



Exploring Entrepreneurial Opportunities in Chemistry Education for Students of Colleges of Education

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ABSTRACT

This study investigated the chemistry entrepreneurial opportunities chemistry students in colleges of education can explore to better their career and help build entrepreneurial attitude within the education space. The study, which was carried out in two colleges of education in Bauchi state, adopted the descriptive survey design. A total of 104 students randomly selected from 100, 200 and 300 levels of chemistry education programme fully participated in the study. Well-developed closed-ended students' questionnaire (SQ1) was used to obtain information from respondents. Data obtained were analysed using frequencies and percentages in order to answer the research questions posed in the study. The findings in the study revealed that only six among the generally identified topics in chemistry are adequately covered (up to 60%) by chemistry teachers. A large number of students admitted being aware of the opportunities available in topics like separation techniques, water and solution, electrochemistry, crude oil and petrochemicals, metals and their compound; and are eager to engage in these businesses. However, they did not fully understand the vast business opportunities inherent in Chemistry Education. The students' choices of businesses were largely dependent on financial benefits and the desire to be self-employed, self-reliant and to provide job opportunities for others. Based on the findings, it was recommended among others that teachers should adequately and comprehensively cover the topics in the chemistry curriculum to ensure students receive a well-rounded understanding of the subject; as well explore those topics from an entrepreneurial perspective while teaching.

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INTRODUCTION

Education has been defined as a process of adequately preparing an individual by equipping him with the appropriate skills and knowledge to benefit himself and the society (Okeke and Uzor, 2024). However, a major challenge in our educational system today is the inability to translate the education received in our educational institutions to solving the problem of unemployment and making the teeming youths in Nigeria self-reliant or entrepreneurially oriented. Entrepreneurship is viewed as the process of

being creative and innovative with the aim of creating wealth for the betterment of man and the society at large. It is seen as a means to solve the problem of unemployment among youths in Nigeria. Umudi (2017) defined Entrepreneurship as the engine that fuels innovation, generate employment and economic growth. Through entrepreneurship education, entrepreneurial mindsets is developed among youth; the right values, the proper managerial, technical and wealth creation skills in students to be able to run successful businesses is impacted.

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Entrepreneurship education in other words produces entrepreneurs, who are smart, innovative and competent; they recognize opportunities in demand-supply chain, develop marketable products, which are not currently in the market in order to fill up the gap. While Chemistry is a subject which explores the chemical phenomena that occur in our environment (Bagley, 2014; Olatunbosun, 2017).

Chemistry education provide the fundamentals for training NCE graduates to acquire the competencies and ability to develop functional knowledge of chemistry concepts and principles, be able to observe and explore the chemical environment, develop scientific attitudes such as curiosity etc, manipulate simple apparatus for purposes of demonstration and use, improvise simple equipment from available junk in the chemical environment and apply the skills and knowledge gained to solve day-to-day problems (Mahadi, 2010; Olatunbosun, 2017). An understanding of the principles of the subject is essential for both human and economic sustainability. Chemistry in synergy with other disciplines such as physics, medicine and engineering has led to the production of new materials such as semi-conductors, superconductors, polymers and plastics. These materials are utilized in fabrics, structural materials, information and communications technologies; and medical imaging (Stephen and Berhanu, 2011). The impact of chemistry on any country economy can never be over-emphasized. It has been a means for creating wealth for individuals and nations. Chemical industries in the UK contributed £258 billion value added to her economy in 2007, supporting millions of jobs, accounted for at least 15% of the UK's exported goods and attracted significant inward investment (Oxford Economy, 2010).

Chemistry students in various higher institutions of learning therefore have higher entrepreneurial potentials and opportunities due to the range of topics and areas in chemistry they are exposed to during their years of study. Chemical substances are used to manufacture basic chemicals such as dyes and pigments, rubber, plastics, and fertilizers, paints, varnishes and

mastics; pharmaceuticals; soap and detergents; agrochemicals, and man-made fibres. Fortunately, many of these materials and more are taught under certain topics or areas of chemistry such as metals and their compounds, environmental chemistry, color chemistry, food chemistry, electrolysis, separation techniques, organic chemistry e.t.c. It is therefore important for students in this field to take advantage of their basic knowledge of the subject, in relation to their understanding of the world around them and venture into entrepreneurial activities that are chemically based.

The general assumption is that colleges of education are considered as training grounds for teachers, with the aim of ensuring that the right pedagogies are imparted and applied for the benefit of the learners. Students in these institutions are not exposed to entrepreneurship opportunities in their field of studies and their trainers lack sufficient knowledge and skills in their field to translate the areas/topics in chemistry they teach into entrepreneurial opportunities. According to Adeyemo (2018), many chemistry students in teacher-training institutions are primarily prepared for classroom teaching rather than entrepreneurial ventures, and this limits their ability to translate scientific knowledge into viable business opportunities.

The traditional curriculum in these institutions focuses heavily on pedagogy and theoretical chemistry, with little or no entrepreneurial training (Ezeudu et al., 2021). As a result, NCE graduates only depend on formal teaching jobs, which are increasingly scarce in the education sector (National Bureau of Statistics NBS, 2022). Little wonder these graduates unfortunately have remained unemployed or unemployable for lack of appropriate skills, knowledge and attitudes in the face of unavailable job opportunities and economic realities; even when the N.C.C.E minimum standard have stipulated that NCE graduates are expected to have the competencies and ability to apply the skills and knowledge gained in chemistry to solve their daily challenges.

It is quite disheartening to note that despite the enormous benefits inherent in the



study of Chemistry and the effectiveness of chemistry entrepreneurship, little attention is given to innovations and entrepreneurship opportunities inherent in its study within colleges of education. The study therefore posits itself to assess the entrepreneurial opportunities and skills inherent in chemistry education for students in colleges of education, their level of these opportunities and readiness to explore them.

Purpose of the Study

The purpose of the study is to explore the entrepreneurial opportunities available to chemistry students in colleges of education in Bauchi state and students' readiness to explore them. Specific objectives will include:

1. Identify topics/areas in chemistry with entrepreneurial opportunities taught to chemistry education students in Colleges of Education in Bauchi state.
2. Find out the level of awareness of chemistry entrepreneurial opportunities and skills among Chemistry Education students of Colleges of Education in Bauchi.
3. Ascertain the readiness of chemistry education students in colleges of education to harness the identified entrepreneurial skill/opportunities in chemistry for business venture.

Research questions

Based on the stated objectives of this study, the following research questions were drawn

1. What topics/areas in chemistry with entrepreneurial opportunities are taught to chemistry education students in colleges of education in Bauchi state?
2. What is the level of awareness of chemistry entrepreneurial opportunities and skills available in identity topics taught in Chemistry Education in Colleges of Education in Bauchi?
3. Are chemistry education students in colleges of education (COEs) ready to harness the identified entrepreneurial

skill/opportunities in chemistry for business venture?

METHODOLOGY

The study employed a descriptive survey research design. This design was deemed appropriate as it allows the researchers to collect data from a specific population to describe the current state of entrepreneurial opportunities in chemistry for science students. It enables the collection of both qualitative and quantitative data regarding awareness, interest, and engagement in chemistry-based entrepreneurial activities. The target population of this study consists of all NCE chemistry education students in three colleges of education purposively sampled in Bauchi, Nigeria.

104 chemistry education students were selected from these schools using simple random sampling. Students' questionnaire (SQ₁) captured detailed profile of the respondents in addition to their responses to the issue being studied. The questionnaires, which had closed ended questions was used to elicit responses to achieve the aim of the study. The questions in this questionnaire adequately structure the concepts under study and minimize the risk of misinterpretation. It also permits easier tabulation and interpretation by the researcher. Data generated was analysed using descriptive statistic such as mean, frequencies, mode, bar charts and simple percentages to answer the research questions.

RESULTS

Research Question 1:

What are the topics/areas in chemistry with entrepreneurial opportunities available for Chemistry Education students in Colleges of Education to explore?

The analysis of the data reveals that the most frequently taught topic in chemistry classes is Separation Techniques (83.7%) indicating it was properly covered. This high percentage suggests that the topic is considered fundamental and is widely emphasized in chemistry instruction. Following closely are metals and their compounds (64.4%), acid, bases and salts (64.4%),



electrochemical reactions (60.6%), fermentation (58.7%); and water and solution (54.8%) showing strong representation as essential components of inorganic chemistry, which are often central to both theoretical and practical aspects of the subject. Other topics, with less than 50% response indicate that teachers hardly teach those topics or lay less emphasis on them during lessons. It therefore reflects poor cover of the NCE chemistry curriculum and underscores the need to effectively monitor the full implementation of the NCCE minimum standard.

Topics like pollution and waste management, reported by 42.5% of the respondents, could show poor awareness of the importance of environmental education and the relevance of chemistry in addressing ecological issues; crude oil (45.2%), Carbon (41.4%) and topics with less than 40% coverage did not indicate substantial focus on organic chemistry and biological processes. These topics not only build students' chemical knowledge but also equip them with skills relevant to public health and local industry.

Table 1 Topics/areas in chemistry generally taught to chemistry education students in colleges of education in Bauchi state

Topic(s)	Frequency	Percentage (%)
Separation techniques	87	83.7
Fermentation	61	58.7
Water and solutions	57	54.8
Saponification	30	28.9
Esterification	27	26.0
Plastics and giant molecules	30	28.9
Electrochemical	63	60.6
Carbon	43	41.4
Pollution and waste management	44	42.3
Fats and oil	27	26.0
Carbohydrates	28	26.9
Metals and their compounds	67	64.4
Acids, bases and salts	67	64.4
Crude oil and petrochemical	47	45.2
Nitrogen	29	27.9
Carbon and Nitrogen cycles	40	38.5

Topics like giant molecules, fats and oil, carbohydrates, nitrogen, and carbon and nitrogen cycles, are fundamental organic and environmental chemistry concepts. saponification, crude oil and petrochemicals are important topics in industrial processes while nitrogen, esterification, plastics and giant molecules are vital in polymer chemistry and some biochemical processes. Overall, while foundational topics appear to receive substantial focus, there is a noticeable neglect of environmentally relevant and more advanced or industrial topics. This imbalance suggests the need for more comprehensive coverage in chemistry teaching to ensure students receive a well-rounded

understanding of the subject as required by the national curriculum.

Research Question 2:

What is the level of awareness of entrepreneurial opportunities available in the identified topics taught in Chemistry Education in Colleges of Education in Bauchi?

The data in Table 2 highlights students' exposure to various chemistry topics that could contain embedded business opportunities and their level of awareness of the inherent business opportunities in those topics. The most widely recognized topic with business opportunities is separation techniques, identified by 65.4% of the

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respondents, suggesting that students are being equipped with foundational skills relevant for processes like distillation, filtration, and solvent

extraction, all of which are applicable in small-scale production industries. Fermentation followed with 55.8% respondents.

Table 2 Level of Awareness of the Entrepreneurial Opportunities available within the identified topics taught in Chemistry Education

Topics	Frequency	Percentage (%)
Separation techniques	68	65.4
Fermentation	58	55.8
Water and solutions	52	50.0
Saponification	28	26.9
Esterification	32	30.8
Plastics and giant molecules	41	39.4
Electrochemistry	58	55.8
Carbon	24	23.1
Pollution and waste management	24	23.1
Fats and oil	28	26.9
Carbohydrates	20	19.2
Metals and their compound	52	50.0
Acids, bases and salts	51	49.0
Crude oil and petrochemical	50	48.1
Nitrogen	22	21.2
Carbon and Nitrogen cycles	22	21.2

This reflects the practical entrepreneurial potential in fermentation like producing items such as alcoholic beverages, bread, and biofuels (Table 3). Electrochemistry and metals and their compounds, with 55.8% and 50% respondents each indicated the opportunities such as energy storage (e.g., batteries), environmental services, and metalwork (Aluminum pots, wires, bead making). With 49% and 48.1% responses for acids, bases and salts; and Crude oil and petrochemicals respectively.

It indicates the students are aware that there are opportunities such as bar/liquid Soap, herbicide, insecticide and fertilizer production within these topics (Table 3), showing an encouraging integration of industrial and household chemical production skills into classroom instruction. Plastics and giant molecules received moderate attention (41%), indicating partial recognition of their business potential in water purification, food chemistry, and plastics recycling or manufacturing. Fats and oils, and saponification (with 26.9% response each) in spite of their relevance in entrepreneurial ventures

such as soap-making, biodiesel, and refining; including esterification, carbohydrates, carbon, nitrogen and their cycles despite their applications in food and cosmetic received the least attention among topics with business relevance, likely due to their more theoretical or ecological orientation in school curricula. This indicates that these topics were underexplored from an entrepreneurial perspective. Hence, there is the need to integrate industrial and household chemical production skills into classroom instruction, beyond mere mentioning the life applications of these topics.

The findings in this study are in line with those in Chiemeka (2019). She revealed that undergraduates could perceive business ideas from chemistry topics like separation techniques, acid, bases and salt, metal and their compounds, electrochemical and others, environmental chemistry, color chemistry, organic chemistry and solubility of substances. She also stated that identified topics like electrolysis, extraction of metals, etc., could advance chemistry students into business. While a good number of chemistry topics are being associated with business

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opportunities, there is still room to strengthen the entrepreneurial interpretation of some scientifically rich areas. The curriculum should be continually reviewed to ensure that students are not only learning theoretical chemistry but also seeing its practical and economic value, especially in ways that promote creativity, local industry development, and self-employment.

The data shown on Table 3 indicates different business opportunities in chemistry students could harness. While there were varying levels of awareness of the various business opportunities in chemistry among the respondents, the most common entrepreneurial/business opportunity is production of soaps and detergents, as reported by 68.3% of respondents. This indicates strong emphasis on practical income-generating chemical processes that are easy to demonstrate and highly marketable. Closely following are water purification/production (58.7%), ethanoic acid production (51%), Insecticides and herbicides Production (49.0%), paint production (47%),

fertilizer production (46%), distilled water production (44.2%) and wire production (40.4), suggesting that these businesses are highly lucrative and very well patronised.

They are also highly valued in food, agriculturally and pharmaceutical-related processes. Many students did not fully understand the business opportunities inherent in tie-dye/batik production, production of cassava flours and starch, toothpaste/tooth powder production, production of thinners, glucose, activated charcoals, gel, charcoal briquettes, batteries, salt, oil, beverages and dyes e.t.c. This is reflected in the less than 30% response to these business opportunities. Studies have indicated that many chemistry students in Colleges of Education are unaware of business opportunities or lack the necessary skills to pursue them (Olutuase, 2021). It is therefore imperative for teachers to explore different avenues to expose students to diverse chemical business opportunities during chemistry instructions.

Table 3 Business Opportunities and Skills available in Chemistry Education

Business Opportunities	Freq	Percentage %	Business Opportunities	Freq	Percentage %
Paint production	49	47.0	Insecticides and herbicides Production	51	49.0
Production of soaps and detergents	71	68.3	Production of chalks	17	16.5
Fertilizer manufacture	48	46.2	Dye production	3	3.0
Tie-Dye/Batik production	11	10.6	Wines and beverages production	11	10.6
Production of cassava flours and starch	27	26.0	Butter and margarine production	14	13.7
Aluminium pots production	33	31.7	Juice production	23	22.1
Wires production	42	40.4	Production of vulcanizer solution	23	22.1
Bead making	20	19.2	Water purification	61	58.7
Disinfectants and Antiseptics	38	36.5	Waste management/pollution control	28	26.9
Ethanoic acid production	53	51.0	Bread making	33	31.7
Toothpaste/tooth powder production	25	24.0	Manufacture of cosmetics	27	26.0
Manufacture of thinners	25	24.0	Yeast production	22	21.2
Production of Glucose	26	25.0	Kernel oil and vegetable	17	16.4

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Business Opportunities	Freq	Percentage %	Business Opportunities	Freq	Percentage %
Distilled water production	46	44.2	oils production		
Production of gums and adhesives	35	33.7	Sugar production	30	28.9
Production of charcoal briquettes	12	11.5	Dry and wet cell batteries production	23	22.1
Production of shoe polish	24	23.1	Salt production	26	25.0
Production of activated charcoals	29	27.9	Drug production	37	35.6
Gel fuel	25	24.0	Perfumes production	31	29.8
			Ethanol production	36	34.2

Research Question 3:

Are chemistry education students in COEs ready to harness the identified entrepreneurial skill/opportunities in chemistry for business venture?

The interpretation of Table 4 reveals significant insights into the entrepreneurial interests of Chemistry Education students. The data shows that the majority of respondents (77.9%) expressed strong interest in the production of soaps and detergents, making it the most preferred business opportunity. This suggests that students are highly aware of the relevance, demand, and low start up requirements of this chemical-based venture in their communities. The next most preferred business areas include fertilizer manufacture (58.7%), Insecticides and herbicides production (54.8%), paint production (52.9%) and chalk production

(51.9%), these choices reflect students' awareness of how chemistry can be applied in agriculture, housing, and educational sectors—highlighting a practical connection between their academic knowledge and societal needs.

Moderate levels of interest (35 – 50%) were recorded in areas such as production of gums and adhesive, tie-dye/batik production, production of charcoal briquettes, production of cassava flours and starch, wires production, production of shoe polish, ethanoic acid production, production of activated charcoal, gel fuel, water purification, salts and sugar production, drug production, perfumes production, cosmetic production and juice production, indicating an awareness of daily household consumables, industrial, medical and educational materials as viable entrepreneurial options.

Table 4: Chemistry student's readiness to harness Entrepreneurial/ Business opportunities in Chemistry Education

Option	Frequency	Percentage (%)
Paints production	55	52.9
Production of soaps and detergents	81	77.9
Fertilizer manufacture	61	58.7
Tie-Dye/Batik production	41	39.4
Production of cassava flours and starch	39	37.5
Aluminium pots production	36	34.6
Wires production	40	38.5
Bead making	40	38.5
Disinfectants and antiseptic	33	31.7
Ethanoic acid production	36	36.6
Toothpaste/tooth powder production	33	31.7
Manufacture of thinner	27	26.0

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Option	Frequency	Percentage (%)
Production of glucose	35	33.7
Distilled water production	34	32.7
Production of gums and adhesive	48	46.2
Production of charcoal briquettes	48	46.2
Production of shoe polish	47	45.2
Production of activated charcoal	42	40.4
Gel fuel	40	38.5
Insecticides and herbicides production	57	54.8
Production of chalks	54	51.9
Dye production	4	3.8
Wines and beverages production	42	40.4
Butter and margarine production	36	34.6
Juice production	41	39.4
Production of vulcanizer solution	34	32.7
Water purification	42	40.4
Waste management/pollution control	37	35.6
Bread making	37	35.6
Manufacture of cosmetic	38	36.5
Yeast production	35	33.7
Kernel oil and vegetable oils production	32	30.8
Sugar production	40	38.5
Dry and wet cell batteries production	33	31.7
Salt production	38	36.5
Drug production	41	39.4
Perfumes production	41	39.4
Ethanol production	35	33.7

Similarly, businesses (with less than 35% responses) like ethanol, yeast, Butter and margarine, Kernel oil and vegetable oils production and Production of vulcanizer solution, also gained traction among chemistry students, reinforcing the potential of chemical products in small-scale industries. Meanwhile, ventures like dye and thinner production attracted 4% and 26% of the students, showing that while not as dominant, these areas still appeal to a portion of the students who recognize their value and marketability.

The results reflect that chemistry education students show strong entrepreneurial interest in products with high societal demand, particularly in areas tied to sanitation, agriculture, and personal care. This finding underscores the potential for integrating entrepreneurship more robustly into the chemistry curriculum to align academic training with real-world business

opportunities. The findings in this study aligns with the work in Eze & Eze (2018), who reported that Chemistry students with a background in organic and formulation chemistry are capable of developing products such as soaps, creams, perfumes, shampoos, and lotions. They asserted that these businesses are not only lucrative but also allows for local raw material utilization and creative branding, especially in African markets where demand for natural and herbal cosmetics is growing.

The data presented in Table 5 reveals the various reasons why Chemistry Education students in the study chose specific entrepreneurial opportunities. A significant proportion of respondents, 60.6% and 57.7%, indicated that financial benefits and self-employment respectively were their primary reasons for selecting an entrepreneurial path. This suggests a strong desire among students to

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create wealth by starting their own businesses rather than depending on government or private sector for white collar jobs in the face of prevalent unemployment. Additionally, 48% and 46.1% of the respondents cited the need to be self-reliant and be able to provide job opportunities for others respectively as their motivating factor, indicating

that many students view entrepreneurship as a viable means of economic empowerment and job creation. It also demonstrates a level of personal responsibility and determination to be independent in terms of livelihood and decision-making.

Table 5: Reasons for choosing the entrepreneurial opportunities

Option	Frequency	Percentage (%)	Ranking
Self-employment	60	57.7	2
Self-reliance	50	48.1	3
Financial benefit	63	60.6	1
Hobby/interest	15	14.4	7
Influence of friends	11	10.6	8
Influence of lecture	14	14.5	6
Acquire employable skills	44	42.3	5
To be an employment provider	48	46.1	4
To be famous	15	14.4	7

Furthermore, 42.3% stated that they chose entrepreneurial ventures to acquire employable skills, showing that students are aware of the importance of practical, marketable competencies in today's competitive job market. Some students selected entrepreneurship based on personal interest or hobby, with 14.4% indicating that their choices align with their passion. This personal motivation is often crucial for long-term commitment and success in any business. Also a smaller percentages of respondents indicated external influences, such as influence of lecturers (14.5%) and friends (10.6%), which underpins the important role of mentoring in teacher education; and how peer groups and classroom interactions can play a minor but notable role in shaping students' career choices.

Additionally, 14.4% of respondents were motivated by the desire to be famous, which reflects a socio-cultural aspiration to achieve recognition and social status through entrepreneurship. In a similar study carried out for graduates of Federal Polytechnic Nekede, Owerri, Nwosu (2017) ranked financial benefit as one of the major reasons why students chose entrepreneurial opportunities while in school, while hobby and fame were ranked among the

lowest. Overall, the table shows that the majority of Chemistry Education students are driven by intrinsic goals like independence, skill acquisition, and financial gain. This highlights the growing awareness of entrepreneurship as a critical pathway to personal and professional development beyond the traditional classroom setting.

CONCLUSION

The study concludes that many of the identified topics/areas in chemistry with environmentally relevant and more advanced or industrial topics with entrepreneurial opportunities are poorly covered in the NCE chemistry curriculum, underscoring the need for effective monitoring of the teaching and learning process to ensure the full implementation of the NCCE minimum standard. While students in chemistry education programs possess foundational scientific knowledge and can identify business opportunities in chemistry, they lack sufficient exposure to entrepreneurial and practical business applications of chemistry, an indication that the chemistry curriculum in colleges of education appears to focus heavily on theory and pedagogical training, with minimal emphasis on applied and entrepreneurial competencies.

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Although students showed varying level of interest in business ventures such as paint production, insecticides, and soap making e.t.c., driven by their passion and desire to be self-reliant, they lack adequate practical training, and mentorship to turn ideas into viable enterprises. The study therefore calls for a broader integration of entrepreneurship education within chemistry education to maximize students' awareness and preparedness for self-reliance and innovation within their field; and the need to prepare entrepreneurial oriented teachers' tertiary institutions.

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