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Chemistry as a Tool for Skill Enhancement among Entrepreneurs: Review Paper

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Abstract: Chemistry is important as each matter in this universe is made up of chemicals. Chemistry explains everything around us. It has made our life comfortable by giving us life saving drugs, paper, synthetic fibres, variety of cosmetics, fertilizer, pesticides, various types of plastics and beautiful Paints etc. Economy of a nation depends on quality of research, innovations and entrepreneurship. In chemistry, there are more business opportunities than any other discipline. Chemistry entrepreneurship involves the process of converting innovations in laboratory into marketable products for commercial gain. Efficient training on enterepreneaureal skills can help scientists, researchers and chemists to commercialize their innovations for financial gains. They can become job creators and contribute to national economy. The paper explains how a person who has studied chemistry as a subject can become a successful entrepreneur?

Keywords: Chemistry, entrepreneurship, business opportunities, innovations and commercialization.

Introduction:

Chemistry is important as whatever we do in our daily life is chemistry. Each matter including our body in this universe is made up of chemicals.

We all human beings are chemists. Chemistry is a big part of our daily life and we make use of chemicals every day and perform many reactions without thinking much about them. Many changes which we observe in our daily life are caused by many chemical reactions. We find chemistry in air, water, soil, foods, environment, our emotions and literally in everything which we can see, touch or taste. With such vast range of topics, it is important to have basic knowledge of chemistry to know the world around us. Chemistry is the study of matter, its properties, why and how substances combine or separate to form other substances and how substances interact with energy[1]? It is related with the uses of natural substances and the synthesis of artificial ones by chemical or physical reactions[2].

Chemistry explains what happens when we breathe, drink, eat or just we do work or take rest. It explains how food changes when we cook it, how to preserve food, how it rots, how our body makes use of the food we consume and how different ingredients interact to make food. Chemistry explains the purity, softness or hardness of water. It explains cleaning action of soaps and detergents. It explains which disinfectant and mosquito repellent is safe for use. We can use chemistry to decide which cleaner is best for dishes, laundry, our self and our home. Knowing some chemistry can help us to take day-to-day decisions that affect our life. It explains how use of supplements, vitamins and drugs can help or harm us. Part of the importance of chemistry lies in developing and testing new medical treatments and medicines. Hand sanitizer generally used to decrease infectious agents on the hands is also a chemical product.

During the covid-19 pandemic because of high demand and shortage of hand sanitizer World Health Organisation produced a guide to make hand sanitizer but there are precautions against making them such as incorrect measurement or ingredient may result in an inadequate amount of alcohol to kill the coronavirus thus making the product ineffective or even poisonous[3]. Exposure to per- or poly-fluorinated substances (PFASs) can increase a person's likelihood of developing severe Covid-19[4]. Chemistry makes one chemical compound a nutrient and another compound a pollutant.

Chemistry is the central point of discussion about environmental problems. Chemical emissions from the motor vehicles are one of the biggest causes of air pollution[5,6]. How can we keep our environment safe and clean? What chemical processes can synthesize the things, which we can use without disturbing the environment? Knowledge of basic chemistry makes us to understand the effects of chemicals on the environment. We can give plants the best nutrients to help them in their growth. Chemistry has made our life simple and comfortable by giving us life saving drugs, synthetic fibres, variety of cosmetics, fertilizer, pesticides, paper ,various types of plastics and paints etc. In a nutshell, chemistry is all around us and the better we know chemistry, the better we know our world.

This subject is studied by students who want to become doctors, nurses, physicists, teachers, nutritionists, pharmacists and chemists etc. You might want to make a career out of chemistry because chemistry-related jobs are plenteous and high-paying. The importance of chemistry won't be diminished over

time and it will remain a promising career path for ever.

Chemistry Entrepreneurship:

Scientists have natural passion for science, not business. Entrepreneurship involves matching a need with an innovation and this concept is not different in the field of science and chemistry. Before talking about the chemical entrepreneurs of the world, let us have a look at internet or computer scientists, who are often known more for their coding capabilities than their business expertise. There is a long list of rich computer programmers such as Elon Musk, Bill Gates, Jan Koum, Mark Zuckerberg, Sergey Brin, and Larry Page etc. Who became exceptionally successful entrepreneurs. But we don't see more chemistry or science entrepreneurs having similar success. What motivational differences exist in the world of computer science that drives entrepreneurship and why is it apparently so different than chemistry?

An entrepreneur is a person who creates a new business, bearing most of the risks and enjoying most of the rewards. Entrepreneur as an innovator does new things in a new way, supplies new products, develops new techniques of production, discovers new markets and builds up new sources of raw materials[7]. Entrepreneurs are path creators rather than path seekers and they benefit from an ever-present sense of urgency8.

Chemistry entrepreneurship is a subset of academic entrepreneurship which involves the process of converting innovations in chemistry into marketable products for commercial gain. It enables chemists to take their work beyond publications in academic journals by patenting and commercializing them for financial gains. Innovation and entrepreneurship in chemistry can have a real world impact on a wide range of very diverse global markets including food, drug, cosmetics, fertilizer, pesticides and energy etc.

Scott P. Lockledge PhD in Inorganic Chemistry, a Chief Executive Officer and Cofounder of Tiptek, a producer of ultra hard and ultra sharp probes for atomic force microscopy applications said, "Founding a company gives you the opportunity to create an enterprise, be it small or large , in which you know you are individually making a difference" and that "working in a large company can feel like being a small gear in a large machine".

Lockledge was also motivated to become an entrepreneur by the desire to control his own destiny. He said, "When you work for someone else, your boss's priorities dictate your work-life and lifestyle," He also added that "as an entrepreneur, you decide when and where you work." Starting a successful business requires a great idea but how can we know that it is good enough? A great scientific idea is not necessarily a successful entrepreneurial idea. Becoming an entrepreneur in chemistry involves taking risk, learning new skills etc. Basic understanding of cost, accounting , marketing, advertising, financial accounting and interpretation etc. need to be acquired, so that the new business and new culture can be run successfully. Chemistry entrepreneurship program is intended for students/chemists who desire to pursue the fields of chemistry and business. It needs foundation in chemistry in addition to good knowledge of business coursework so as to start a small business in the chemical sciences i.e., consulting, lab work etc.

Laboratory is the foundation of all scientific and technological development. Chemistry education is an experimental science. Mystery of chemistry cannot be imagined without lab experiments. Entrepreneurship programme in chemistry can only be achieved, if the complementary role of laboratory practices is exploited. The quality of work done in labs and the outcomes depend on the qualities of the equipments as well as the technologist/scientist performing it. One better thing you can do in school/ college is to get as much laboratory experience as possible, mainly in an area where you want to work after graduation. The specific experience you get doesn't matter so much as making sure that you learn laboratory techniques, instrumentations, scientific calculations, problem solving and so on. Take advantage of opportunities to learn and practice non technical skills, such as written and oral communication, time management and collaboration etc. There will be lot of training during job but you need to be capable of having your own schedule, keeping a complete and accurate record of observations, storing data properly, communicating your work effectively with others and so on. All these skills will be fruitful in future. The relationship between academia and entrepreneurship is mutually beneficial. Entrepreneurship provides alternative career options and new experiences for students, particularly at a time at which students are facing a challenging job market.

From chemistry entrepreneurship point of view, chemists with great ideas and efficient training on entrepreneurship are assumed to be job creators rather than job seekers. But this objective requires scientists and chemists to have a critical combination of both technical and entrepreneurial skills as activities of commercialization are somewhat different to the activities in the laboratories.

Research-Inspired Entrepreneurship:

Recent advances in science and technology have opened up new ways for researchers to commercialize innovative products and processes for economic gains which they have developed in their labs. The research community is becoming more aware of the benefits of patent protection, licensing, and innovation-driven

entrepreneurship. In India, budding researchers are increasingly publishing their work in reputable journals and are commercializing their research so as to benefit society. Funding agencies in India and abroad are now giving higher priority to innovations that can have a direct impact on the society, either through high-impact publications or through marketable patents.

Science and technology driven innovations are now being patented and commercialized by research institutes and universities from around the world[9]. Easy access to information, higher Internet speeds and efficient business networking have now made it possible for entrepreneurship-supporting communities to spread awareness about the importance of entrepreneurial ventures[10]. Many academic scientists start startup businesses based on their own discoveries and sometimes their businesses become so successful that they become full-time entrepreneurs. Entrepreneurship education helps students to form a knowledge base of the functions and operations of a business[11].

In USA, Department of Chemistry at Case Western Reserve University, Cleveland, Ohio runs the Chemistry Entrepreneurship Program (CEP), a two-year professional M.Sc. in chemistry entrepreneurship where students study state-of-the-art chemistry, practical business and technology innovation. The CEP provides opportunity for students to work on a real-world entrepreneurial project with an existing company or their own startup and also connects students with advisors, mentors, partners, funding sources and job opportunities.

Chemistry World Entrepreneur Award:

To recognize chemistry entrepreneurship as a discipline and profession, as well as to promote and encourage chemistry entrepreneurship, the Royal Society of Chemistry, has instituted an award, i.e. Chemistry World Entrepreneur of the Year. The Royal Society of Chemistry's Prizes and Awards are awarded in appreciation of originality and impact of research, or for each recipient's contribution to the chemical sciences industry or education. They also recognize the abilities of individuals to develop successful collaborations. This annual award of a cash prize of £4,000 is given to an individual demonstrating creativity and vision, driving chemistry innovation to commercial success for his/her business. The award for 2018 was received by Clementine Chambon for her work using bioenergy to solve environmental, social and gender challenges in rural India. For 2020, this award was received by Professor Daryl Williams for the pioneering invention of the dynamic vapour sorption instrument, which has transformed research laboratory practice worldwide.

Things to know in becoming Chemistry Entrepreneurs:

Judith J. Albers, Cofounder and Managing Partner of Networks based in New York noted that Scientist who wants to be an entrepreneur must have answer to the following questions so as to evaluate his/her personal business ideas.

i. Is there a market need?
ii. Do you have solution to the market need?
iii. Does anyone else have the solution?
iv. Can you make serious money here?
v. How close are you going to market need?
vi. Do you have a team that can take it to the market?
vii. Do you have a realistic business plan?
viii. How much will it cost?
ix. Is this the suitable time in your life?
x. Is this something you actually want to do?

Albers also gave following suggestions to scientist who wants to become an entrepreneur:

a) Know the market where your technology fits.
b) Be prepared to take risk.
c) Talk to experienced people so as to build support network.
d) Make a team of excellent people.
e) Don't overlook students when you are making business teams.

Some recognized steps to start a New business (Oyeku, 2008)[12] are:

1. One of the most important traits of entrepreneurs is self- motivation.
2. Make up your mind as to whether you want to be an employer or an employee.
3. Read concerned materials on entrepreneurship.
4. Evaluate yourself thoroughly to know whether you can be an entrepreneur.
5. Decide on the type of business ownership.
6. Conduct a thorough research into various windows of investment opportunities without necessarily limiting

yourself to a particular area.
7. Get investment profiles on the selected options (if available).
8. For a start, keep your choice to one option.
9. Conduct a personal research into the industry becoming knowledgeable in the industry (i.e. raw materials, packaging, machinery and equipment, process technology etc)
10. Prepare a feasibility report (you can engage a professional but get involved in the preparation).
11. Make a Business Plan . Think a name and register your company.
12. Decide on business location.
13. Design your company/product identity package (trade mark/logo, letter headed paper etc.).
14. Open a corporate account. Discuss with funding/ financial institutions.
15. Keep records /accounting procedure.
16. Acquire necessary inputs including building construction/rent/lease.
17. Get necessary training. Recruit labour. Conduct trial production. Register your product (if applicable) .

Entrepreneurs should have personality, temperament and attitude of taking on the world on their own terms. The entrepreneurial procedure is uncertain as opportunities can only be identified after they have been exploited[13]. Entrepreneurs convert bold ideas into reality. Entrepreneurs who prove to be successful in taking on the risks of a startup are rewarded with profits, reputation, and continued growth opportunities[14].

Indian entrepreneurs are increasingly getting support from startup incubators all over the country. Examples include:

1. Venture Center an initiative of the Council for Scientific & Industrial Research, works to nurture businesses through their start-up phase by creating and running an efficient business incubator offering not only space but also access to technology support, networks, business mentoring, scientific and information resources. It mainly focuses on the commercialization of technologies related to chemical synthesis, material science, biomedical research, and chemical engineering.
2. IIT Kharagpur's Science & Technology Entrepreneurship Park (STEP) gives support to new ventures during their initial growth phase.
3. IIM Bangalore's Nadathur S. Raghavan Center for Entrepreneurial Learning (NSRCEL) offers training to promising entrepreneurs.
4. The International Centre for Entrepreneurship & Technology in Gujarat provides incubation and guides entrepreneurs through mentorship, workshops, and seminars focused on building the entrepreneurial spirit and enabling the growth of existing companies.

In addition to above mentioned, many other startup incubators have already been set up or are presently being set up across the country and the number is expected to increase gradually in the next coming years.

Government Initiatives for Indian Entrepreneurs:

Indian Government is actively supporting science and technology-driven entrepreneurial initiatives and it is easier for budding researchers to transform themselves into successful entrepreneurs. A number of schemes have been recently started by Indian Government to facilitate the establishment of entrepreneurial ventures across the country. The "Make in India" scheme aims to build an environment that is favourable to inventors, investors, entrepreneurs and manufacturers.

In January 2016, the Startup India campaign was launched. This pro-entrepreneurship campaign mainly includes simplified e-registration, self-certification, reduced patent application fees, fast-tracked patent applications for new India startups, an easy exit policy, financial support, income tax relaxation for the first three years etc. The campaign will also organize startup festivals to showcase India's research-inspired entrepreneurial initiatives and to connect entrepreneurial innovators with mentors, technology incubators, and investors. Research parks, startup centres, and technology business incubators will be set up across the country at premier institutes. From this platform, student innovators will get help to demonstrate their work in order to secure sufficient funding for their entrepreneurial innovations.

Some other Possible funds that are available to entrepreneurs are : Research & Development Grants, Cooperative Societies, Bank Loans, Micro Units Development and Refinance Agency Bank (MUDRA Bank) etc.

Conclusion:

Chemistry Entrepreneurship is helpful in solving the problem of unemployment and it also contributes to the national economy. Entrepreneurs are the driving force of every nation's economy and society. Entrepreneurial businesses are very important for every country. Although chemistry entrepreneurship is a personal choice of individual researcher, chemists and students, their adequate motivation is required so as to take their laboratory products to market zones though innovations. With the ever increasing pace of change in the chemical and pharmaceutical industry, universities need to be more aware of the skills that employers are seeking in students. These skills frequently include creative thinking, risk taking ,entrepreneurship and are not naturally associated with chemistry related curriculums. At every stage in chemistry courses, entrepreneurship courses should be included.

Conflict of Interest:

The author declares that I have no affiliation with or involvement in any organization or entity with any financial or nonfinancial interest in the subject matter or materials discussed in this manuscript.

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