GE phenomenon through interviews of ten graduates of the Niger State College of Education and the University of Maiduguri. The study corroborated the findings of Oluseye et al. (2017) and Faloye and Olatunji (2018) who found that EE has a positive impact on the entrepreneurial competencies of Nigerian graduates of higher education.

Five years after Ann Storen’s (2014) investigation of the EE-GE nexus in Norway, Hasleberg et al. (2019) conducted a similar investigation among engineering graduates from the University of South-Eastern Norway. A survey of 112 graduates revealed that 12% of these graduates had actually started their own business, which the authors felt was “quite high” considering that these graduates had their pick of offers of employment with private and public sector organizations in the country. This is only the second study (see Jones et al., 2017) in this empirical review section that found that EE led to a significant level of new venture creation by higher education graduates; both studies were from a Western European context.

Kwara State, in North Central Nigeria, was the focus of the study by Mamman (2019) who sought to determine the impact of EE on the entrepreneurial intentions of 372 business graduates from three universities in the State. Unsurprisingly, the study found that EE had a significant positive impact on the entrepreneurial intentions of these graduates, but as has been mentioned earlier, this finding has limited value as it does not translate into actual entrepreneurship, which is the ultimate objective of EE.

Similar to Premand et al. (2016), Alaref et al. (2020) investigated the EE-GE nexus in the context of Tunisian higher education graduates. Specifically, Alaref et al. (2020) sought to determine the short-term (one year after graduation) and medium-term (four years after graduation) impact of EE on self-employment among these graduates. The study adopted a pre-test/post-test control research design involving 1506 participants, with the study finding that EE had a small but significant short-term impact on self-employment among Tunisian university graduates, but that this impact dissipated four years after their graduation. The authors made an important observing by stating that EE was insufficient as a stand-alone policy to lead to sustained self-employment by university graduates and that it needed to be complemented by policies that provided affordable and easily accessible capital to help these graduates start their own businesses.

The study by Guerrero et al. (2020) provided empirical validation of the assertion by Alaref et al. (2020) that EE combined with complementary policies can lead to a significant increase in graduate entrepreneurship. A survey of 11,512 graduates from the Monterrey Institute of Technology and Higher Education (ITESM) in Mexico revealed that EE combined with business services and affordable finance provided by the Institute’s business incubator helped a significant level of graduates to pursue a career of self-employment rather than rely on paid employment.

Unfortunately, the Nigerian study by Otache et al. (2020) take a step back by only focusing on how EE affects the self-employment intentions of graduates rather than actual self-employment; this is a limitation affecting several of the Nigerian studies reviewed in this section of the paper (for example: Oluseye et al., 2017; Faloye & Olatunji, 2018; Anosike, 2019; Mamman, 2019). A survey of 95 accounting students from two polytechnics revealed that EE had a significant positive impact on their self-employment intentions. Other studies have clearly shown that self-employment intentions alone do not translate into new venture creation by university graduates.

Iyortsuun et al. (2021), also a Nigerian study, followed the same path as previous Nigerian studies reviewed by only focusing on the relationship between EE and attitude towards self-employment of university students soon to graduate. Specifically, the study relied on a survey of 445 students in four North Central Universities, and found the already established fact that EE has a positive effect on students’ attitudes towards self-employment after graduation.

Kisubi et al. (2021) further confirmed that EE has a significant and positive impact on the self-employment intentions of graduating university students through a survey of 458 final-year students from two universities in Uganda. The study recommended that an entrepreneurship competency assessment be performed on first-year university students to that EE curricula can be modified to contain information that will address deficiencies in the entrepreneurial competences of students in every university.

Rahman et al. (2021) responded to the suggestion made by Kisubi et al. (2021) regarding enhancing the impact of EE on self-employment intention by upgrading the content of the curricula. The study sought to determine the mediating effect of integrating artificial intelligence (AI) components into the curricula on the relationship between EE and self-employment intentions among business graduates in Bangladesh. Analysis of survey data from 401 respondents revealed that AI partially mediated the positive relationship between EE and self-employment intention of business graduates.

Based on the well-established premise that EE positively impacts the self-employment intentions of university graduates, John et al. (2022) sought to determine which teaching methods were most effective in achieving this positive relationship among graduates from Kenyan institutions of higher learning. A survey of 273 polytechnic graduates revealed that EE programs that emphasized active learning techniques had a significantly more positive impact on self-employment intentions that EE programs that emphasized traditional lecture formats.

Ramadani et al. (2022) also built their study based on the same premise as John et al. (2022), but rather than focus on teaching methods, they sought to determine if there was a gender difference regarding how EE impacts the self-employment intentions of higher education graduates in Bangladesh. Analysis of survey data from 449 respondents revealed that there was no significant gender difference in the existing positive relationship between EE and self-employment intentions of graduates.

The empirical review section concludes with a review of the study by Uddin et al. (2022) who sought to provide a deeper understanding as to how EE positively affects the entrepreneurial intention of higher education graduates by testing a mediation-moderation model consisting of entrepreneurial passion as the mediating variable and entrepreneurial self-efficacy as the moderating variable. Data was obtained from a survey of 359 private university students in Bangladesh and the study found that entrepreneurial passion and entrepreneurial self-efficacy respectively mediated and moderated the positive relationship between EE and entrepreneurial intention.

A critical assessment of the studies reviewed in this section revealed that the extant studies on the relationship between EE and GE can be divided into three broad categories. The first category of studies represents the majority of studies reviewed who sought to establish the relationship between EE and the entrepreneurial intention of higher education graduates. The second category of studies went a step further by seeking to determine if EE led to the actual establishment of new businesses by graduates, rather than merely influencing their intentions, and the third category of studies sought to determine the obstacles that were preventing graduates from venturing into self-employment, with lack of capital identified as the biggest obstacle.

What these three categories of studies have in common is that they are strictly descriptive, seeking to provide an accurate and detailed account of the EE-GE nexus. The limitation of descriptive studies is that they do not provide any guidance on how to address or improve the phenomenon being studied. This paper addresses this important limitation by providing a normative and prescriptive, step-by-step guide, on how microbiology graduates in Nigeria can translate their self-employment motivations into actual new venture creation, thus helping to attain the ultimate objective of EE, which is to create a generation of graduates that seek to establish their own businesses and eventually become employers of labor rather than waiting for limited jobs in the public and private sector. This guide is provided in the next section of the paper.

**ENTREPRENEURIAL OPPORTUNITIES IN MICROBIOLOGY**

**Academia**

Academia in this paper refers to the teaching of Microbiology to students. This is different from being a Microbiology lecturer employed by a university; rather it involves the provision of tutorial services in various Microbiology courses to university students. There are certain Microbiology courses which students tend to find difficult to understand due to their highly technical nature. Examples of these courses include microbial genetics, microbial metabolism and physiology.

Unlike developed country universities where tutorials are institutionalized to assist struggling students, Nigerian universities generally do not offer such academic support to their students. An entrepreneurial opportunity thus exists for Microbiology graduates who are highly proficient in these technical courses. They can provide tutorial services to students for a fee. This business model is sustainable as every year new students enroll into Microbiology programs in various Nigerian universities. Microbiology graduates interested in exploring this opportunity are advised to start from their alma mater. This is because they are very familiar with the peculiarities of that university and more likely than not will have existing relationships with Microbiology students at the university. This prior relationship makes marketing the tutorial service easier as the proficiencies of the budding tutors are already established. Furthermore, prior knowledge of the Microbiology student body allows the tutors to know how much students will be willing to pay for the service.

Another opportunity in academia for graduates of Microbiology is freelance research assistants for lecturers and postgraduate students. Graduates can offer their research services to these two groups on a case-by-case basis or on short-term contracts as the situation demands. A third entrepreneurship opportunity is for Microbiology graduates to serve as home tutors in Biology and Chemistry for secondary school students. This will require graduates to market their services to prospective parents and is particularly suitable for graduates with 1st class or second-class upper degrees as these provide tangible evidence of their proficiency in these subjects.

**Food**

The world is a very complex and dynamic place so gone are the days when microbiologists are only working in laboratories. Microbiology graduates can get themselves busy by developing fortified foods/food products or beverages particularly fermented local foods/food products (meals which are usually comfort foods in Nigeria) such as fortified akpu or fufu, millet products such as fura etc, locust beans (daddawa) from the kitchen countertops!. These foods can be developed to have longer shelf life and can be introduced to hypermarket or supermarket shelves. Additionally, a new category of fermented foods can be develop using their knowledge and understanding of which microorganisms are beneficial in foods and which are harmful. The opportunities are endless with regards fermented food products as different kinds of fermented foods and food products or beverages can be developed and produced using surface or liquid fermenters in commercial quantities.

Entrepreneurial opportunities also exist for microbiology graduates as they can use their knowledge of how microbes grow, what enhances microbial growth and what limits it to develop preservation techniques for foods that are perishable. A huge opportunity exists especially with current incessant power failure in Nigeria. Microbiologists can also develop products for storing perishable foods such as tomatoes and peppers.

Microbiology graduates can become self-employed as advocates of food safety and food hygiene. Their knowledge of how microbes cause food spoilage and what inhibits or can reduce food spoilage can be developed and aired on TV or radio shows. They can also disseminate authentic information on the role of microorganisms in our lives by creating an account on op social media platforms (as content creators) to share their knowledge and gain paid commercials from food industries, home cleaning products industry, beverage due to the followership that they may attract.

**Agriculture**

In the agricultural sector, microbiology graduates can come up with innovative ways by which microorganisms can be used to produce high quality composts, biofertilizers, biopesticides and even remediate contaminated water that can be used on farmlands. For example, biofertilizers or microbial-based fertilizers are considered to be crucial components of sustainable agriculture, with long lasting effects on soil fertility and the soil ecosystem in general (Kumar et al., 2021). A microbiology graduate can come with formulations consisting of microbial cells (which could be single or multiple strains, mixed or consortia) to promote plant growth by increasing nutrient availability and acquisition (Mitter et al., 2021).

This is a particularly interesting field that a microbiology graduate can explore especially that the world is desperately seeking cleaner technologies to reduce carbon emissions, water wastage and thereby reduce carbon footprints of farming activities/ practices. Composts and biofertilizers can develop can be sold to local farmers. This will go a long way in gradually reducing reliance on imported fertilizers which are often expensive for our local farmers, may affect our ecosystem and has hindered successful large scale organic farming in Nigeria.

**Laboratory services**

A microbiology graduate in Nigeria who wants to pursue entrepreneurial opportunities by providing laboratory services can start by identifying the market demand for such services. This will require conducting thorough market research to determine the specific services in demand, the target customers, and other factors that may impact the success of the business. With a clear understanding of the market demand, the entrepreneur can then develop a comprehensive business plan that outlines the scope of services, pricing strategies, marketing plans, and operational procedures. The business plan should also include a financial plan that outlines the capital requirements, revenue projections, and break-even analysis.

Once the business plan is in place, the entrepreneur must obtain the necessary licenses and certifications from relevant regulatory bodies such as the National Agency for Food and Drug Administration and Control (NAFDAC) and the Medical Laboratory Science Council of Nigeria (MLSCN). This will require careful attention to the requirements and guidelines set by these bodies, including having the necessary infrastructure, personnel, and equipment to provide high-quality services.

With all the necessary paperwork and infrastructure in place, the entrepreneur can begin marketing and promoting their services to potential customers. This may involve leveraging social media platforms, attending relevant conferences and exhibitions, and partnering with other businesses or organizations in the industry. It is also important to maintain a high level of quality and professionalism in all aspects of the business, from the services provided to the interactions with clients and customers. By following these steps, a microbiology graduate in Nigeria can successfully pursue entrepreneurial opportunities by providing laboratory services and contribute to the growth and development of the industry in the country.

**Water quality services**

The first step for a microbiology graduate in Nigeria who wants to provide water quality services is to research the market demand for these services. This will involve understanding the specific types of water quality testing and analysis that are in demand, the types of customers who require these services, and any regulatory requirements that need to be met. With a clear understanding of the market demand, the entrepreneur can then develop a detailed business plan that outlines the services offered, pricing strategies, marketing plans, and operational procedures.

The next step is to obtain the necessary licenses and certifications required to provide water quality services in Nigeria. This will involve understanding the requirements and guidelines set by relevant regulatory bodies, such as the National Water Supply and Sanitation Policy (NAWAS) and the Nigerian Environmental Standards and Regulations Enforcement Agency (NESREA), and meeting these requirements by investing in the necessary infrastructure, personnel, and equipment.

Once the necessary licenses and certifications are in place, the entrepreneur can begin marketing and promoting their services to potential customers. This may involve developing a website or social media presence to showcase services and attract customers, attending relevant conferences and exhibitions, and networking with potential customers and industry stakeholders.

Finally, the entrepreneur will need to invest in specialized equipment and training to provide high-quality water quality testing and analysis services. This may include purchasing portable water quality meters, spectrophotometers, and microbiological testing kits, as well as training personnel to use these tools effectively.

By following these steps, a microbiology graduate in Nigeria can successfully pursue self-employment by providing water quality services, helping to address the pressing issue of water quality in the country and contributing to the growth and development of the industry.

**Pharmaceutical industry**

To pursue self-employment in the pharmaceutical industry, a microbiology graduate in Nigeria can begin by identifying specific products or services they can offer, such as developing and manufacturing antimicrobial drugs, herbal medicines, vaccines, or other specialized medications. The graduate can conduct market research to determine the specific needs of the target customers and develop a business plan that outlines the scope of services, pricing strategies, marketing plans, and operational procedures. Obtaining the necessary licenses and certifications from relevant regulatory bodies such as the National Agency for Food and Drug Administration and Control (NAFDAC) and the Pharmaceutical Council of Nigeria (PCN) is crucial to comply with regulations and ensure quality control. The entrepreneur can then begin marketing and promoting their products or services to potential customers, including individuals, hospitals, clinics, and pharmacies. Investing in specialized equipment and training to produce and distribute high-quality pharmaceutical products, such as a manufacturing facility, laboratory equipment, and skilled personnel for research and development, production, and quality control, may also be necessary, and this will serve as the biggest obstacle in achieving this self-employment dream due to the very large capital requirements. However, by following these steps, a microbiology graduate can successfully contribute to the growth and development of the pharmaceutical industry in Nigeria and improve the health and well-being of the population.

**Public health**

To pursue self-employment in public health, a Nigerian microbiology graduate can start by identifying the specific areas of public health in which they would like to work. For instance, they could specialize in disease surveillance, where they would provide diagnostic services, monitoring of infectious diseases outbreaks, and report on disease patterns. Alternatively, they could focus on environmental health, where they would provide services such as environmental impact assessments, water and air quality assessments, and management of hazardous waste. The graduate could also choose to specialize in health promotion, where they would provide health education, outreach programs, and campaigns for disease prevention, or in health policy, where they would be involved in policy research, development, and evaluation. Once the specific area of public health is identified, the graduate should conduct market research to determine the demand for services in that area. Based on the findings from market research, the microbiology graduate can develop a comprehensive business plan that outlines the scope of services, operational procedures, marketing strategies, pricing strategies, and quality control measures. This business plan should also identify the necessary certifications and licenses required to comply with regulatory standards and ensure quality control. In addition to obtaining the necessary certifications and licenses, the entrepreneur can also invest in specialized equipment and personnel to provide high-quality public health services. By following these steps, Nigerian microbiology graduates can successfully contribute to the public health sector, provide valuable services to the community, and achieve their self-employment goals.

**CHALLENGES HINDERING NEW VENTURE CREATION FOR MICROBIOLOGY GRADUATES IN NIGERIA**

Starting a self-employment venture as a microbiology graduate in Nigeria by taking advantage of one of the many opportunities outlined in the previous section of this paper is not without its challenges. One of the most significant challenges is the limited access to funding. Funding is essential for purchasing equipment and technology, paying for office space and staff, and marketing the services. Without funding, it can be challenging to get a new business off the ground. A practical step that graduates can take to overcome this challenge is to seek out investment from various sources such as angel investors, venture capitalists, or government funding agencies. Grants from non-profit organizations and foundations can also be an option. Additionally, they could look for a loan from a financial institution that offers small business loans or a microfinance bank that caters to entrepreneurs.

Another challenge is the lack of business management skills. Microbiology graduates may have excellent research skills but may not have the necessary business acumen to run a successful venture, despite the EE received at their institutions of higher learning. In this case, they could consider taking courses in business management, partnering with someone who has business management skills, or hiring a business consultant or mentor to guide them. They could also join an entrepreneurship network that provides support and training in business management.

Limited access to technology is another challenge that microbiology graduates may face. Specialized equipment and technology are necessary for microbiology research, and these can be expensive and difficult to access. Graduates can explore various options, such as leasing equipment, partnering with academic institutions or research centers that have the necessary equipment and technology, or purchasing used equipment. They can also consider crowdfunding options for purchasing equipment.

Limited access to markets is another significant challenge that graduates may face when starting a self-employment venture. To overcome this challenge, graduates can develop a marketing plan that targets potential customers in their area of expertise. They could attend conferences, workshops, and exhibitions to network and showcase their services. Graduates could also consider partnering with industry associations or other organizations that can help them access new markets.

Finally, navigating regulatory hurdles can be a significant challenge when starting a research center or providing research services. Microbiology graduates must comply with various regulations and guidelines to operate legally. Graduates can overcome this challenge by consulting with regulatory bodies and seeking advice on the necessary requirements for compliance. They could also consider partnering with experienced professionals who have dealt with regulatory requirements in the past.

In conclusion, while there are significant challenges that can prevent a microbiology graduate from achieving self-employment in Nigeria, there are practical steps that they can take to overcome them. By seeking funding, developing business management skills, accessing necessary technology, finding markets, and navigating regulatory hurdles, a microbiology graduate can establish a successful self-employment venture.

**CONCLUSION**

This paper has shown that Nigerian microbiology graduates have numerous self-employment opportunities in different sectors of the economy. These opportunities range from academia, food, agriculture, laboratory services, water quality services, pharmaceutical industry, and public health. These opportunities are essential in helping to reduce the unemployment rate in Nigeria and contribute to the country's economic development.

However, Nigerian microbiology graduates face several challenges in achieving self-employment. These challenges include limited access to funding, lack of business management skills, limited access to technology, limited access to markets, and navigating regulatory hurdles. Nevertheless, this paper has provided practical steps that graduates can take to overcome these challenges. For example, seeking investment from various sources, developing business management skills, leasing or partnering to access technology, developing a marketing plan, and complying with regulatory requirements.

To achieve their self-employment dreams and become employers of labour, Nigerian microbiology graduates need support from policymakers. This support can come in the form of targeted policies and programs that promote entrepreneurship and support self-employment ventures. The Nigerian government can also establish an innovation and entrepreneurship fund that provides funding and mentorship opportunities for graduates who want to start their own businesses. This will create a more enabling environment for graduates to establish and grow their businesses, thereby creating employment opportunities for others.

Additionally, universities and academic institutions can support self-employment by improving the quality and content of their entrepreneurship education courses. This will equip graduates with the necessary business management skills to manage their businesses. They can also establish business incubators and innovation centres that provide graduates with access to equipment, technology, and mentorship.

In conclusion, self-employment is a viable option for Nigerian microbiology graduates, and policymakers should support their efforts to become employers of labour. By overcoming the challenges, they face and taking advantage of the opportunities available in different sectors, graduates can contribute to Nigeria's economic growth and reduce unemployment levels in the country.

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