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Educating students about the complexity of green chemistry and Incorporating information of theoretical green chemistry courses

Akbare Azam[1]

Assistant Professor Department of Chemistry

Govt. Women P. G. College Ghazipur U. P.

Dr. Awanish Kumar Pandey[2]

Assistant Professor Department of Chemistry

S. M. M. Town P. G. College Ballia U. P.

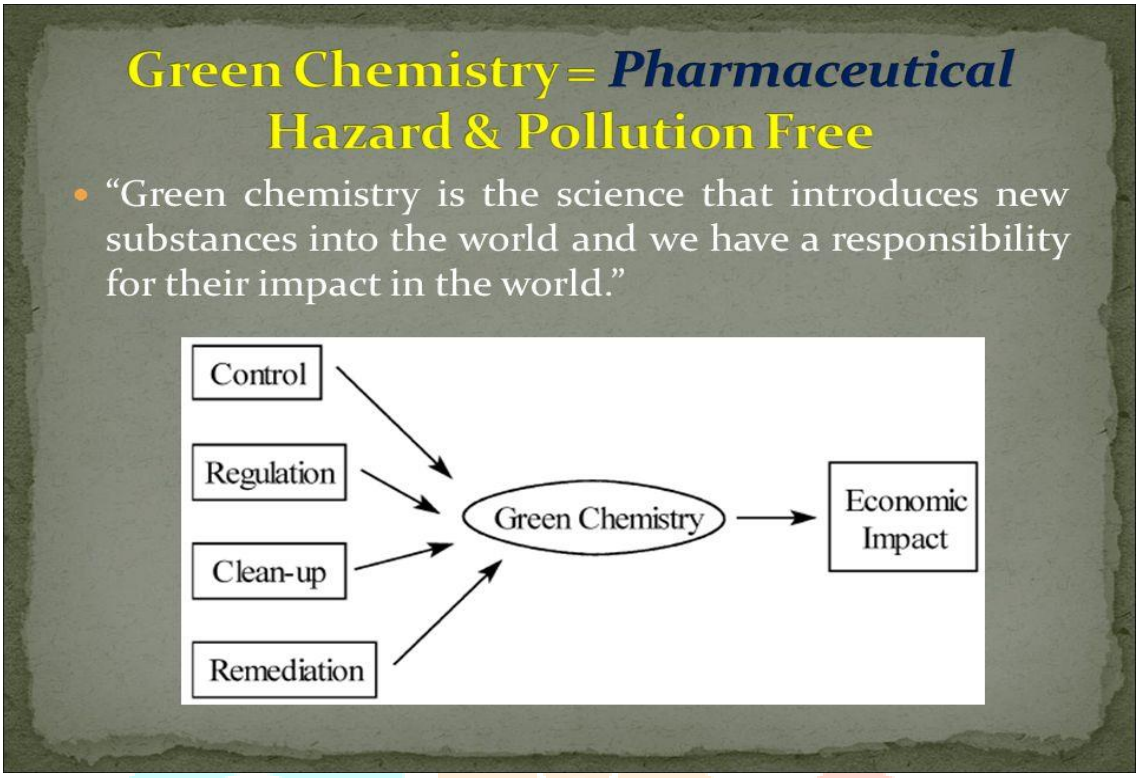
ABSTRACT

For a long time, use of green chemistry (GC) showed that a basic scientific methodology and advanced practice can increase the safe output to the human life and without any environment disturbances. For this, the advancement in scientific processes were made within the field of designing safer reagents and solvents, advancement in catalysis and possible development of the renewable feedstock. For better achievements, currently the long run chemists are being taught and trained to a wider concept of green chemistry to the practice and increased awareness towards human also as environmental impact. However, a global push towards sustainable development challenged green chemistry educators to show students to weigh the complex factors of green chemistry and consider societal factors of sustainability. during this paper, we review courses and programs that strive to attain these goals and assessment methods that are accustomed evaluate student outcomes of green chemistry courses.

Keywords **:** Green chemistry, Scientific methodology, Environment disturbances, Safer reagents, Sustainable development.

Introduction

Green chemistry emerged as a boon for mankind against environmental issues and it became an important tool for the foundation of environmental activism, policies, and regulations. With passes of time the principles of green chemistry became an important part of industrial, educational, and societal applications. In recent times, the environmental protection laws are gradually being made more and more stringent with the environmental degradation beginning to take alarming situation. **(Fig. 1).**



(Fig. 1). Impact of Green chemistry on Economy

For a long time environmental awareness programs have been carried out to get rid of these problems. Though several legislations have been made and many more are being formulated against the use of hazardous chemicals and pollutants, the implementation of rules alone is not expected to be an end in itself. It is equally necessary for all practicing chemists/technologists to realize the importance of preservation of the environment. Actually main reason for environment pollution and health-related problems is chemical hazards which are produced by different industries, pharmacy companies and research institutes. These problems would have been solved if researchers follow eco friendly methods. On the basis of global scenario, it was found that our unlimited social demand for better products and services evolved a lot of non degradable chemicals in the environment and day by day exploitation of resources have been created danger situation before us. However, with preservation of the environment being a major concern, the chemical industry has to now seek to wean users away from the conventional methodologies by driving towards those that are more efficient and environmentally benign. In this there seems to be a dichotomous challenge as, on the one hand, there is a requirement for increasing synthetic efficiency in chemical transformations, while on the other, there is a demand for minimizing environmentally hostile wastes. And thus, there lies a responsibility on chemists and chemical technologists in the development of a more sustainable chemistry, rendering it incumbent upon them to promote and disseminate awareness of environmentally compatible synthetic pathways throughout the academic and industrial research community, thereby setting a scene for the emergence and growth of a concept which allows for improving the quality of life and environment. Insofar as India is concerned, it is possible that some thinking may have been going on in the 'green' direction in our country, but we are not sure of any coordinated effort being made in a well-orchestrated manner. Hence it is imperative to take note of the prevailing situation because India is also an important global player in human resources production, even though it may stand way behind in terms of industrialization. Thus, the human resources need to be trained in a manner that keeps pace with the contemporary international requirements. It is with this intent that the authors have made an attempt to put their thoughts together, under the back-drop of certain measures that have been taken by some of the industrially developed nations. It would be rewarding if the readers take some time out to

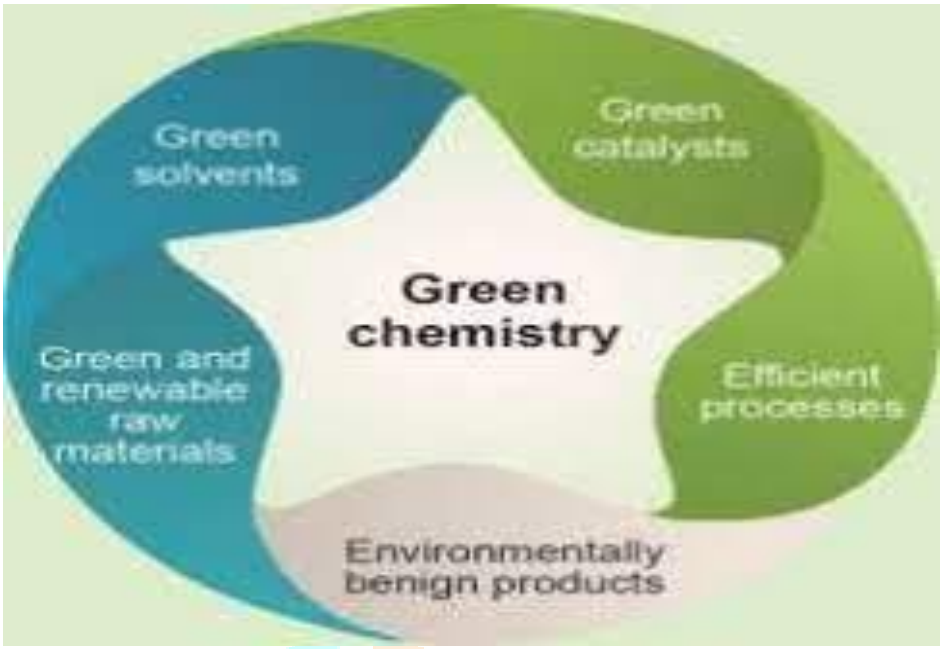
provide inputs to help set guidelines, in order to address the issue in a manner that is conducive to adaptation to the Indian context.

introducing proper curricula and societal relations for a larger green chemistry community

At International level it was assumed that green chemistry is necessary for sustainable development. Educational workshops, seminars and considerable curricular materials education led to the development of green chemistry importance in daily life. This has also produced a growing body of literature assessing student learning and attitudinal outcomes from these curricula .Green chemistry education aims to teach students chemical and societal decision making by using multidimensional green chemistry metrics and considering broader societal factors driving green chemistry and sustainable development. We believe that effective green chemistry pedagogy is the first step in creating a knowledgeable green chemistry community comprised of professionals, teachers, students, and the public. Green chemistry courses and curricula It is challenging to teach students to critically apply the 12 Principles of Green Chemistry, while also considering broader societal factors. Introducing students to the complexity of green chemistry metrics The practice of green chemistry involves optimizing for many different goals and desired outcomes. To give students some experience making these decisions, a number of courses introduce green chemistry concepts and metrics and then ask students to change a single aspect of an existing synthesis or process to improve greenness. Integrating larger societal goals in green chemistry curricula Students need to consider societal factors that extend beyond the Principles of Green Chemistry to extend green chemistry's implementation outside of the classroom .This has the added benefit of improving student engagement with the material [3,8]. Many courses introduce limited societal factors, like cost analysis. However, to provide a more authentic understanding of societal impact, some courses focus on a particular geographic area or introduce students to case studies. The integration of green chemistry and sustainable development with other disciplines would help apply chemistry to social justice problems and develop humanistic approaches to chemistry.

Integrating larger societal goals in green chemistry curricula

Green chemistry education could be a relatively new addition to the chemical education field. New courses and curricula should be closely linked with assessment to assist measure implementation and outcome success. Best practices and pedagogy will be developed by educators with systematically assessing new green chemistry courses and curricula. Sustainable Development requires a bigger green chemistry community that features students, educators, professionals and therefore the public at large. For reaching the ambitious goals of Education, many programs specialize in teacher training since teachers influence the knowledge and opinions of future generations. Public support for green chemistry requires a broader societal education. Some educators have tried to satisfy this goal by developing student communication skills that may be accustomed build public support for green chemistry policy. In the first course students will develop green chemistry educational materials for local high schools while in another course paired green chemistry and communications provide students to form simpler ways of communicating green chemistry concepts. Thus, teaching green chemists a way to facilitate discussion between and within groups can help promote public discourse. This study also demonstrates the worth of assessing programmatic outcomes to point out which approaches are presumably to impact societal practice. **(Fig. 2).**



(Fig. 2). Scope of Green Chemistry

The planning of a replacement substance requires reliable predictions of its properties. The properties of a substance rely on the properties of its molecules. The more we all know about the properties of molecules, the more we will understand the behavior of gear and predict the properties of molecules and substances that haven't yet been synthesized. the foremost refined tools for knowing the properties of molecules are those provided by quantum chemistry and realized through computational chemistry. it might appear obvious to infer that interfaces between green chemistry and theoretical/computational chemistry are important both in chemistry practice and at educational level. The latter would imply the incorporation of knowledge about green chemistry into theoretical chemistry courses and about quantum chemistry into green chemistry courses. the data to be incorporated doesn't must reach high levels of specialization, because the objective is that of building a viable background for professional interactions between theoretical chemists and specialists engaged on the look of recent environmentally-benign substances; during this perspective, theoretical chemists can provide information about molecules of interest to experts acting on substance design for the industry, while the latter experts can pose challenging research inquiries to theoretical chemists. The realization pathways of the envisaged incorporation of data are largely to be explored. Descriptions of in-class practical implementations aren't yet available. Even the incorporation of data on computer aided substance-design into the chemistry engineering curriculum isn't always finalized, “the issues in chemical product design are multidisciplinary in nature” because the main challenge. Providing information across disciplines and specialization areas at both education and training levels has the potential to contribute to deal with this challenge. this work proposes to spotlight some threads that may be utilized to tell students about the challenges of the planning of environmentally-benign substances pro re natal by the industry. it's therefore more apt for the presentation of basic information to students taking a theoretical chemistry course, but it also can be utilized to supply information to chemistry students who don't seem to be majoring in chemical engineering but who must comprehend the most questions and practices of recent chemistry. due to the explorative character of this work, the references don't seem to be limited to the last two years, but span through the recent history of green chemistry and theoretical/computational chemistry. this is often generally in line with the acknowledged importance of historical perspectives in chemistry and science education; for theoretical chemistry courses specifically, it responds to the benefits of data on the recent history as a method to stimulate creativity.

Conclusion

Green chemistry education is an increasingly integrated component of chemical education schemes. There are considerable educational materials created and broad investment from the international community, especially associated with sustainable development. Educators are designing curricula that challenge students to form decisions using complex green chemistry metrics and societal factors. Educators also are employing a sort of

assessment methods to live the implementations and outcomes of their programs, which may be wont to identify effective green chemistry pedagogies. Finally, it's important for college students to develop skills to coach and interact with non-experts so they will build broad support for green chemistry priorities. Ultimately, for green chemistry to be a component of societal practice, we'd like to make a knowledgeable green chemistry community comprised of pros, teachers, students, and therefore the public.

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