NAVIGATING FROM THE LABORATORY TO THE MARKETPLACE: SCIENCE STUDENTS & ENTREPRENEURIAL DEVELOPMENT

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Abstract

Entrepreneurship is undoubtedly the panacea to economic growth and development. The goals set by Nigeria for science education include making Nigeria scientifically and technologically literate and developing technologically to a level for solving her housing, food and healthcare problems and production of made-in-Nigeria goods. Teaching and learning of science should therefore be geared not just at raising scientists but at developing scientist-entrepreneurs as well. It is noticeable that some of history's outstanding scientists also exhibited entrepreneurial streaks. For marked technological development to be recorded, today's science students need to be trained to discover the opportunities available to them. Entrepreneurial education focused at developing scientist-entrepreneurs should be made a part of the science curriculum at all levels. Teachers need to watch out and identify entrepreneurial traits in science students and help them develop the potentials through school, governmental and non-governmental interventions.

Keywords: Entrepreneurship, Science Education, Science Curriculum, Scientist-Entrepreneur

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Introduction

Entrepreneurship is undoubtedly the panacea to economic growth and development. This is the reason behind the efforts of government at all levels to create development of the micro, small and medium enterprises sector (Fate, 2004). One of the eight millennium development goals (MDGs) is poverty reduction, achievable through development of micro and small enterprises. The entrepreneur has been described as one who starts an enterprise; the one who puts new forms of industry on their feet; the one who shoulders the risks and uncertainty of using economic resources in a new way; and the one with the right motivation, energy, and ability to build something by his or her own efforts (Akpomi, 2009).

Science & Entrepreneurship Education (EE) in Nigeria

The importance of science education to the development of any nation cannot be over-emphasized. Hence, the tying of national goals to challenges of science and technology education is not new (Okebukola, 1998). In the National Policy on Education, the goals set by Nigeria for science education include making Nigeria 'scientifically and technologically literate, developing technologically to a level for solving our housing, food and healthcare problems and production of made-in-Nigeria goods including aircrafts, oceanliners, submarine, luxury cars, television, etc.' (NPE, 1998) The current state of science education in Nigeria however reveals serious challenges to the achievement of these lofty goals.

EE is distinctive in its focus on realization of opportunity. It can be oriented towards different ways of realizing opportunities which include a new organization (e.g. starting a new business), promoting innovation or introducing new products or services or markets in existing firms (corporate entrepreneurship or intrapreneurship), clustering (breaking off of a group of employees from the parent company to found a new company which continues to do business with the parent) or social entrepreneurship (creating charitable organizations designed to be self-supporting in addition to doing their good works.

Despite the fact that EE has been found to have the ability to increase graduate self-employment potential (Bassey and Daniel, 2009) and hence economic development, it is not yet a serious aspect of the Nigerian education system and the nation is still far away from realizing any

meaningful development in this area. The focus has been more on providing education on the basics of entrepreneurship and for the most part, students in the sciences are neglected with a failure to realize EE is valuable to all students in all fields (Smith, Collins & Hannon; 2006 in Akpomi, 2009). EE is not a concept to dream about (Ikeme, 2007) and if the nation will realize meaningful development in science and technology, there is the need to introduce in-dept entrepreneurial education in the sciences. The average science student should be trained to transit from inside the walls of the laboratory or classroom to the marketplace. So, while development in research is being encouraged, much more can be realized when the scientist understands his labour does not end inside the pages of some journals, but that it can bring financial returns. This will renew interest in the sciences among students and reduce the failure rate that has been experienced in recent years.

Entrepreneurship and National Development

Entrepreneurship is the act of 'undertaking innovations, finance and business acumen in an effort to transform innovations into economic goods'. In the 20th century, the understanding of entrepreneurship owes much to the work of economist Joseph Schumpeter in the 1930s and other Austrian economists such as Carl Menger, Ludwig von Mises and Friedrich von Hayek (Zhan, 2010). Schumpeter (1947) describes an entrepreneur as a person who is willing and able to convert a new idea or invention into a successful innovation. He believes entrepreneurship resulted in new industries but also in new combinations of currently existing inputs.

Scientist Entrepreneurs (SEs)

A scientist entrepreneur may sound like a contradictory term; however it is noticeable that some of history's most well-known scientists also exhibited an entrepreneurial streak. Several inventions of the past are responsible for the revolution that human life has experienced and also form the basis for modern inventions and discoveries. Some scientist/inventors who fall into the category of Scientist-Entrepreneurs include the following:

Ben Franklin: A first-rate scientist and businessman. He invented lightning rod, bifocals, the iron furnace stove, a carriage odometer, and the harmonica and owned a print shop, a newspaper, and a general store at 24. Franklin was one of the wealthiest men of his time.

Thomas Edison: Although credited with more than 1,000 U.S. patents, his greatest discoveries were the phonograph and the light bulb and formed the Edison Electric Light Company.

George Eastman: Obsessed with designing a development process that was convenient and hassle-free and with a mindset toward marketing the results of his research to the general public, upon receiving the patent for his roll film camera in 1888, he immediately began production, selling his product under the marketing slogan, "You press the button, we do the rest." His company name, Kodak, went on to be the leader in film and photography for much of the twentieth century.

Marie Curie: Living at a time when women were not generally accepted within either the scientific or business communities, she made an extraordinary mark as her discovery of the element radium opened the door for further discoveries in the area of radioactivity. She won two Nobel prizes including a Nobel Peace prize.

Edwin Armstrong: He developed several electronic circuits and systems that were crucial to the development of radio, including the regenerative circuit and the frequency modulation (FM) radio broadcasting system (Encarta, 2009).

Alexander Graham Bell: Since age 18, Bell had been working on the idea of transmitting speech. In 1874, while working on a multiple telegraph, he developed the basic ideas of the telephone. His discovery led to the organization of the Bell Telephone Company in 1877. In 1880 France bestowed on Bell the Volta Prize, worth 50,000 francs, for his invention. With this money he founded the Volta Laboratory in Washington, D.C., where, in that same year, he and his associates invented the photophone, which transmits speech by light rays. Other inventions include the audiometer, the induction balance and the first wax recording cylinder. Later, Bell's interest turned mostly to aeronautics. Applying the principles of aeronautics to marine propulsion, his team developed the full-sized “hydrodrome,” which reached speeds beyond 113 km/h (70 mph) and was for many years the fastest boat in the world.

Building the Bridge between the Classroom/Laboratory and the Marketplace

The Nigerian education system as inherited from the British colonialists was deficient in many ways; it produced school leavers who have no clue as to how to survive outside the school system except as employees; individuals incapable of transferring their classroom knowledge to their out of school life. This has resulted into mass unemployment among graduates of tertiary institutions and several resultant vices and various forms of violence. The dangerous trend in the education system occasioned by under-funding, lack of motivation for teachers and poor infrastructures among others issues in the last three decades has resulted in the loss of interest in research which forms the foundation for inventions among scientists. It is therefore not surprising that scientific discoveries have become a thing of the past and science students have no flair for making discoveries-a characteristic for which scientists are noted. This is a defeat for the national objective on science education. Teaching and learning of science should therefore be geared not just at raising scientists but at developing scientist-entrepreneurs as well. Learners with such streak should be identified and encouraged. According to Gaerba (2000), some scientists are interested strictly in science while others have a propensity for entrepreneurship. According to Zhang Liyan (2010), if the university students with high entrepreneurial potentials get proper training, they will have the best prospects for becoming "real" entrepreneurs.

Entrepreneurship is a matter that involves everyone—the government, society, and the educational institutions. Since scientific development and entrepreneurship go hand in hand and most entrepreneurs don't have a background in science but rely on entrepreneurially-minded scientists for the expertise their goals require, it becomes imperative therefore to seek out the SE, encourage and provide them with necessary training. This will produce scientists who have the personality and characteristics to help transform science into a marketable product. Certain traits identify the SE; teachers and other stakeholders need to watch out for these traits.

a. **Innovation**: The type of individuals who do not try to do what everyone else is doing, but is always searching for ways to improve on current designs and take them one step further than everyone else.

b. **Application-mindedness**: The effective SE appreciates science for its own sake, but also understands that the goal is to create commercial applications from the research and so is consistently engaged in research likely to produce commercial applications.

c. **Risk-taking**: Scientists generally tend to be cautious people, preferring to delay action until they have all the facts about the subject they are studying. Entrepreneurs, on the other hand, are risk-takers. The SE strikes a balance between the two.

d. **Time-conscious**: Scientists avoid setting schedules since the research itself determines the timeline. The entrepreneur will always have cause to work with timelines and schedules; however, the SE is aware that the commercialization process requires adherence to a firm schedule. Investors and other interested parties need a reasonable estimate of how long it will take for the product to hit store shelves in order to make an informed investment decision. As such, the SE must be schedule-minded.

e. **Team Spirit**: The process of taking a product from the research lab to store shelves hinges on collaboration. Individuals who spend significant amounts of time alone in a laboratory are not always the best collaborators. The team spirit is a SE trait.

f. **Willingness to Share**: Even with a scientific background, the SE probably does not possess all the expertise required to turn the research into a commercially viable product. He therefore needs to learn to tap into other people's expertise when the need arises. Although a partnership will undoubtedly require profit-sharing, the alternative may be a product concept that never makes it out of the laboratory.

a. **Business Sense.** A scientist who loathes the mechanisms of free market capitalism is clearly not a good candidate for an entrepreneurial partnership. (Gaebla, 2000)

There are several other competencies or characteristics attributed to entrepreneurs in the literatures; some are generally agreed to by several authors while others are based on the opinion of a few or just an author. Nixdorff (2005) examined literature to see if there were any commonalities in competencies across authors. An extract is presented in Table 1.

Table 1: Commonalities in Entrepreneurial Competencies Across Authors (Nixdorff J.,2005)

Competencies	Bird, 2002	Thompson, 1999	Fiet, 2000	Hisrich, 1992	Hood et al, 1993	Vesper et al, 1988	Ronstadt, 1985
Achievement/task motivation	√	√					
Creativity/Idea generation	√	√	√	√	√	√	√
Decision making/evaluation				√	√		√
Design products/services	√	√					
Discipline/Drive	√			√			
Interpersonal skills	√	√			√		
Leadership	√		√				
Manage risk		√	√	√			
Motivate team members	√						
Negotiation				√		√	√
Opportunity recognition		√			√	√	√
Oral communication	√				√	√	
Vision				√			

From the Laboratory to the Marketplace

Every entrepreneur savors the possibility of turning the latest technological discovery into the next great consumer product. SEs however have an obvious advantage over the rest of the entrepreneurial field. For the SE, navigating from the laboratory bench to the market requires

more than having a good idea backed by good science, it needs funding for the research, obtaining patent protection, negotiating good deals, obtain government authorization, developing good manufacturing practices, selling the product with sufficient margin to cover all of these early expenditures, and to comply with all post-market government requirements.

Valoir (2000) identified some of the bolts and nuts to be screwed tight by the SE before going to the market as including the following:

- Written contracts that define ownership rights, confidentiality and other important obligations and understandings.
- Finance is one of the most important issues; it can put an end to every effort of the SE.
- Cultivating a culture of invention is an important issue as well. Encouraging invention is the first step to creating valuable intellectual property. Without commercialization, even the best science will never benefit the public and without patents, basic research often cannot get funded. Getting inventorship right is critical because if this is not got right, patents can be lost.

Learning from Others

According to Paul Reynolds as cited by Wiki (2010), 'participating in a new business creation is a common activity among U.S. workers over the course of their careers' And in recent years has been documented to be a major driver of economic growth in both the United States and Western Europe. Nigeria can learn many lessons from other nations in the area of entrepreneurial development by looking at what makes the difference for emerging economies like China.

While Nigeria is still at the policy-level concerning entrepreneurship development, China has developed a strong entrepreneurial education programme over the years. China's University Entrepreneurship Education has the direct support of the government through incentives including tax deductions and other forms of financial support to student entrepreneurs. An Annual National Business Plan Competition is organized by one university each year in collaboration with the Ministry of Science and Technology and other related government organizations where students from almost all relevant universities in China join in. Support and encouragement is critical to the survival of start-ups, hence, many Chinese universities have their own incubator for the students' start-ups. In each city, incubators are also available to other

young people. These incubators are mainly set up by government organizations and offer services to entrepreneurs at favorable prices. Many intermediary firms facilitate the entrepreneurs' activities. In addition, young people are more mobile and parents have also become broad-minded; and in some cases even providing encouragement like the seed fund, sharing their business experiences and network and seeing entrepreneurial endeavor (even when the project fails) as a good experience that will help their children in their future careers.

Compared with some other nations, the Chinese entrepreneurial culture is generally more open to risk-taking and advocates an entrepreneurial spirit. Entrepreneurs are respected in Chinese society.

Conclusions

If outstanding technological development shall be recorded, today's science students need to be trained to discover the opportunities available to them. Entrepreneurial education focused at developing scientist-entrepreneurs should be made a part of the science curriculum at all levels. Trainers/teachers need to watch out and identified entrepreneurial traits in science students and help them to develop the potentials.

Recommendations

Promotion of entrepreneurship among Science Students with in-depth entrepreneurial education for identified SEs. Government- and non-government-funded as well as school-funded programmes meant to create and stir the interest of science students in entrepreneurial development. Opportunities for students to brainstorm about product ideas and new methodologies should be part of science education.

The use of entrepreneurs as instructors to provide case-based teaching should go with mentoring programs in partnership with accomplished SE. programmes to encourage show-casing are also very important in addition to entrepreneurship-friendly government policies and development of infrastructure. Also germane are sincere lending policies by banks to encourage micro- and small enterprises development.

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