

## Teaching Chemistry at Indira Gandhi National Open University

Dr. Bharat I. FOZDAR  
Dr. Lalita S KUMAR  
School of Sciences, IGNOU  
Maidan Garhi, New Delhi, INDIA

### ABSTRACT

The Open Distance Learning (ODL) concept is fast becoming popular all over the world and it has a lot of relevance for a highly populated country like India. However, the most important aspect of this type of teaching-learning process is establishment of the credibility especially when the laboratory based science programmes are delivered from such institutions. The apprehensions arise because teaching laboratory based science related subjects at a distance is difficult due to students' compulsory presence for the experimental work and also the cost involvement.

Through this paper we intend to establish the credibility and authenticity of the B.Sc. (major) in chemistry programme by giving a brief comparative account of IGNOU and conventional university courses. It discusses the delivery aspects of this programme highlighting the existing delivery mechanism, analyses the weaknesses in the present system substantiated by a survey study and also suggests some new approaches to make chemistry courses more effective from learner's learning point of view.

The survey study has been helpful also in suggesting appropriate technologies for the effective delivery of Chemistry courses.

**Keywords:** Open distance learning (ODL); laboratory courses; chemistry teaching; multimedia; interactive radio counseling; teleconferencing and web based counseling, face-to face counseling.

### INTRODUCTION

The concept and practice of Open Distance Learning (ODL) system in the field of education, especially for post secondary stage is catching up in a tremendous manner in India. Before 1970 there were few conventional universities with distance education programmes and courses. As on date, there are 104 ODL units in conventional Universities and deemed Universities and eleven Open Universities (DEC website). Among all these ODL institutions, Indira Gandhi National Open University (IGNOU) has emerged as a trendsetter in providing a wide range of programmes and courses through distance mode in India and even abroad.

As of today, the ODL institutions are providing education to nearly 22% of the total number of students in the higher education system of the country. IGNOU alone caters to education needs of nearly half of this and the projected growth is to double this number by the end of the 10<sup>th</sup> plan (IGNOU Annual Report 2003, Dikshit 2003, VC's Report 2004).

IGNOU is not only providing learner centric quality education to a large number of learners with a target of fulfilling their needs and requirements but also accomplishing major responsibility of determining and maintaining standards and promoting the ODL systems in the country through Distance Education Council (DEC).

**Flexibility, innovation, use of new technologies, cost effectiveness and quality education materials are mainly responsible for the popularity of IGNOU programmes amongst masses (Ansari 2002).**

**Science and Technology has always been viewed as an effort to systematise knowledge and inculcate a logical approach in the study of any subject. And laboratory work is an important and integral component of Science and Technology based programmes in order to understand the basic concepts associated. It has been always a concern of educators to deliver laboratory-based science programmes and courses through distance mode also. However, establishment of a laboratory with an involvement of expenditure is inevitable to accomplish this and at times it becomes a difficult task.**

**The main factors, which discourage laboratory based science programmes, are cost of equipments, chemicals etc. and safety issues. Because of this only a few post secondary institutions that offer distance education programmes have been reported to offer a substantial number of laboratory based science courses or complete science programmes (Holmberg and Bakshi, 1982). As on date in India, out of eleven Open Universities five are offering Bachelor's degree programme in sciences and only one, Madhya Pradesh Bhoj Open University (MPBOU) is providing education at the level of Masters in laboratory based science disciplines. Needless to say that IGNOU is one amongst the five mentioned offering laboratory based Science and Technology programmes.**

**On the other hand ODL units of conventional system are hardly having laboratory based science programmes (DEC website).**

**Besides a number of laboratory- based programmes like B.Sc. (N) (Post Basic Bachelor of Science in Nursing), CPLT (Certificate Programme in Laboratory Techniques), BTC (Bachelor of Technology in Civil), IGNOU offers a Bachelor's degree in various science disciplines. Chemistry is one such discipline.**

**The main objective of IGNOU's B.Sc. programme is to provide opportunities for higher science education to those who missed a regular education (working persons, those living in rural or remote areas, housewives and also for economic and opportunity reasons) and to create scientific attitude towards life. So far more than thousand learners have successfully completed the B.Sc. programme. They have been received well and many of them have got admission in postgraduate programmes in premier institutions of India and abroad.**

**However, there is always a feeling of ambiguity in everybody's mind as far as the delivery of the lab based Science Programmes through distance mode is concerned. Through this paper an effort has been made to realise that distance chemistry learners in B.Sc. programme of IGNOU are not any way getting a lesser amount of knowledge, skills and information for their theory and lab courses compared to their counterparts in conventional Universities and colleges.**

**A survey study was also carried out to know the background and profile of IGNOU chemistry learners and identify the problems associated with the present delivery strategy followed. The study substantiates the suggestion made at the end of this paper in order to improve teaching-learning process.**

### **CHEMISTRY TEACHING and CHEMISTRY COURSES at IGNOU**

**For completing B.Sc. programme either as general or major in any of the science disciplines: Chemistry, Physics, Maths, Botany and Zoology from IGNOU learner has to earn 96 credits worth of courses. In IGNOU system one credit is equivalent to 30 hours of learning activity. Out of 96 credits, 24 credits are devoted to foundation courses and 8 to 16 credits to application oriented courses the remaining 40 or 48 are subject specific credits.**

For getting major degree in chemistry the learner is required to complete minimum 40 credits worth of chemistry elective courses. As on date, in chemistry, there are 7 theory courses and 5 laboratory courses worth 40 credits (see Table: 1)

**Table:1**  
**Chemistry Elective Courses in B.Sc. Programme of IGNOU**

Sl. No.	Course Code & Table	Credits
1	CHE-1: Atoms and Molecules	2
2	CHE-2: Inorganic Chemistry	4
3	CHE-3(L): Chemistry Lab I*	2
4	CHE-4: Physical Chemistry	4
5	CHE-5: Organic Chemistry	4
6	CHE-6: Reaction Mechanism	4
7	CHE-7(L): Chemistry Lab II*	2
8	CHE-8(L): Chemistry Lab III*	2
9	CHE-9: Biochemistry	4
10	CHE-10: Spectroscopy	4
11	CHE-11 (L): Chemistry Lab IV*	4
12	CHE-12 (L) Chemistry Lab V*	4
	<b>Total</b>	<b>40</b>

\* These depict laboratory courses

Environmental Chemistry (AEC-01) worth 8 credits has been put to offer from July 2005 in Application Oriented Course category and another course, 'Advanced Inorganic Chemistry' worth 4 credits as an elective course will be on offer in another year's time.

### **DELIVERY OF COURSES**

The methodology of instruction of IGNOU is different from that followed in the conventional system. Most of the instructions are imparted through distance rather than face-to-face communication as is true of any distance education institution. However the system at IGNOU is more learners oriented and the student is an active participant in the teaching-learning process.

A multimedia approach is followed for instruction. Besides the self instructional printed materials both for theory and practical courses, other means of imparting education are audio and video cassettes/CDs (these are available at study centres only), audio-video programmes transmitted through the National Network of Doordarshan and All India Radio (selected station), face-to-face counseling at study centres by academic counsellors, assignments, laboratory work, teleconferencing, interactive radio counseling and video programmes through National and Gyan Darshan Channels.

Recently, EDUSAT a satellite dedicated to education purposes has also been made available to IGNOU. Chemistry faculty is presently using EDUSAT for the tele-counseling.

With the increased availability of new educational technologies, distance educators have got the opportunity to design laboratory based science courses which could provide their students with a wider range of learning aids such as radio and TV channels, internet, computer-aided learning, local area networking and computer simulation to support teaching in laboratories (Kennepohl, 2001 and A. Kahveci, 2003).

Never the less, face to face counseling sessions are very important tools for the guidance and problem solving in the overall teaching learning process. However, it is not compulsory for IGNOU students to attend the counseling sessions.

In our view good laboratory component is essential to the overall success and credibility of any chemistry programme or in general any science programme. Distance education institutions are offering laboratory courses by three modes. In first mode the laboratory is conducted at home using home-study kits (Bennett 1995, Kennepohl 1996).

In second mode experiments are conducted on weekends throughout the year and in the third mode lab courses are conducted in concentrated laboratory session for a weeklong. These practices are followed by a number of distance education institutions (Kennepohl & Last 2000, Koshy et al 1994, Chandra et al 1995). At IGNOU we are following both weeklong and in some cases weekend approaches.

The laboratory courses are conducted at study centres scattered all over India during summer and autumn vacations, so that in-service persons can attend laboratory courses without difficulty. The laboratory component is delivered through innovatively designed laboratory courses. These courses are worth 2 or 4 credits. A 2 credit laboratory course requires full-time presence of the learner at the study centre for 7 days continuously. During this time a learner has to work for around 60 hrs. Around 40 hours are spent on experimental practical work and remaining time is used for doing calculations, preparation of records, viewing or listening to the video/audio programmes. Unlike theory counseling attendance in the laboratory courses is compulsory.

Every experiment is evaluated daily and 70% weightage is given to this continuous assessment; this is unlike the theory courses where weightage is only 30%. For theory courses term end examination carries 70% weightage in the final result. For laboratory courses, assigned experiment, which is unguided, is like a term end exam in case of theory courses and carries 30% weightage. In order to optimise the time available for laboratory work well designed laboratory manuals, counsellor's manuals and in some cases video programmes are provided. Lab manuals contain complete details of experiments and methods of taking observations and calculations. Counsellor's manual provides details of activities to be performed by counsellors with respect to conduct of a laboratory course.

As per the instructions of counsellor's manual the counsellor carries out pre-lab preparations before the start of lab session, so that she /he is left with sufficient time to guide learners through the lab sessions. As mentioned earlier some laboratory courses are well supplemented with video programmes. These programmes further reduce the demonstration time of the counsellors. It has been observed from the students' examination records that their performance in the laboratory courses of IGNOU is very good. This may be attributed to the following :

- the laboratory courses are performed under direct guidance of the counsellors in face to face situation, and
- preparation prior to attending lab sessions and instant feedback (Pankaj et al. 2003).

In our view besides these factors, other factors, which also have a role to play in the good performance of learners in laboratory courses, are well-designed laboratory manuals, counsellor's manual, and more weight age of continuous assessment (70%).

### **CONVENTIONAL CHEMISTRY COURSES VS IGNOU COURSES**

A comparison between courses offered for B.Sc. (major) in Chemistry from IGNOU and B.Sc. (Honours) in Chemistry from University of Delhi has been made. Delhi University is the premiere Central University of India and is known for very high educational standards. List of chemistry courses, which are presently on offer by IGNOU are given in Table 1. As mentioned before beside these courses learner has to take 24 credits worth from the category of Foundation Courses.

These courses provide a broad base knowledge in the area of Science and Technology and Humanities and Social Sciences. To improve the communication skills, two language courses are also part of this category. Another category of courses is Application Oriented Courses. These courses are developed to equip learners in some area of their choice, which requires application of skills.

Option of these courses is available in 3rd year only. At present there are eighteen such courses on offer, few examples of Application Oriented Courses are Human Environment, Environmental Chemistry, Feature Writing in English and Hindi, Translation, Operational Research, etc. Thus IGNOU is providing a broad base education along with specialisation in Chemistry. On the other hand in Delhi University more emphasis on specialisation only. There is only one language course in English and two optional courses viz.

#### **Computers and Application to Chemistry and Entrepreneurship and Small Business**

The discipline based theory courses include inorganic, organic and physical chemistry courses are thought throughout the three years of the programme. Some courses like environmental science, industrial chemistry and computers in chemistry were introduced only last few years. On the contrary chemistry programme from IGNOU offers an interdisciplinary course, Biochemistry (CHE-09) along with the three main area of chemistry.

This course (CHE-09) provides background knowledge to those learners who are interested in taking up higher studies in emerging areas of Biotechnology and Bio-informatics. Two specialised and advanced courses in Organic Reaction Mechanism (CHE-06) and Spectroscopy (CHE-10) are also being part of Chemistry programme of IGNOU. Although present Inorganic Chemistry course (CHE-02) has no coverage on topics like bioinorganic, reaction kinetics and mechanism and inorganic polymers but soon an Advanced Inorganic Chemistry course (CHE 13) would be on offer, which will cover these topics.

IGNOU laboratory courses in chemistry are listed in Table 1. These courses are 2 to 4 credit courses, which are stand alone in nature. Many experiments of these courses are at par with those of Delhi University Chemistry honours programme. For example, experiments on titrimetric analysis, inorganic and organic preparations, physical chemistry, identification of functional groups of organic compounds and inorganic qualitative analysis.

There are few innovative experiments which are the part of Chemistry programme of IGNOU and are not covered in laboratory component of DU. For example experiments on separation techniques like solvent extraction, paper chromatography, column chromatography; analysis of oil & fats; preparation of face cream; preparation of Nylon 66; preparation of aspirin and analysis of a commercial sample of aspirin etc.

The students of Chemistry programme of IGNOU spend around 420 hours to complete all five courses. While designing the curriculum for laboratory courses of chemistry, importance has been given to utility of an experiment with respect to real life experience,

development of experimented skills and industrial applications. Repetition of experiment is avoided and emphasis on wide range of experimental techniques is given. Use of instruments is also emphasised. IGNOU provided low cost instruments like, pH meter, conductometer and colorimeter in the initial stages to some study centres.

## USE OF NEW TECHNOLOGIES AND FUTURE DIRECTIONS

### Survey Study

The B.Sc. Chemistry programme at the IGNOU has been on offer for the last twelve years and revision of various Chemistry courses is being initiated now. Not many new technologies are used right now for the delivery of chemistry programme. A few video programmes are supplemented and modes like interactive radio and video counseling are used minimal. It is a well-established fact that modern educational technologies have provided powerful tools to enrich learning environment (Kahveci 2003).

But before using any new technology we should keep in mind the suitability to our learners. To find this, a survey was conducted to collect information regarding learner's back ground, profile, reason for joining B.Sc. programme through distance mode, reason for doing B.Sc. major in chemistry, availability of computer at home or office, effectiveness of present mode of counseling sessions and the views regarding web based counseling.

A sample of 200 learners was randomly selected for those who had taken Biochemistry course as elective. This course is generally opted by the students who are aspiring to do major in Chemistry. The questionnaires were administered by post to learners. 56 Responses (28%) were received out of the 200 sent.

The sample (n=56) comprised of 70% (n=40) males and 30% (n=16) females. The mean age of the sample was 21 years at the time of joining IGNOU's B.Sc. programme. Regarding residential background, 31% (n=18) were rural living in rural 6.8% (n=04) rural living in urban, 48.2% (n=28) urban living in urban, 3.4% (n=2) urban working in rural and 6.8% (n=04) working with arm forces (See table 2). From the sample 70% employed and 30% are unemployed (see Table: 3).

This finding shows that IGNOU's B.Sc. programme is fulfilling its one of significant objectives of providing higher education to employed persons. In response to the reasons for joining B.Sc. programme of IGNOU, the two most common reasons given by students are improvement in job prospects (57.14%) and to get a Bachelor's degree (57.14%) (Table: 3, bearing in mind that the questionnaires allowed students to select more than one reason). In response to the reasons of studying B.Sc. (Major in Chemistry), majority of learners gave two reasons;

- keen interest in subject (46.43%) and
- (ii) to pursue higher studies in the area of Chemistry (46.43%) (Table: 5).

Table: 2  
Residential background of Chemistry Learners

Rural living in rural	32.14%
Rural living in urban	7.14%
Urban living in urban	50%
Urban living in rural	3.58%
Any other (arm forces)	7.14%
<i>Total</i>	<b>100%</b>

**Table: 3**  
**Employment Status of the Chemistry Learners**

<b>Unemployed</b>	<b>28.57%</b>
<b>Employed</b>	<b>71.43%</b>
<b>Total</b>	<b>100%</b>

**Table: 4**  
**Reason for joining B.Sc. Programme of IGNOU**

<b>Reasons</b>	<b>Percentage*</b>
<b>To improve job prospects</b>	<b>57.14</b>
<b>To get a degree</b>	<b>57.14</b>
<b>Because of family constraints</b>	<b>57.14</b>
<b>Employed</b>	<b>17.26</b>
<b>Lack of time</b>	<b>21.43</b>
<b>Did not get admission</b>	<b>14.29</b>
	<b>07.14</b>

\*bearing in mind the questionnaire allowed students to select more than one reason

**Table: 5**  
**Reason for Studying B.Sc. (Major in Chemistry)**

<b>Reasons</b>	<b>Percentage*</b>
<b>Interest in Subject</b>	<b>46.43</b>
<b>To pursue higher Studies</b>	<b>46.43</b>
<b>Better employment prospects</b>	<b>42.86</b>
<b>Family pressure</b>	<b>03.57</b>

\* bearing in mind the questionnaires allow students to select more than one reason

Face-to-face counseling by the counsellor as mentioned before is a one of the important components of the programme delivery (Tait 2004).

The main purpose of this is to clarify doubts and motivate and encourage learners to progress in studies and complete programme successfully. This aspect was also included in the survey study. Of the total number of respondents 60.72% did not receive any intimation regarding the conduct of counseling session and only 39.28% received the intimation. Only 39.28% attended counseling session and 60.72% did not attend.

Regarding the reason for not attending counseling sessions majority of learners have given three most common reasons;

- not receipt of counseling schedule (32.14%),
- distance of study centre from their residence (25%) and time constraint (21.43%) (Table: 6).

**Table: 6**  
**Reason for not attending the Counseling Session**

<b>Reasons</b>	<b>Percentage*</b>
<b>Distance of Study Centre</b>	<b>25.00</b>
<b>Time Constraint</b>	<b>21.43</b>
<b>Employed</b>	<b>17.86</b>
<b>Non receipt of counseling schedules</b>	<b>32.14</b>

Responses are given by mostly those students who have not attended counseling session.

Majority of student attended counseling sessions between four-five. For this course maximum numbers of counseling sessions are five and one counseling session is of two and half hours duration.

Most of the respondents have asked for more counseling sessions (85.71%). Learners (n=48) have shown interest in web based counseling. From 56 respondents (60.71%) (n=34) have computer facility and 39.29% (n=22) do not have computer at home or at work place. This study suggested that there is great scope of improving the counseling and one way could be using computer-aided learning. As majority of our learners are working (71.43%), therefore they have difficulty in attending face-to-face counseling. On the other hand most of the learners (60.71.5%) have computer facility either at home or workplace.

This suggested that along with present face-to-face counseling the web based counseling would be a better alternative. Web based counseling would help our learners to remove their doubt about the course related problems. Though IGNOU have the facility of Interactive Radio Counseling and video counseling, but there are some problems associated with these modes ( Rao & Zeba 1998, Choudhry and Bansal 2000 ).

If we can take care of the mentioned hindrances these can also be other educational modes, which can also be used for chemistry learners to improve there learning environment. We can also think of sending multimedia CD ROMs along with course material, which is used, else also very effective mode of teaching also used else where (Patterson 2000).

## **CONCLUSION**

The survey analysis clearly indicated the following:

- **Most of the learners find it difficult to attend the face-to-face counseling sessions because of the reasons stated.**
- **Most of the learner's are employed and it's difficult for them to have a physical presence for face-to-face counseling.**
- **Maximum numbers of learners have computer facility either at home or at workplace.**
- **Most of them did not have any hindrances as far as using web based counseling is concerned.**

All the above observations indicate that modern educational technologies can really play an impotent role in imparting Chemistry education to the B.Sc. students. In fact those students who are employed preferred having a web based counseling instead of face-to-

face or video teleconferencing. Further using computer simulations difficult concepts of chemistry could be explained.

The computer-simulated experiments could be used in place of demonstration. This will not necessarily impart skills but definitely would be able to give an exposure of the technique and method used (Yu et al 2005).

This would also save demonstration time of counsellor. 'Distance' between teacher and learner can be reduced by using innovative methods of teaching using modern technologies.

#### **BIODATA and CONTACT ADDRESSES of AUTHORS**

**Dr. Bharat Inder FOZDAR** is a Reader in Chemistry in the School of School, Indira Gandhi National Open University (IGNOU), New Delhi, India. He obtained his Ph.D degree in Chemistry from Aligarh Muslim University, India. He joined IGNOU in 1988. He received extensive training on designing and development of self-instructional course metrical and multimedia package for distance and open learning courses and programmes. He had played a significant role in course development of Bachelor degree program in Sciences (B.Sc.) and Certificate Programme in laboratory Techniques (CPLT). He participated in national and international conferences, and published several research articles in reputed journals.

Dr. Bharat Inder Fozdar  
School of Sciences, IGNOU, Maidan Garhi,  
New Delhi 110068, India  
E-mail [fozdar@hotmail.com](mailto:fozdar@hotmail.com), [bifoazdar@ignou.ac.in](mailto:bifoazdar@ignou.ac.in),

**Dr. Lalita S KUMAR**, is a Reader in Chemistry, in the School of Sciences, Indira Gandhi National Open University, New Delhi, India. She had Ph.D degree in Chemistry from Delhi University and had two decades of experience in designing development of self-instructional course metrical and multimedia package for distance and open learning system. She has several publications and a book to her credit.

Dr. Lalita S Kumar  
School of Sciences, IGNOU, Maidan Garhi,  
New Delhi 110068, India  
E-mail [lalitaskumar@ignou.ac.in](mailto:lalitaskumar@ignou.ac.in),

#### **REFERENCES**

Ansari, M.M. (2002). Best Practices in Open and Distance Learning Systems in India: An Assessment, *Indian Journal of Open Learning*, 11(2), 219-228.

Bennett, S (1995). Opening up Science: the Teaching of Science at the Open University, UK. Paper presented at the 17<sup>th</sup> ICDE Conference, Birmingham, UK.

Chandra, S. and Wong, T. M. (1995). Practical in Science and Technology Courses in the Open Learning Institute of Hong Kong-an Institutional Report. Presented at the post-AAOU Satellite Round Table meeting, New Delhi.

Chaudhary, S. S. and Bansal, K. (2000). Interactive Radio Counseling in Indira, Gandhi National Open University: A study, *Journal of Distance Education* 15(2)

DEC website: <http://www.ignou.ac.in/dec/index.htm>

Dikshit H.P. (2003). Growth of open and flexible learning in India: Emerging Challenges and Prospects, *Indian Journal of open Learning* 12(1,2), 7-15.

Holmbers, R.G., & Bakshi, T.S. (1982). Laboratory work in Distance Education, *Distance Education*, 3(2), 198-206.

*IGNOU Annual Report (2002-2003)*. Indira Gandhi National Open University, New Delhi.

Kahveci, A (2003). Chemistry at a Distance: Instructional Strategies and the Internet Component of the Course – A Chronological Review of the Literature. *Turkish Online Journal of Distance Education-TOJDE*, 4(3)

Kannepohl, D (2001). Using Computer Simulation to Supplement Teaching Laboratories in Chemistry for Distance Delivery, *Journal of Distance Education*, 16(2), 58-65

Kennepohl, D & Last, A. (2000). Teaching Chemistry at Canada Open University, *Distance Education* 21(1), 183-197.

Kenneponi. D. (1996). Home Study Micro labs, *Journal of Chemical Education*, Vol. 75, 938-39

Khare, P, Sexena, A, and Garg, S (2003). Knowledge Discoveries on Performance of IGNOU Graduates Through Data Mining, *Indian Journal of Open Learning*, 12(1), 29-45.

Koshy, K, Bonato, J, and Faasalanina T. (1994). Chemistry Through Distance Teaching: A South Pacific Experiment, *Distance Education*, 15(2), 291-299.

Mahajan, S.L. (2002). Information Communication Technology in Distance Education in India: A Challenge, *Indian Journal of Open Learning*, 11(2), 269-277.

Patterson, M. J. (2000). Developing an Internet-Based Chemistry Class, *Journal of Chemical Education*, 77(5), 554-555).

Rama Rao and Zeba Khan (1998). Satellite-based Interactive Learning System at IGNOU, Retrospect & Prospects, International Conference on Collaborative Networked Learning, IGNOU, New Delhi, 229-234.

Tait, Jo (2004). The Tutor/facilitator Role in Student Retention, *Open Learning*, 19(1).

*Vice Chancellor's Report (2004)*. 14<sup>th</sup> Convocation, Indira Gandhi National Open University, New Delhi.

Yu, Jian Qing, Brown, David J. and Billet, Ellen E (2005). Development of a Virtual Laboratory Experiment for Biology, *European J. of Open, Distance and E-learning*, 2005/II ([http://www.eurodl.org/materials/contrib/2005/Jian\\_Quing\\_Yu.htm](http://www.eurodl.org/materials/contrib/2005/Jian_Quing_Yu.htm))