



Entrepreneurship Skills Acquired by Undergraduate Chemistry Students during the Course of their Studies in the University

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Abstract: Chemistry is a utility course filled with a lot of business opportunities. It enlightens students on various kinds of business opportunities during their course of study. This paper therefore assessed the business ideas generated by undergraduate chemistry students during the course of their study. The investigation was carried out using descriptive research of the survey type. Percentage, mean and standard deviation were used to answer the research questions. Two hundred (200) Chemistry undergraduates from University of Ilorin were sample for this study. The results of the study revealed that; Chemistry undergraduates had moderately positive attitude towards adoption of entrepreneurial activities; Chemistry undergraduates displayed moderately positive attitude towards adoption of entrepreneurial skills which can be started with little capital and require low technical know-how; The product most chemistry undergraduate proposed to produce after graduation is soap. More so, Chemistry undergraduates are business oriented and high percentage of them will probably pursue business upon completion of their study.

1. Introduction

The educational system of any country aiming to develop must have set goals relevant to the citizen's need and national aspirations. Its major task lies in the process of how to ignite the latent talents in its citizens, prepare and thoroughly equip its citizens with relevant knowledge and skills for viable

functionality and ability to cope with any intellectual or cultural challenges (Eya, 2011).

For any nation to be a developed one, it has to be fervent in producing a scientifically oriented citizen through an efficient and quality science education. Abimbola (2013) defined science as a branch of knowledge that deals with a

body of facts or truth systematically arranged and showing the operation of general laws. The major branches of science are Chemistry, Physics and Biology (Abimbola, 2013).

Chemistry as one of the main branches of science deals with the composition, properties and uses of matter which lobs into the principles governing the changes that matter undergoes (Ababio, 2015). Chemistry also has to do with the utilization of natural substances and creation of artificial ones hence, Chemistry is ubiquitous. It is therefore imperative to say that everything we see, hear, taste, smell or touch involves intricate series of chemistry and chemical reaction in our body (Bagley, 2014). With such an enormous range of topics, it is essential to have basic knowledge of chemistry to understand the world around us and to take pretty advantage of such knowledge to convert them into entrepreneurial activities.

Business and Entrepreneurship today has become an unavoidable issue especially by policy makers who see entrepreneurship as a means to alleviate unemployment in Nigeria; and so, the concept is gaining so much ground as a powerful agent for job creation especially through the small and medium enterprises (SMEs). The concept of business and entrepreneurship is fast becoming a great phenomenon in the world and it is being embraced by developed and developing nations alike. Aminu (2008) defined entrepreneurship as a process of creating something new with value, by devoting quality time and effort, assuming the accompanying financial, psychic and social risks, and

receiving the resulting reward of monetary and personal satisfaction and independence.

The hall mark of entrepreneurship is the setting up of a new business. Starting up a new business requires an entrepreneurial spirit which is characterized by innovation and risk taking. As defined by Aminu (2008), an entrepreneur is a person who have the ability to see and evaluate business opportunities, gather the necessary resources to take the advantage of them and initiate appropriate action to ensure success.

Academic entrepreneurship has the sole objective of commercialisation of innovations developed by academic scientists in universities and research institutes via patenting, licencing start-up creation and academic/university-industry partnerships (Phan & Siengel, 2006; Siengel, Veugelers & Wright, 2007). It is highly important to note that increment in the rate of innovation and business organizations in Nigeria could be achieved by establishing a relationship between chemistry and entrepreneurship. However, the extent to which undergraduate are aware of this seems to be undetermined.

As a remedy, chemistry serve as one of the best way to utilize the classroom knowledge to practical aspect of business and entrepreneurship life, the question that raises from the mind is "why chemistry"? This is because acquisition of professional qualification in chemistry will allow individuals to apply or transfer the acquired knowledge into the immediate environment (Jack, 2012). This is the one of the purposes of

National Policy on Education (FRN, 2004) that, the acquisition of appropriate skills and development of mental, physical and social abilities and competency to contribute to the development of the society should be embraced.

According to Ugwu and Etiubon (2009) and Jack (2012), some of the entrepreneurial skills in chemistry content include: production of dyes from knowledge of colour chemistry; production of aluminium pots from knowledge of metallic chemistry; production of local drugs from knowledge of medicinal chemistry; treatment of water from knowledge of Environmental Hydro Chemistry amongst others. Olokun (2017) conducted a study on the perceptions of students on entrepreneurship education and entrepreneurial intentions selected in Nigeria Universities. The findings of the study revealed that practical activities are mainly based on vocational skill acquisition and university support systems do not involve students across all levels.

It was emphasized that the links between science, innovation, creativity and entrepreneurship are important (European Commission, 2015). Researchers such as Agommuoh and Akanwa (2014), Ejilibe (2012), Ezeudu, Ofoegbu and Anyaegbunnam (2013) and Hilario (2015) opined that entrepreneurship has an important implementation area in terms of education in physics, chemistry and biology. This implies that scientific entrepreneurship means the process of producing innovative, science-based

products based on the ability to forecast new products that is not on the market (Peter & Anne, 2000).

Chemistry as a science course will therefore provide opportunities for students due to its numerous topics and practical which are easily convertible into useful and finished products consumable for the final consumer and profitable for the entrepreneur himself. Upon graduation, graduates can thus apply the concepts of chemical concepts to become self-employed.

Despite the effectiveness of chemistry in entrepreneurship, little attention is given to the aspect of innovation and entrepreneurship opportunity in it. According to the National Bureau of Statistics (2014), unemployment rate in Nigeria in the first quarter of 2013 was 23.9% (Odia & Odia, 2013). The rate of unemployment in Nigeria is indeed alarming (Ogunsola, 2009; Aja, Okorie & Adali, 2013). Ajagu (2005) argued that entrepreneurship in Nigeria is near absent and the dearth of information in this area has resulted in only few venturing into it without the prerequisite information to succeed, while others have to abandon their dreams.

This study will thus add to the existing body of literature in science and entrepreneurship by assessing the entrepreneurial skills that has been acquired by chemistry undergraduates during the course of their studies in the university.

2. Literature

2.1 Contents of the Undergraduate Chemistry Curriculum

Chemistry is a central subject of science and is closely related to daily life

(Oyeku, Oduyoye, Elemo, Akindoju, Karimu & Unuigbe, 2015). The objectives of chemistry contents as stated by Das (2006) in the journal of the National Teachers Institute (NTI, 2006) are:

1. To encourage students take active part in class.
2. To encourage students develop curiosity and spirit of enterprise.
3. To teach good laboratory practice and skills.
4. To enable students become committed to safe practice in daily life.
5. To teach students to analyse data or experiment from other sources.
6. To provide students with some insight into further career prospect in the field related to chemistry.

It can be seen above that the development of entrepreneurial skills is imbedded in the objectives of the chemistry curriculum as mentioned in the second point above, (spirit of enterprise). Speaking on the content of undergraduate chemistry curriculum, Eya (2011) asserted that Thirty three (33) out of the Fifty (50) major topics in chemistry curriculum such as Organic chemistry, Rate of reaction and Equilibrium, Acid, Base and Salt, etc. promotes inculcation of entrepreneurial skills among our students while seventeen of the content namely, Concept of matter, Particulate nature of matter, Periodic table, Chemical bonding, etc. do not.

Chemistry contents can therefore be seen as useful topics that serve as stepping stones to entrepreneurial achievements.

2.2 Chemistry Topics that Business could be generated from

Varieties of topics are contained in the chemistry curriculum, but some of these topics are very good source of business for prospective entrepreneurs. Dike (2008) asserted that Environmental Chemistry taught in institution serves as a very good topic for entrepreneurship. They can set up waste management services which will involve collection and disposal of wastes from homes, offices etc. Dike (2008) pointed out that public health authority responsible for the collection of wastes from the government owned and personal dustbin to the dumping site is generally low and inadequate with the results that they remain uncollected for months, thus graduates can turn waste to wealth.

Ugwu and Etiubon (2009) and Jack (2012) opined that topics such as Colour chemistry, Metals and their compounds, Medicinal chemistry etc., offered in universities are few examples of important topics that have real practical application in the outside world after the knowledge have been internalized while in school. According to the authors, useful application of some of the topics includes: production of dyes from knowledge of Colour Chemistry; production of aluminium pots from knowledge of Metallic Chemistry; production of local drugs from knowledge of Medicinal Chemistry etc. Chemistry therefore provides opportunities for students due to its numerous topics and practical which are easily convertible into useful and finished products consumable for the

final consumer and profitable for the entrepreneur himself.

2.3 Economic Benefits of Understanding Business Ideas in Chemistry

There are many factors necessitating the adoption of business ideas by the students. The following are some of the general reasons laid down by Oyeku, et al. (2015)

- a. The need to tackle Unemployment
- b. The need to grow the national economy.
- c. The need to create wealth to reduce poverty.
- d. Incessant civil unrest.
- e. Personal contentment.

Aside from the stated reasons of adopting entrepreneurship, there are also several benefits that the nation and individual stands to gain by engaging in chemistry entrepreneurship. According to the report submitted by the Royal Society of Chemistry (RSC) in September 2010 to the Research Institute of the United Kingdom (UK), some of the important economic benefits of chemistry entrepreneurship over the years include:

- **Water:** application of chemicals in the treatment and delivery of drinking water free from impurities. Ranging from simple disinfection to multistage advanced treatment, ensuring that water is not harmful to the environment.
- **Health:** chemistry entrepreneurs in their research have significantly impacted on the health of the nation in many ways. From the development of

diagnostic devices, through the discovery and development of highly effective drugs for treating disease and of substance that enables medical procedures to be accomplished to advanced materials for use in prosthetic and regenerative medicine, this significantly enhance the lives of patients and improve quality of life for the population.

- **Food and drinks:** chemistry entrepreneurs today develop flavours, additives and introduction of nutritional enhancement. They do researches to synthesize and extract natural food components, their research has led to commercially successful reduced fats and reduced salt food, against a backdrop of increasingly demanding consumers.
- **Farming:** chemistry entrepreneurs have contributed to increase in crop productivity with significant impact on crop yield. These achievements includes the development of insecticides, fungicides, and many world class herbicides, the basic understanding of chemical cycles throughout the food chain underpin the development of enhanced feed and food production.
- **Packaging:** chemistry entrepreneurs have produced numerous types of plastic packages from single use food packaging containers to high

strength protective ones. They are also giving packaging a more sustainable future through development of bio renewable plastics such as Polylactic Acid (PLA) and more recently biomaterials from non-food crops using low energy and low water process.

- **Textiles:** chemistry entrepreneur through their continuous innovation produce textiles and clothing which react to climate change, medical textiles, military and industrial textiles with critical performance and patterns of requirement.
- **Electronics:** chemistry entrepreneurs have contributed towards many of the advances in electronic industry, development of semiconductors which serves as the basis of modern electronics such as radio, computers and telephones. They also reduce the dependence of electronics upon finite metal resources and as well increase the ability to recover and recycle metals from electronic wastes.

2.4 Factors Hindering the Success of Entrepreneurship Ideas Developed by Undergraduate

The factors militating against success of business ideas developed by undergraduate chemistry students are numerous. Some of these factors as enumerated by Elemo (2014) are presented below:

- a. Lack of financial capabilities by chemists to develop the innovation to market place.

- b. General apathy for made in Nigeria goods/technologies and high taste of Nigerians for foreign goods including foreign technologies.
- c. Low level of funding of research and development in Nigeria.
- d. Weak linkage between academia and industry.
- e. Lack of appropriate legal framework on protection and commercialisation of innovation.

2.5 Promotion of entrepreneurial skills among undergraduate by Institutions

According to Okello, Obura and Matovu (2011), the growth of any enterprise among other things depends on the entrepreneurship spirit, the qualification of its owner, quality provision of information, knowledge, skills and advice on the various aspect of business. However programmes to prepare for entrepreneurship training to support small businesses have become subject of further education and training. Students are thus equipped with necessary skills to become a successful entrepreneur. The effort of the Federal Government in conjunction with various institutions towards entrepreneurship can be seen in the establishment of the following skill specific enterprise (FRN, 2014):

- Industrial Attachment or Student Industrial Working Experience Scheme (SIWES).
- Vocational and Technical Training.
- Information and Communication Technology Training (ICT).
- Workshops and specific trainings on tie and dye, welding and fabrication, preparation of perfumes, etc.

- National Directorate of Employment (NDE).

The above mentioned skills and training were established by various institutions in conjunction with the government to boost the practical and entrepreneurial skill of undergraduate students of chemistry, and science related discipline. For example, the vocational and technical training as entrenched in the Nigeria National Policy on Education (FRN, 2004) refers to those aspect of education processes involving the study of technology and related science as the acquisition of special skills, attitudes, understandings and knowledge relating to occupation in various sector of the economy and social life, all the programmes have entrepreneurship focus undertaking in various institutions of learning.

Realising the benefit of chemistry entrepreneur, higher institutions in Nigeria such as Adeniran Ogunsanya College of Education Lagos, an affiliate of Ekiti State University, Ado-Ekiti, has converted many of its students' laboratory innovations to marketable products. The chemistry graduates of this institution are most likely to be wealth creators rather than white collar jobs seekers (Ogunsola, 2009).

In addition, the Lagos State Government should be commended in this regard for putting in place a Ready Set Work (RSW) programme which seeks to develop entrepreneurial skills in the school graduants. In the process, two students of College of Health Technology, Lagos have succeeded in developing technology for Biogas production which has earned them a

whooping sum of five million naira from the state government for start-up business in that area (Nigeria Tribune, 2016). If chemistry entrepreneurship and by extension, could be offered at all levels of education, the rate of unemployment in Nigeria would be drastically reduced. Not only this, the ailing Nigeria economy would also be improved.

2.6 Entrepreneurial Skills Required by Chemistry Undergraduate.

Becoming an entrepreneur involves learning of new skills and taking risks. Scientists also need a basic understanding of the elementary financial structures including basic understanding of Balance Sheets, Cash Flow statements, financial ratios and their interpretations and general accounting principles to run the business effectively as well as an understanding of legal topics such as business structure, contracts ,liability and intellectual properties; these involves learning a new culture.

Judith J.Albert, co-founder and managing partner of network based in New York noted that Scientist who wants to become entrepreneur must provide answer to the following questions as a way of personal evaluation of their business ideas.

- a. Is there a market need?
- b. Do you have solution to the market needs?
- c. Does anyone else have the solution?
- d. Can we make serious money here?
- e. How close are you going to market?

- f. Do you have a team that can take it to the market?
- g. Do you have credible business plan?
- h. How much will it cost?
- i. Is this something you really want to do?
- j. Is this the right time in your life?

Albert also offered the following suggestions to Scientists who want to become entrepreneurs:

- a. Understand the market and where your technology fits.
- b. Be willing to take risks.
- c. Talk to people who have done this before and build support network.
- d. Surround yourself with excellent people that you trust.
- e. Do not overlook students when you are setting up business teams.

The following are also some of the identified steps to take in starting a new business, the steps are however not listed in particular order of occurrence (Oyeku, 2008).

- a. Make up, your mind as to whether you want to be an employer or an employee.
- b. Read up material on entrepreneurship.
- c. Do a thorough evaluation of yourself to know whether you can be an entrepreneur.
- d. Decide on the type of business ownership.
- e. Conduct a thorough research into various windows of investment opportunity without necessarily limiting yourself to a particular area.

- f. Select two or three out of the various option of investment opportunity.
- g. Get investment profiles on the selected options.
- h. Narrow down your choice to one option for a start.
- i. Conduct a personal research of chosen industry to become knowledgeable e.g. competition, raw material, packaging, machinery and equipment, process technology etc.
- j. Prepare a feasible report.
- k. Develop a business plan.
- l. Adopt a name and register your company.
- m. Decide on business location.
- n. Design your company/product/package e.g. logo, letter headed paper, business card etc.
- o. Open a corporate account.
- p. Discuss with financial/ funding institutions.
- q. Develop records keeping/ accounting procedures.
- r. Contact supplies of machinery and equipment, raw materials, packaging materials, electricity, water etc.
- s. Acquire necessary input including building construction/ rent /lease.
- t. Acquire necessary training.
- u. Recruit labour.
- v. Locate your market.
- w. Conduct trial production.
- x. Register your product (if applicable).
- y. Open your door for business.

3 Research Method

Descriptive research of the survey type was used for this study. The population for this study comprised of all undergraduate chemistry students in University of Ilorin, Ilorin, Nigeria. For the purpose of this study, 200 undergraduates were randomly selected from 300 and 400 levels. 100 undergraduates were selected from each level in two departments (Department of Chemistry and Department of Industrial Chemistry). In total, 50 undergraduates (respondents) were selected each from

300 level chemistry, 400 level chemistry, 300 level chemistry education and 400 level chemistry education, which brought the total number of respondent to 200. Simple random sampling technique was used for this study. The instrument used for this study was an adapted questionnaire from the work of Bamidele (2019). The data collected was analysed using descriptive statistic. Percentage, mean and standard deviation were used to answer the research questions.

4. Data Presentation and Analysis

Table 1: *Chemistry topics in which business ideas could be generated from*

Items	Mean	SD
Separation techniques	3.14	0.70
Acid-Base and salt	3.21	0.93
Metal and their compounds	3.13	0.78
Electrolysis	2.91	0.91
Environmental Chemistry	2.96	0.81
Color Chemistry	2.74	0.89
Medicinal Chemistry	2.99	0.92
Organic Chemistry	2.78	0.92
Industrial Chemistry	3.18	0.91
Solubility of Substances	2.99	0.89

From Table 1, the mean obtained for each items is greater than 2.50 which serve as the baseline for affirming positive response. It can therefore be concluded that all chemistry topics in Table 1 can generate business ideas.

Table 2: Business Ideas that come to the mind of Chemistry undergraduates during the course of learning

Items	Mean	SD
Distillation of wine during separation technique class	3.22	0.76
Production of soap in the course of acid and base class	3.13	0.73
Production of wires and aluminum	2.96	0.88

URL <http://journals.covenantuniversity.edu.ng/index.php/cjoe>

during metal and its compound class		
Treatment of water as being taught in electrolysis class.	2.97	0.89
Municipal waste treatment during environmental chemistry class	2.64	0.99
Production of dye while in color chemistry class	2.92	0.82
Production of vulcanizer solution during medicinal class	2.99	0.93
Production of starch in organic chemistry class	3.11	0.69
Production of plastic during industrial chemistry class	3.14	0.87
Production of drugs while in solubility class	2.78	0.90

From Table 2, it can be concluded that during the course of learning all the listed topics comes to mind of undergraduate chemistry students.

Table 3: *Business ideas that Chemistry undergraduate determined to pursue within their field on graduation*

Items	Mean	SD
Refined salt and sugar in separation technique	3.12	0.81
Water treatment in Acid, base and salt	2.93	0.79
Aluminum refining in metal and its compound	2.89	0.83
Dry and wet cell production in electrolysis	2.99	0.89
Municipal waste treatment in separation techniques	2.73	0.81
Dye production inorganic chemistry	2.92	0.82
Electroplating in medicinal chemistry	2.85	0.91
Yeast production in organic chemistry	2.76	0.85
Tiles production in industrial chemistry	2.74	0.82
Perfume production in solubility	2.91	0.92

Table 3 depicts that the business ideas undergraduate chemistry students has decided to pursue within chemistry field on graduation includes; Refined salt and sugar in separation technique, Water treatment in Acid, base and salt, Aluminum refining in metal and its compound, Dry and wet cell production in electrolysis, Municipal waste

treatment in separation techniques, Dye production inorganic chemistry, Electroplating in medicinal chemistry, Yeast production in organic chemistry, Tiles production in industrial chemistry and Perfume production in solubility. This is shown by their mean values which are above 2.50.

Table 4: Products which Chemistry undergraduate proposed to produce from the knowledge of Chemistry on Graduation

Items	Yes	%
Sugar and salt purification.	126	63.0%
Soap	128	64.0%
Lightweight aluminum pots	97	48.5%
Toiletries	90	45.0%
Purified and distilled water	102	51.0%
Paint and dye	111	55.5%
Drugs	111	55.5%
Wines and beverages	96	48.0%
Plastic wares	101	50.5%
Dry and wet cells	102	51.0%
Cosmetics	109	54.5%
Electroplating of metal	103	51.5%
Rubber and vulcanizer solution	119	59.5%
Treatment of water	124	62.0%
Fabrics and clothing materials	101	50.5%
Chemicals and reagents	119	59.5%
Distilled laboratory water	116	58.0%
Chalk	102	51.0%
Disinfectants	104	52.0%
Agrochemicals	97	48.5%

It is observed from the responses in Table 4 that the major product students would like to produce include sugar and salt purification, soap, purified and distilled water, paint and dye, drugs, plastic wares, dry and wet cells, cosmetics, electroplating of metal, rubber and vulcanizer solution, treatment of water, fabrics and clothing materials, chemicals and reagents,

distilled laboratory water, chalk and disinfectants. This is because the total number of respondents who attested to each of the products is above 100.

5. Discussion

The finding revealed that the chemistry topics which undergraduates could perceived business idea from are separation techniques, Acid-Base and salt, Metal and their compounds,

Industrial chemistry, Electrolysis and others, Environmental Chemistry, Color Chemistry, Medicinal Chemistry, Organic Chemistry and Solubility of Substances. The finding is in line with the research work of Martinez (2007) whose result revealed that the chemistry student have higher entrepreneurial potentials.

Finding from the study also showed that the business ideas developed by undergraduates during the course of their learning include; distillation of wine during separation technique class, production of soap in the course of acid and base class, production of wires and aluminum during metal and its compound class, treatment of water as being taught in electrolysis class, municipal waste treatment during environmental chemistry class, production of dye while in color chemistry class, production of vulcanizer solution during medicinal class, production of starch in organic chemistry class, production of plastic during industrial chemistry class and production of drugs while in solubility class. This finding gives credibility to the work of Paul (2012) who stated that electrolysis, extraction of metals, etc., could advance chemistry students into business.

The finding also revealed that the business ideas which undergraduates have determined to pursue within chemistry field upon completion of their study include; refined salt and sugar in separation technique, water treatment in acid, base and salt, aluminum refining in metal and its compound, dry and wet cell production in electrolysis,

municipal waste treatment in separation techniques, dye production inorganic chemistry, electroplating in medicinal chemistry, yeast production in organic chemistry, tiles production in industrial chemistry and perfume production in solubility. This finding is in accordance to the findings of Paul (2012) who opined that electrolysis, extraction of metals, etc., could advance chemistry students into business.

The result of this study also indicated that undergraduates would love to produce soap, lightweight aluminum pots, toiletries, paint and dye, drugs, wines and beverages, plastic wares, dry and wet cells, cosmetics, electroplating of metal, rubber and vulcanizer solution, treatment of water, fabrics and clothing materials, chemicals and reagents, distilled laboratory water, chalk, disinfectants, agrochemicals and purify water, sugar and salt. This finding gives credibility to the finding of Uzezi and Jen (2015) who discovered that Nigerian chemist through chemistry entrepreneurship would choose to commercialize chemistry by producing dry and wet cells, cosmetics, electroplating of metal, etc.

6. Implications of the Study

The findings from this study will be of great importance to many stakeholders such as students, lecturers, government, policy makers, society in general and nations at large. The importance of this study is to assess the entrepreneurship idea conceived by undergraduate chemistry students during their studies in the university, and to show them the various ways by which their knowledge of chemistry can be put into various use

for self-reliance and gainful employment.

Students would find benefits in this study in the sense that despite all the stated problems about the issue of unemployment, students will get to know the usefulness of the knowledge of chemistry in becoming the sole proprietorship of their business. The study might provide science stakeholders and government with detailed information about the importance of entrepreneurship and the need for its promotion especially for individual still in school.

The findings may also be of benefit in teacher's education, as it will prepare

teachers towards giving their students not only the theoretical aspect of work, but also preparing their mind for the outside world by providing them with adequate practical knowledge of the subject matter. In the area of Educational research, this study could be of relevance as it encourages further research into the subject matter. .

Conclusion

From the finding of the study, it can be concluded that the areas in Chemistry like Industrial chemistry could help students in the generation of business ideas like soap, lightweight aluminum pots, toiletries, textile production, etc.

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