TechnoChem

International Journal of TechnoChem Research
ISSN:2395-4248 www.technochemsai.com
Vol.02, No.02, pp 177-187, 2016

Green Chemistry and Green Business –Educating Prospective Under graduate Students and Teachers in Education for sustainable Development

[*1]A.Sameena, [2]S.M.S. Gowda

[1]VTU, Belgaum, Karnataka, India
Work Place: Visiting Faculty in Dept of Chemistry, SEA College of Engineering, Ektanagar, Bangalore-560049, India

[2]Bangalore University, India
Work Place: Professor & Principal (REDT), B.E.S College of Education, ayanagar, Bangalore-11 , India
E-mail for Correspondence : shaminaezzy@yahoo.co.in
Phone Number : +919900273284

Abstract: The understanding of Environmental Challenges and their root causes has evolved and sharpened with progress of time. Internationally Environmental thinkers and Educators had long back understood the inextricable relationship between environment and Development. Internationally American chemical Society ACS and Institute of Green Chemistry IGS are contributing considerably by offering UG courses and Projects for the progress of Green Chemistry and sustainable development .Most of the developed countries also started offering UG courses in Green chemistry and Environmental sciences. In India at least a short term course in Green chemistry is necessary for science undergraduates and teachers.

In the present study the overall awareness results of Green chemistry and Green Business were investigated among undergraduate Science and Commerce students respectively of Bangalore city. Some good Colleges were selected under different categories. The awareness was monitored through the questionnaires. The results were analyzed .For a better awareness and understanding of Green Chemistry a short term course curriculum design has been purposed. Further more for a better awareness and understanding of environmental sciences few topics for the curriculum have been suggested.

Keywords: Environmental Education (EE); Education for Sustainable Development (ESD); Green Chemistry; Pollution Remediation; Sustainability; Environmental Protection AgencyGreen Business Management BMP; Green Products; Green House Gases GHG ;Climate Change; Renewable Technologies, Green and Clean Technology.

INTRODUCTION:

Environmental Education (EE) is a process in which individuals gain awareness of their environment and acquire knowledge ,skills,values,experiences and also the determination ,which will enable them to act-individually and collectively-to solve present and future environmental problems.

EE is a complex process, covering not just events,but a strong underlying approach to society building as a whole.EE provides people with the awareness needed to build partnerships, understand NGO activities ,develop participatory approaches to urban planning, and ensure future markets for eco-business.

The growing recognition Worldwide about the inextricable relationship between environment and development led to the emergence of the concept of sustainability and sustainable development (ESD) as a powerful enabler in helping people work towards the elusive but desirable goal of sustainable development.

Both EE and ESD are essentially an approach to education. Much of the work in ESD has been pioneered by Environmental educators. Both seek to instill in learners the knowledge attitude, skills and commitment to work for a better World for all, now and in the future. Both refer to education that is contextual and is therefore meaningful for the learner; encourages critical thinking and has a value orientation.ESD emphasizes the economic aspect of environmental challenges more than EE, and has introduced the concepts of Green economy and green growth.

The shift our society and economy in a truly sustainable direction ,we need to teach the next generation of chemists and engineers to practice Green chemistry .Of course,the ultimate goal is that the very notion of "Green Chemistry" should disappear-"greenness" ,or environment and health qualities, should be assumed in everything we create, not included as an afterthought. But we are a long way from this future.

Traditional Chemistry, as it is now predominately taught, does not provide chemists the skills they need to make the products and processes which will substitute for the current hazardous economy.

To teach using the principles of green chemistry is especially important in undergraduate chemistry laboratory classes' .In these classes, students learn the techniques and protocol that they will take with them to their own labs or industry. Hence it is essential that we train our future chemists using green chemistry methods and ideals.

Green Chemistry is emerging in academic institutions all over the World particularly in developed countries. In India the Green Chemistry Net work GCN in New Delhi is participating in projects and Conferences conducted by ACS and IGS internationally.

Green Chemistry or Sustainable Chemistry is interdisciplinary in nature and involve exploration of environment. Hence it can serve as theme to facilitate integrative and interdisciplinary learning experiences where students use their critical thinking and communication skills to address complex problems facing the chemical enterprise. While Green chemistry encompasses human health and the environment, it is guided by very specific principles of Chemical practices [1].Through application and extension of 12 principles; green chemistry can contribute to sustainable development [2, 3].

There is a need to introduce Green chemistry for sustainable development to educate the student Teachers enrolled in Chemistry teaching methods course. By incorporating Green Chemistry principles into chemistry curriculum, these future educators can provide with a massive message about what Chemists are doing for the Environment in fulfilling to obligation and responsibilities of Environmental Stewardship [4]

Many industries began to incorporate green chemistry techniques into their production processes. Early adopters included a pharmaceutical company that discovered a way to synthesize ibuprofen without generating waste. Other examples included the development of sustainable laundry detergents and compostable plastics designed to eliminate harmful emissions in the manufacturing process.

The presidential Green chemistry Challenge Award has in the past been awarded to companies including Dupont, ADM, Life Technologies, Novozymes and more,and it is now regarded as one of its highest honors in the industry. Solazyme's win represents the first time a company working with microalgae to produce renewable oils, has been recognized with the award. With this breakthrough Technology it is possible to decouple the production of oil from geography and reduce the ecosystem damage that unsustainable oils have caused around the world. These

Algal oils can replace fossil fuels at one end of the spectrum and unsustainable plant based oils on the other side.

More recently in May 2013 researchers Donald Sadoway and colleagues from Massachusetts MIT USA have discovered Greener and cheaper way to make Greener steel by molten electrolysis method and published their work in Journal Nature.[5].Their process could produce

Steel of higher purity, while cutting Greenhouse gas emissions, and may be even be useful on missions to Moon and Mars.

In India few articles on Green chemistry have been reported [6-8] However green chemistry courses for UG levels have not yet started in Indian universities. The study on green chemistry awareness levels of UG students [9] reveals that at least a short term course in Green chemistry is necessary for UG science students and Teachers to have a better awareness.

On the other hand Green Marketing and Green Business awareness is essential for undergraduate of Commerce and Business students to know the Concept of Green Business and the need in the present Global Climate Change awareness. Environmental and Energy conservation issues have taken Central theme in Global Business arena. Hence, the Business community is now in search of Eco-friendly Business Model. The Institute for Green Business Certification IGBC enables Business to achieve "Green Business Certification" by working collaboratively.

A key Global Challenge in the 21st Century is how to address the Climate Change and reduce Green House Gas Emission GHE emissions. Government regulatory bodies and consumer pressure groups have aggressively lobbied for Business to adopt Green practices.

Business can assist in protecting the environment by becoming Green Business, in other words sustainable Business [10]. Green Marketing is related to all activities designed to generate and facilitate any exchange Indented to satisfy human needs or wants with minimal determinable impact on the natural environment .The aim of the programme, called the clean energy Investment Initiative, is To help wealthy investors mobilize $ 2 Billion Dollars in New Clean Technology Investment.

Green Marketing assumes even more importance and relevance in developing Countries like India. The need for Green Marketing in India and its emerging Opportunities and Challenges has been reported(11). Green Computing is considered as a Gate Way to Green Business (12).Green Cloud Computing and Environmental Sustainability has been reported by MelbourneUniversity of Australia (13).

The study on the awareness levels of Green business via green and clean technology among UG Business students [14] revealed that it is necessary to add few topics in environmental science course for better awareness.

Materials and Method:

To assess the awareness in Green Chemistry and Green Business for Sustainable growth. Few good colleges of Bangalore with good Grades from NAAC.

were selected under the following categories:

(1)Deemed Universities. (2) Autonomous Colleges (3) Private Aided Colleges

(4) Private Unaided Colleges (5) Government Colleges

In order to obtain full and relevant information from the students from the above mentioned Institutions Questionnaires were prepared by the investigator. The Questionnaire consisted of 35 questions and being a multiple choice had four answers for each question. The students Were Provided with OMR sheets to circle their correct answers. Before giving the Questionnaire to the students, a brief presentation about sustainability was made by The Investigator to explain the basic principles of Green chemistry and Green Business to The students. The Questionnaire were designed in such a way that it covered all the Fundamentals and Basic Questions needed for the awareness.

SAMPLE SIZE: The sample consisted of the Science Under graduates students from different Categories as mentioned above for the awareness of Green Chemistry is shown in Table-1 .

Table-1 Sample Size- No of Science Students under various Categories

SL NO	Name of the Category	No of Students	Total No of students
1	Deemed Universites	68	**247**
2	Autonomous Colleges	69	
3	Pvt.Aided Colleges	33	
4	Pvt.Un aided Colleges	36	
5	Govt.Colleges	41	

The number of Commerce and Business students from different categories for the Awareness of Green Business via Clean and Green Technology is shown in Table-2 as follows.

Table-2 Sample size –No of Commerce Students under different Categories

SL NO	Name of the Category	No of Students	Total No of Students
1	Deem Universities	124	**745**
2	Autonomous Colleges	250	
3	Pvt.Aided Colleges	60	
4	Pvt.Unaided Colleges	243	
5	Government Colleges	68	

It can be seen from the table-1 that a total number of two hundred and forty seven [247] science Undergraduates answered the Questionnaire for Green chemistry awareness.

From table-2 one can see that total number of seven hundred and forty five [745] commerce and Business under graduates answered the questionnaire for Green Business via Green and Clean technology awareness.

Experimental Investigations

The Green chemistry awareness results obtained from the students of various Institutions were assessed, Depending upon the number of correct answers from the OMR answer sheets of students. These results are shown in Table-3

Table-3 Awareness Levels among Science Students for Green Chemistry and among Commerce Students for Green Business

Subject of Awareness	Well Aware	Fairly Aware	Partly Aware	Poorly Aware
Green Chemistry	28	65	119	35
Green Business &Green Marketing	38	165	465	177

It can be observed from the above tables that the results are categorized under four levels of awareness as follows:

1. **Well aware level**: Students who obtained percentage between 100-80% by getting

35-28 correct answers from the questionnaire.

2. Fairly aware level: Students who obtained percentage between 79-60% by getting 27-21 correct answers correct from the questionnaire.

3. Partly aware level : Students who obtained percentage between 59-33% by getting 20-12 correct answers from the questionnaire.

4. Poorly aware level : Students who obtained percentage between 32-20% by getting 11-7 correct answers from the questionnaire.

The overall percentage of each level of awareness of the students obtained by the combination of all the categories of the institutions is shown in Table-4.

Table-4 Overall awareness level percentage

Subject of Awareness	Well Aware	Fairly Aware	Partly Aware	Poorly Aware
Green Chemistry	10.0%	5.0%	63.0%	22.0%
Green Business	11.3%	26.3%	48.2%	14.2%

It can be seen from table-4 that the overall awareness in the Well aware and Fairly awareness levels is only 10% and 5% respectively in case of green chemistry awareness among Science under graduates.The highest percent is seen in partly aware level which is 63% the poorly aware level shows 22%. The graphical representation of the above mentioned results of overall awareness of different levels for Green Chemistry consisting of students from different categories of the institutions can be seen from Fig-1.

Figure-1 a Overall Awareness levels of Green Chemistry

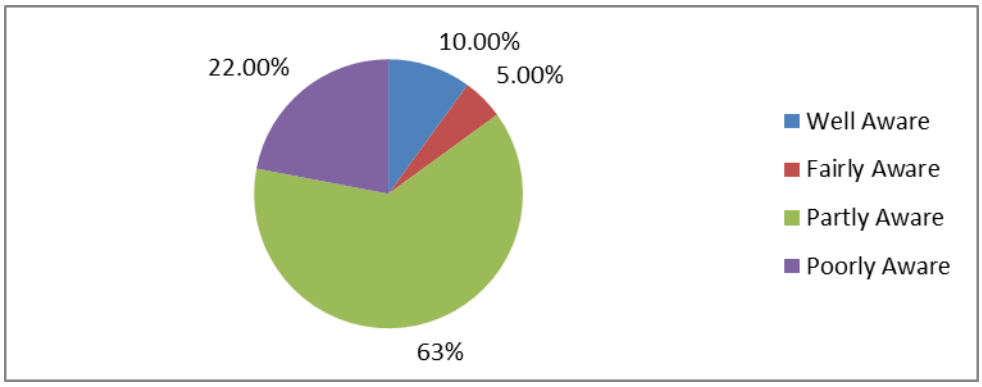
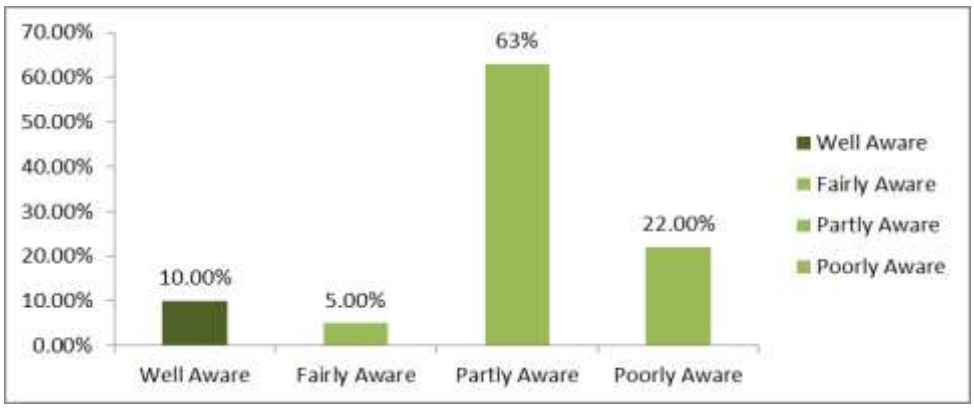


Figure-1 b Overall Awareness levels of Green Chemistry



The above figure-1a and figure-1b clearly shows the percentages of the various levels of overall awareness of Green Chemistry among Science undergraduate consisting of students from different categories of the institutions.

The Awareness results of Green Business via green and clean technology as shown in Table-4 shows that the overall awareness in the Well aware and Fairly awareness levels is only 11.3% and 26.3%respectively among Under graduate commerce and Business students .The highest percent is seen in partly aware level which is 48.2% the poorly aware level shows 14.2%. The graphical representation of the above mentioned results of overall awareness of dIffernt levels for Green Business via green and clean technology consisting of Commerce & Business under graduates from different categories of the institutons can be seen from Fig-2.a and 2.b.

Figure-2-a Overall Awareness of different levels for Green Business via green and clean Technology.

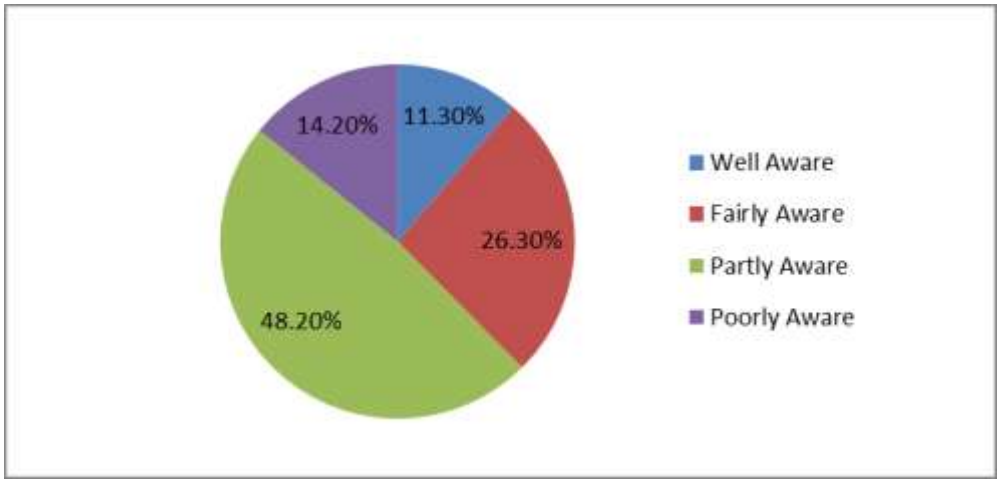
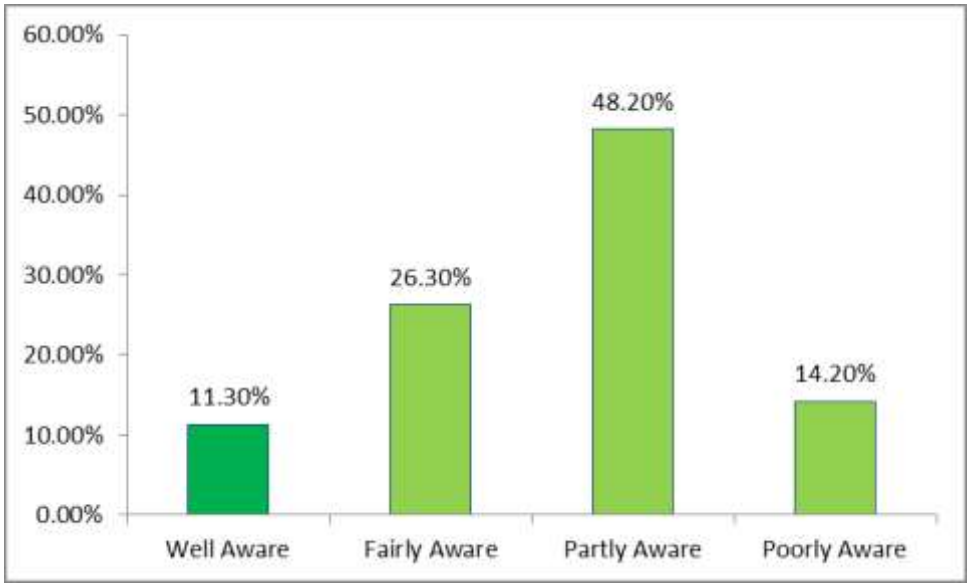


Figure-2-b Overall Awareness of different levels for Green Business via green and clean Technology



The above figure-2a and figure-2b clearly shows the percentages of the various levels of overall awareness of Green Business via green and clean technology consisting of Commerce and Business undergraduates from different categories of the institutions.

RESULTS AND DISCUSSIONS:

In the present study it is observed that the overall awareness percentage in the well aware level and fairly aware level of Green Chemistry as well as Green Business is very less. The highest percentage is seen in partly aware level. Thus there is a need to educate undergraduates through a course work in Green chemistry and also in environmental sciences.

Green Chemistry is emerging in academic institutions all over the world. In US, dozens of university, colleges of varying disciplines offer green chemistry lectures, readings, assignments and lab exercises. In USA Ten academic institutions currently pursue or support Green chemistry research. Thirteen universities offer Green Chemistry courses. Seven graduate programs offer a degree in Green chemistry. Five Centers are dedicated to performing Green Chemistry research. Two Universities integrate Green Chemistry across its undergraduate chemistry curriculum. Green Chemistry Education Network (GC Ed Net) and Green Chemistry Education Materials (GEMS) sites are of great help for Green chemistry advancement internationally.

In India the Green Chemistry Net work Centre (GC NC) at New Delhi participates in international programmers in Green Chemistry, but so far there are no regular courses or short term course is offerd by any of the universities In India. A curriculum design of Green Chemistry for undergraduates in India is the need of the hour. Hence, In the present study for a better awareness and Understanding of Green Chemistry a short term course curriculum design has been purposed for under graduate Science students and for prospective Teachers .The Design of the course is shown below.

A SHORT TERM COURSE ON "GREEN CHEMISTRY'

A THEROTICAL AND PRACTICAL APPROACH FOR BACHELOR'S DEGREE)

COURSE DESIGN -1

A. OVERALL OBJECTIVES:

1. To develop awareness about the effect of chemicals/chemical waste on environment.
2. To increase atom economy.
3. To encourage students to think in rational way.
4. To develop awareness about time,economy and methods.
5. To trigger minds on co-existance.

B. SPECIAL OBJECTIVES:

1. Utalization of minimum resources.
2. Appreciation of life and knowledge of side effects.
3. Save natural resources for future.
4. In depth understanding of chemistry and application of technology.

C. CONTENTS

Theory: 20 hours

Unit: I -5 hours

Introduction: Definitions of "Green and Sustainable sources"; Green chemistry –history, principles;

Degradable, on degradable and recyclable materials in the environment. Environmental impact of conventional energy sources.Chemical aspects of Green materials,Need for switching to Green materials from conventional ones.

Unit:II -10 hours

Methodologies in Green and Sustainable sources: Green materials-"Atom Economy".

Laboratory synthesis of Green materials:

(i) Green organic materials: Principles, Synthesis, uses,examples and excersises. e.g .,Solvent free

Synthesis.

(ii) Physical approaches towards atom economy-principles of electro-synthesis,batteries,fuel cells.

Unit:III -5 hours

Applications of Green materials:

Applications of Green materials like ecyclable plastics ,bio-fuel,fuel cells,synthetic applications of catalyst,simple organic redox reactions,reactions in aqueous medium.

PRACTICALS : -3 hours per week

1. Preparation of carbon electrodes from waste/used dry cells and fabrication of an electrochemical

Cell for organic synthesis.

2. Estimation of cell voltage/over voltage for simple organic reactions; electro deposition of copper on steel.

3. Quantitative conversion of nitrobenzene to aniline.

4. Recycling biodegradable plastics and estimation of Molecular weight by viscometry.

5. Reactions in aqueous medium using Pd catalyst.

6. Microwave assisted synthesis of an Oxime and its estimation.

Text books for references:

1. Green Chemistry-theory and practice: Paul P.Anastas and John C.warner

2. Introduction to Green Chemistry-II Edition:Albert S.Matlack.

3. Green Chemistry: An Introductory Text:M.Lancaster**.**

4. Green Chemistry and Engineering-A Practical design approach: David J.C.Constabel.

5. Experiments in Green and Sustainable Chemistry: Herbert W.Roskey, Diemer kennephol And Jean Mary Lehn.

6. Green Organic Chemistry-Strategies,tools and laboratory experiments: Kenneth Doxsee and James Hutchison.

D. METHODS AND MEDIA FOR THE PURPOSED COURSE

A lecture method by discussion, audio visual method and a field work can be done for the proposed course.

COURSE DESIGN –II

Sl.No	Contents	Duration/ hours	Method	Medium
01	Unit: 1	05	Concept based, Lecture, Discussion	Black board, audio visual and Internet sites
02	Unit: 2	10	Concept based , Lecture, Discussion	Black board, audio visual and Internet sites
03	Unit: 3	05	Concept based, Lecture, Discussion	Black board, audio visual and Internet sites
04	Unit: 4	18	Concept based , Lecture, Discussion	Black board, audio visual and Internet sites

Suggestions for inclusions some topics for Environmental sciences (EVS)

The Commerce and Business undergraduates have to study Environamental Sciences (EVS) in their course and thus have assumed greater importance. In order to improve the awareness of Green Marketing via clean and Green technology for commerce and Business undergraduates it is necessary that the curriculum of Environmental science should include few more topics. The environmental Science course for Commerce and Business undergraduates should focus on topics which deal with the important components of environmental Education which are as follows:

1. Awareness and sensitivity to the environment and environment challenges.

2. Knowledge and understanding of the environment and environment challenges.

3. Attitudes of concern for the environment and motivation to improve or maintain

   Environmental quality.

4. Skills to identify and help resolve environmental challenges.

5. Participation in activities that lead to the resolution of environmental challenges.

Topics describing some important drivers for Green Business in both public and private sectors should be included in the curriculum. Some of the factors that should be highlighted are mentioned below:

i) Global Environment and Public awareness: The public are increasingly aware of environmental issues. Over the past few years public awareness and concern about global climate change has risen considerably.

ii) Capital markets acceptance: Now, Capital market investors understand the level of public interest in climate change issues. They have started to invest in industries that reduce human impact on environment. The clean tech market originally consisted mostly of specialist investment firms and people with strong environmental focus.

iii) Ensuring market demand for clean tech products or services: Government can directly stimulate market demand by leveraging their own buying power through procurement policies and by large clean purchases. On the other hand government not only increase the market size for such products ,but also set a strong example for ordinary consumers that clean tech purchases are good for the Society. Government can also create demand.

iv) Creating environmentally -friendly market: One of the most commonly cited proposals for dealing with climate change is establishing carbon price through an emissions ‘cap –and-trade ‘system,where greenhouse gas(or carbon) emissions would be ‘capped’ at a given level for different compnies.those companies who

exceed their allocated limit are required to buy credits to cover their surplus from those companies who emit less than their limit.

v) Providing extra financial backing to clean tech companies: Policies can take the form of subsidies and incentives or tax credits for clean tech products,or taxes on non-clean tech products.Tese programs are typically financed by taxes and also demonstrated the ability to generate a positive return,which could could ultimately lower the consumer's bills.

CONCLUSIONS

1 .The Overall percentage in Well Aware level and Fairly Aware level of Green chemistry of Science under graduates is less and only higher percentage is seen in Partly Aware level. For better understanding of Green Chemistry it is necessary to incorporate Green Chemistry into the Chemistry curriculum. Thus a course design for a short term course is proposed. Catalysis continues to revolutionize the science and art of organic chemistry with both the 2001 and 2005 Chemistry **Nobel prizes** awarded in new –metal –catalyzed reactions. Using catalytic Strategies is additionally one of the Twelve principles of Green Chemistry .It is therefore Essential that undergraduates learning organic synthesis are exposed to modern catalytic approaches from both a therotical and practical prospective.

2. The Overall percentage in Well Aware level and Fairly Aware level of Green Business via Green and Clean technology of Commerce and Business under graduates is less and only higher percentage is seen in Partly Aware level. For better understanding of Green Business it is necessary to incorporate few topics in the course of Environmental Sciences (EVS) for Commerce and Business Undergraduates. Thus in this study, topics have been suggested. As Society faces huge challenges in transitioning toward sustainable life styles and practices, and education is clearly vital to make this transition happen. Data released by the World Health Organisation shows that of the 20 most polluted cities of the world, 13 are in India. It is Left to the younger Generation along with the older ones to sort out the solution for the Question **Is environment paying the price for development?** The biggest problem of Climate Change has to be tackled by reducing the emissions of Green House Gas Emissions.As agreed upon during the International conference on **Climate Change in PARIS during No.Dec.2105**

ACKNOWLEDGEMENT:

Dr.Sameena thanks all the HOD's of the Colleges who have permitted for carrying out the questionnaire Tests . I am grateful to His Holiness Dr.Syedna Aali qadar Mufuddal Saifuddin(TUS) Chancellor Aligarah university for Blessings and encouragement For Environamental research through the Burhani Foundation-India(BFI)Trust Established in 1992 to commemorate the 80th Birth day of His Holiness Dr.Syedna Mohammed Burhanuddin sahib(RA) who passed away in Feb 2014.My thanks to my late Parents ,late younger sister Tasneem Izzy Dhar wala,my sisters ,Brother and his family as without their patience and Cooperation my humble contribution to the society would not have been Possible in the past and in recent years.

REFERENCES

1) P.T Anastas and G.C.Warner, Green Chemistry: Theory and Practice. Oxford University press, Oxford 1998
2) http://www.advancinggreenchemistry.org
3) http://www.epa.gov(greenchemistry/index
4) Mageswarywary Krpudewan ,Zurida Hj Ismail and Nortia Mohamed Journal of Social Sciences 7 (1) 42-50,2011.
5) A.Allonare,L.Yin and D R Sadoway.Nature,2013,DOI:1038/nature 12134.
6) Green Chemistry A potential tool for Chemical Synthesis .S.Ravichandran. Int.J .Chem Tech.Res.Vol.2,No.4 ,PP 2188-1291,Oct-Dec 2010.
7) Perspective and Fate of Green Chemistry.S.Ravichandran.Intl.J.Chem Tech.Res.Vol.3,No.4, PP 1882-1885,Oct-Dec.2011.
8) Green Chemistry : Need of the Hour.Urmila Joshi,K.M.Gokhale,A.P.Kantikar. Indian J Pharm Edu Res,Apr-Jun,2011.

9) Green Chemistry-An Awareness Among 1Degree Students of Bangalore City Colleges.A.Sameena, S.M.S.Gowda.Int.J.of Chem Tech.Res.Vol.8,No.3,PP1275-1281,2015.
10) Perceptual Study of the impact of green practice implementation on the Business functions. Smith and S.Perks. Southern African Business Review, Vol.14,No.13,2010.
11) Green Marketing in India:Emerging opportunities and Challenges.Paran Mishra , Payal Sharma. Journal of Engineering,Science and Management Education Vol.3, PP 14-19,2010.
12) Going Green - A Holistic Approach to transform Business .Dr.Sajal labiraj,Dr.Vinay Topkar And Walke.international Journal of Managing Technology (IJMIT)Vol.2.No 3,PP22-30, August 2010.
13) Green Cloud computing and Environmental Sustainability .Saurabh Kumar Grag and Rajkumar Buyya ,Cloud Computing and Distributed Systems(CLOUDS) Laboratory,Dept Of Computer and Soft ware Engineering ,The University of Melbourne,Australia.
14) Green Business Via Green and Clean Technology – An Awareness Among 1 Degree Commerce and Business Students of Selected Bangalore City Colleges.A.Sameena. Intl.J.of Chem Tech.Res.Vol.8,No. 12,PP 375-385,2015.

*****