

# Opportunities and Challenges in Learning Chemistry Through ODL Mode: NSOU's Experience

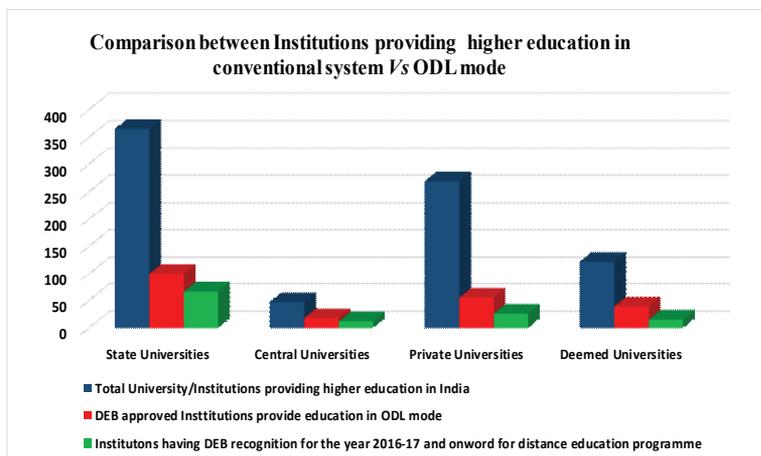
*Dr. Sintu Ganai*

## 1. Introduction:

Today two terms that are being used almost inter-changeably are 'Open Learning' and 'Distance Education' and they are often combined to be known as Open and Distance Learning (ODL). Open learning is a philosophy and Distance Education is the mode used to turn it into reality, as these two are complementary to each other. The concept of 'open and Distance Learning' is gradually becoming popular in the whole world. As far as a highly populated country like India is concerned, it has a great significance [Fozdar & Kumar, 2006]. In science education, "the term theory is used to describe an organized body of principles and assumptions that account for a set of phenomena along with the rules for its application" [Chauhan 2005]. On the other hand, practical classes of laboratory based science subject are used to give the opportunity to the students to have a hands on experience and its onward application. However, in science classes, demonstrations can be carried out to refute the misconceptions that exist in the personal theories and models of students [Chauhan, 2005]. However, there arises a big question here, i.e. "Whether is it possible to include science subjects in distance mode, where the possibilities of face to face interactions are very less?" Different Universities in India and abroad took the challenge for successful running of science subjects in their curriculum by overcoming various constraints in the distance mode. In the early seventies, there were few conventional universities with distance education programmes and courses. As on date, there are more than 212 Distance Education Institutions, including Conventional Universities, Deemed Universities, State Open Universities and one Central Open University i.e. IGNOU in India [UGC-DEB website]. The present scenario of the Institutions providing higher education in conventional system as well as ODL mode is depicted in Chart-1. From the chart, it is clear that the different ODL institutions play a vital role in providing higher education in India. With fresh enrollment in ODL programmes at approximately 40 lakhs annually, the share of distance education in the GER is about 22-23% of the total number of students in the higher education of the country,

which is significant [UGC-DEB website]. Among all these ODL institutions, Netaji Subhas Open University (NSOU) has emerged as a trendsetter in imparting a wide range of programmes and courses through distance mode in Eastern India.

**Fig 1:**



However, there is always a feeling of ambiguity in everybody's mind, so far as the delivery of the lab based Science Programmes through distance mode is concerned. Thus, the present paper aims at discussing about the existing delivery mechanism, innovative approaches taken by NSOU and analysing the weaknesses in the present system for conducting science courses especially in BDP Chemistry.

## 2. General idea of Teaching Chemistry in Distance Education:

Teaching of lab-based subjects like chemistry through Open and Distance Learning (ODL) has been a challenge to the educators due to the nature of its communication with learners and material delivery for instruction. Laboratory work is an important and integral component in order to understand the basic concepts associated with the subject and a laboratory with an involvement of expenditure is inevitable to accomplish this. However, for teaching chemistry, there is a dire need to provide flexible and cost-effective study support, including:

- i. Good quality self-learning materials (SLM), books and resources to develop the students own scientific abilities;
- ii. Innovative course curriculum to enhance the competitive ability of

the students covering the recent scientific knowledge in all of the subject domains such as organic, inorganic, physical and analytical chemistry;

- iii. The course that is designed to cover practical training skills required for a profession with chemistry background or in the Industry.

The main factors, which discourage laboratory based science programmes in Chemistry through distance education, are the mode of delivery, cost of equipment, use of chemicals and other safety issues etc. 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 [Holmbers & Bakshi, 1982]. As on date in India, only seven out of fourteen Open Universities are offering Bachelor's degree programmes in chemistry but few are providing education at Master's level in laboratory based science discipline like chemistry [URL-1]. NSOU is one amongst them offering Bachelor's degree programme in Chemistry. On the other hand, ODL units of conventional system are hardly having laboratory based science programmes like Chemistry [UGC-DEB website].

### **3. Laboratory based Science Programmes in NSOU:**

NSOU is successfully running science courses for the last sixteen years in their curriculum by a meaningful convergence of conventional and distance education. Besides a number of laboratory-based UG programmes (Physics, Chemistry, Mathematics, Zoology, Botany and Geography) and PG programmes (Mathematics, Zoology, Geography), NSOU offers various certificate, diploma and postgraduate diploma in the science discipline [URL-2]. The main objective of NSOU's B.Sc. programme is to provide opportunities of higher education in science to those who missed a regular education (working persons, those living in rural or remote areas, housewives and also those who have economic and opportunity constraints) and to create scientific attitude towards life. It 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. Flexibility, innovation, use of new technologies, cost effectiveness and quality education materials are mainly responsible for the popularity of NSOU programmes specially B.Sc. chemistry amongst masses. So far, more than thousand learners

have successfully completed the B.Sc. programme in chemistry. They have received quality education and have got success in their academic careers.

#### **4. Undergraduate Chemistry Courses and Teaching at NSOU: Subject Combination:**

NSOU introduced chemistry subjects in the BDP (Bachelor's Degree Programmes) level from 2000-01 sessions. For completing B.Sc. programme as Honours Graduate in chemistry, a student has to study Foundation Courses one in Humanities and Social Science (FHS), the other in Science & Technology (FST) along with one Application Oriented Course (AOC). Apart from this foundation course, one has to study languages consisting of Bengali (FBG) and English (FEG). All students have to study Environmental Studies in the 2<sup>nd</sup> semester. BDP students of chemistry are required to take Mathematics as subsidiary subject of 300 marks consisting of three papers. The students need to perform practical classes in such centres as may be allotted by the University. There are three practical courses during the three years of study. Only one practical course may be done at a time. The practical classes are generally arranged during puja vacation for twelve days.

#### **Method of Evaluation:**

The method of evaluation of students is different in an Open University System. Students are continuously evaluated through assignments prior to the term-end examination. In compiling results, 30% comes from the assignment evaluation and 70% from the performance in the term-end examination.

#### **Credit Distribution:**

For completing B.Sc. programme with major in Chemistry from NSOU, the learner has to study 124 credits or 1550 marks worth of course. One credit is equivalent to thirty hours of study time (which includes all the learning activities) from the learner's point of view. Out of 124 credits, 16 credits are devoted to foundation courses (FHS & FST) and 8 credits to application oriented courses (AOC), 4 credits to Environmental Studies, 24 credits to one Subsidiary subject (Mathematics for Chemistry Hons) and the remaining 64 are subject specific (Honours Level) credits. For getting honours, degree in chemistry the learner is required to complete minimum 64 credits worth of chemistry elective courses, which contain 10 theory courses, and 3 laboratory courses. Detailed credit system for

B.Sc. chemistry honours (ECH) programme at NSOU are summarized in **Table 1:**

**Table 1:** Details of the Credit System for Elective Chemistry Honours (ECH) Programme of NSOU

Course Code	Course Title	Credits	Full Marks	Credit Distribution
ECH 01	General Chemistry	4	50	Elective Chemistry 800 Marks (64 Credit)
ECH 02	Inorganic Chemistry-I	4	50	
ECH 03	Inorganic Chemistry-II	4	50	
ECH 04	*Practical Chemistry-I	8	100	
ECH 05	Inorganic Chemistry - III	4	50	
ECH 06	Physical Chemistry-I	4	50	
ECH 07	Physical Chemistry-II	4	50	
ECH 08	*Practical Chemistry-II	8	100	
ECH 09	Physical Chemistry-III	4	50	
ECH 10	Organic Chemistry-I	4	50	
ECH 11	Organic Chemistry-II	4	50	
ECH 12	*Practical Chemistry-III	8	100	
ECH 13 & 14	Organic Chemistry-III and Biochemistry	4	50	

SMT-01	Subsidiary Mathematics-Paper 1	8	100	Subsidiary 300 Marks (24 credit)
SMT-02	Subsidiary Mathematics-Paper 2	8	100	
SMT-03	Subsidiary Mathematics-Paper 3	8	100	
FST	Foundation Course in Science & Technology	8	100	Foundation course 200 Marks (16 credit)
FHS	Foundation Course in Humanities & Social Science	8	100	
AOC-3	Application Oriented Course	8	100	100 Marks (8 credit)
FBG	Foundation Course in Bengali	4	50	Language course 100 Marks (8 credit)
FEG	Foundation Course in English	4	50	
Environmental Studies	Environmental Studies	4	50	50 Marks (4 credit)
<b>Total</b>		<b>124</b>	<b>1550</b>	

\*These are the laboratory courses

## 5. Delivery of Courses at NSOU:

From the personal experiences, it is evident that teaching learning in science is a difficult task in open and distance education and thus, NSOU adopted few innovative approaches to teach science subjects including chemistry in their course curriculum. NSOU uses the following variety of methods for science teaching:

**Self-Learning Material:** Self-learning study materials (SLM) are distributed to the students through the Study Centres after taking admission.

**Personal Contact Programme:** Instructions are imparted through self-learning study materials and Personal Contact Programme (PCP).

The Personal Contact Programme is generally held on Saturdays and Sundays and the classes are taken by the counsellors of specific areas. The counsellors are mainly the University faculty members, other faculty members from recognized Colleges, Universities and Institutes following the guidelines of University Grants Commission (UGC), thus depicting a beautiful convergence between the distance and conventional education system. Ten counselling sessions of 1 hour 30 mins duration are allotted for 100 marks of BDP subjects.

**Audio-Video Lecture (AVL):** Audio and video lectures are being recorded regularly on different topics by eminent professors which are available for the learners on the university website.

**Audio-Video Laboratory Demonstration:** Demonstration of the process of chemical analysis, chemical reaction according to the practical curriculum is being recorded in the university laboratory and is available for the learners. These practical classes in laboratory give the opportunity for the students to have a better understanding of laboratory classes and its onward application.

**E-Resources:** Various e-resources including set of digitized course materials, model Questions are available in the University website for learner's self-evaluation. An effort has also been made to minimize student's effort by listing of E-resources under Consortium of Educational Communication (CEC), UGC in the University website. Besides that, NSOU provides innovative E-contents by editing of content with quiz, academic script, summary, animation etc

**Application of Web 2.0:** A Web 2.0 site allows users to interact and collaborate with each other in a social media dialogue as creators (prosumers) of user-generated content in a virtual community, in contrast to websites where users (consumers) are limited to the passive viewing of content that was created for them. This technology has been used for teaching of science-based courses on a regular basis.

**Library facility:** To cater to the needs of huge number of registered students, the University has taken an initiative for the first time in the country to set up a strategic partnership with the existing network of Public Libraries that are available in the state of West Bengal to offer educational support to our learners all over the state. With the active support from the Department of Mass Education Extension and Library Services, Government of West Bengal, the strategic partnership has been started with seven (7) Public Libraries at different locations in the

first phase. The students/ learners of the University may avail library services without any cost at these libraries during their working hours.

**Gyan Vani FM Channel:** Time specific broadcasting (both live and recorded) have been done from the Gyan Vani FM, Kolkata, a radio channel on 105.4 MHz for the students.

**Interactive Radio Counselling:** The University broadcasts different subjects through All India Radio (AIR) at Kolkata. Apart from the regular classes, various topics on related to some awareness programmes and other programmes on support services are also broadcast.

**Student Support Cell:** The SSC is the central point of contact for all student support issues. Students are being encouraged to contact the Support Centre to report problems, any queries including audio/visual lectures, mobile app enquiries, software problems, and the like.

**SMS and E-Mail Notification:** SMS and Email are being used at different stages of the whole support cycle period for the students to inform important schedule, course feedback and reference seeking etc.

**Student Portal:** Students get access to their virtual classroom through their unique login ID and Password within the Student Portal. The entire student portal is also available on a mobile platform. Students get access to ticketing system and their emails through the same.

**Learner's Management System (LMS):** Through this platform the University provides all of the ICT Services to the learners in user-friendly manner.

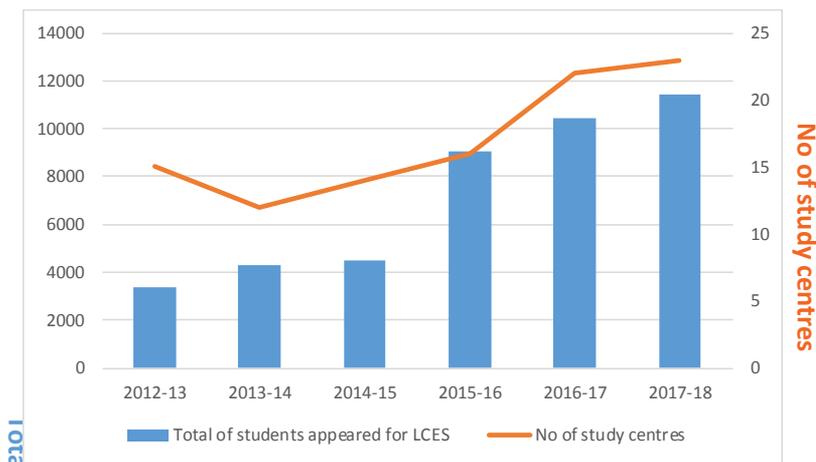
**Laboratory Classes at NSOU:** To educate the students in more scientific way, a rhythmic practical class has been introduced by the University. The Study centres provide the necessary laboratory facilities in addition to the university's own laboratory. For BDP level, a period of 12 days (eight hours per day) named as Laboratory counselling-cum-Evaluation Session (LCES) are allocated for the students during the Puja vacation. The College and University teachers are appointed to take classes, which show a beautiful sharing of resource persons among the conventional and distance institutions. The students of different study centres have been clubbed into nearby study centres for practical classes. During the first 11 days during the total session (88 hour), the learners gain hands on experiences with the help of counsellors. Marks are allotted on each day's work and awarded on the basis of the actual performance of the students. The sum total of marks awarded by the

Counsellors in continuous assessment contributes to 70% of the final marks. On 12<sup>th</sup> day of the programme, a Practical Examination which is unguided have been conducted and evaluated jointly by an external and internal examiner and 30% marks from this examination is reflected in the final marks. Attendance in the LCES is mandatory, if a candidate fails to appear in the LCES for more than three days, he / she will not be eligible to participate in the rest of the session. A regular inspection and surprise visit is being arranged by the University to sustain the quality of education during the practical classes. It has been observed from the students' examination records that their performance in the laboratory courses of NSOU is very good.

Summary of number of students appearing for LCES programme for all BDP science subjects and number of study centres engaged for conducting the programme during last five years is shown in Chart-2.

**Fig 2:**

**Number of students & Study centres engaged for conducting the laboratory counselling programme for BDP science subjects**



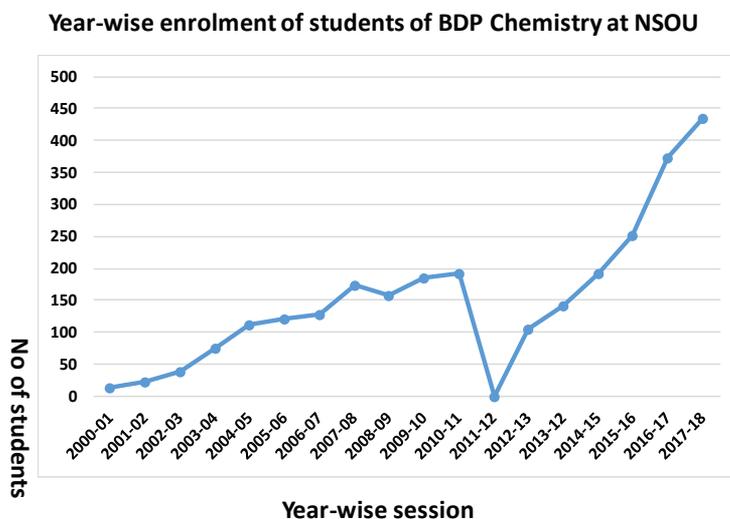
It can be seen from the chart that due to the increased number of enrollments, the number of study centres for practical classes have been increased accordingly. Hence, it is clear that the popularity of science subjects at NSOU has increased.

## 6. Enrollment pattern in BDP Chemistry at NSOU:

NSOU introduced chemistry in the BDP level from 2000-01 session onwards. Chart-3 will give us an idea about the student enrolment

pattern in BDP chemistry at NSOU. From the chart, it is clear that in BDP chemistry, the student enrollment increased gradually from 2000-01 session to 2007-08 session and then dropped down in 2008-09 session and finally increased during 2017-18. However, during the 2011-12 academic session admission was not done due to some administrative decision. The reasons for this decrease in not properly known and/or identified. Considering the increasing number of enrollment of students, it is evident that BDP Chemistry at NSOU is getting popularity amongst masses and it is going to acquire broader prospects in distance education system in the near future.

**Fig 3:**



## 7. Undergraduate Chemistry Courses at Conventional University Vs NSOU:

A comparison between courses offered for B.Sc. (major) in Chemistry from NSOU and B.Sc. (Honours) in Chemistry from conventional University like University of Calcutta has been made. University of Calcutta is the premiere State University of West Bengal and is known for very high educational standards. A statement of fact in Table-2 will give an idea for both the systems.

**Table 2:** Showing a Comparison between a Conventional University and an Open University for Chemistry Course.

Courses	Items	Conventional University (Calcutta University)		Open University (Netaji Subhas Open University)	
<b>B.Sc.(Hons)/ BDP Chemistry</b>	<i>Maximum year allotted</i>	5 Yrs.		6 Yrs.	
		<i>Theory</i>	<i>Practical</i>	<i>Theory</i>	<i>Practical</i>
	<i>Total marks</i>	550	250	500	300
	<i>Total Learning Activity</i>	550-770 hour	700-800 hour	1200 hour	288 hour
	<i>Subsidiary paper</i>	Physics (300 Marks) Mathematics (300 Marks)		Mathematics (300 Marks) Foundation Course in Science & Technology (FST, 100 Marks) Foundation Course in Humanities & Social Science (FSH, 100 Marks) Application oriented courses (AOC, 100 Marks)	
	<i>Compulsory paper</i>	Environmental Science (50 Marks) Bengali (50 Marks) English (50 Marks)		Environmental Science (50 Marks) Bengali (50 Marks) English (50 Marks)	

As mentioned before, besides these courses the learner is required to take 16 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. The Application Oriented Course is developed to equip learners in some areas of Household Chemistry, which requires application of skills. Thus, NSOU is providing a broad based education along with specialisation in Chemistry. On the other hand, at the University of Calcutta more emphasis is given on specialisation only. The discipline based theory courses include inorganic, organic physical and analytical chemistry courses throughout the three years of the programme in both the systems. On the contrary, chemistry programme from NSOU offers an interdisciplinary course, Biochemistry (ECH-13&14) along with the three main areas of

chemistry. This course (ECH-13&14) provides background knowledge to those learners who are interested in taking up higher studies in emerging areas of Biotechnology and Bio-informatics. NSOU laboratory courses are 24 credits worth, which are standalone in nature. Many experiments of these courses are at par with those of the University of Calcutta's 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 of Biochemistry which are a part of Chemistry programme of NSOU and are not covered in laboratory component of CU. Use of instruments is also emphasised. NSOU provides financial support to the study centres to purchase low cost instruments during the LCES programme. Although NSOU uses ICT for better communication but there is no such facility to connect all the study centres in one platform through video teleconferencing. There is no online examination facility at NSOU.

### **8. Suggestions for Teaching Chemistry through Distance Education:**

The following suggestions are made by the author in order to improve the quality education in open and distance mode:

- Distance between teacher and learner can be reduced by using innovative methods of teaching using modern technologies such as video teleconferencing through study centres [Kannepolh, 2001 & Kahveci, 2003]. This is suggested that along with present face-to-face counselling the web based counseling would be a better alternative. Web based counselling would help learners to remove their doubt about the course related problems.
- Online examination facility should be introduced for better evaluation process by creating a standard questionnaire hub and using modern technologies.
- 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 save a huge amount of time that is usually spent by the counsellor in giving demonstration.
- Constant updating of study materials, laboratory manual through innovatively designed framework considering the cognitive model of scientific reasoning is needed.

- Use of multimedia support with innovative course materials (topic wise AV-Lectures) so that the learners can use their android phone as an important learning kit.
- Well organised counsellor's manual is needed for their preparation prior to attending lab sessions and instant feedback [Khare et. al, 2003].

## 9. Conclusion:

Open and Distance Learning is an amalgamation of two approaches to education that focuses on expanding access to learning and the use of multimodal delivery systems such as technology and printed modules. Incorporating practical work into Distance Education courses is a worldwide challenge that calls for careful planning and creative curriculum development. The main challenges with practical work in ODL are that students are geographically scattered and that they come from very different educational backgrounds [Bhukuvhani et al, 2012]. Now, most affluent countries are convinced that they will not be able to provide adequate education to people unless they abandon their exclusive dependency on formal system of education [Naik, 1978]. Keeping this in mind, Open Universities started their functioning by launching various innovative programmes including science in their course curriculum. From the previous discussion, it is evident that by meaningful convergence between both the conventional and distance education, NSOU explored a new dimension of science teaching especially for a subject like chemistry. It has been realized that distance learners in B.Sc. programme in Chemistry of NSOU 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. Successful enrolment, its year-wise growth and timely completion of BDP chemistry, NSOU proves itself as a forerunner among the distance education institutions. Finally, it is needless to say that learning of science is a process of construction and reconstruction of personal theories and models. Previously suggested approaches can be introduced in distant education to make chemistry courses more effective from learner's learning point of view. Teachers should take students' theories and models into account when developing curriculum plans. Finally, efforts are needed from the Government and the funding agencies to sustain lab base subjects in distance education system.

## **Acknowledgement:**

The author is thankful to Netaji Subhas Open University for the help in collecting data and is also grateful to UGC-DEB for the financial support.

---

## **References:**

Bhukuvhani C, Mupa M, Mhishi M and Dziva D. (2012). "Science practical work instructional technologies and open distance learning in science teacher training: A case study in Zimbabwe", *International Journal of Education and Development using Information and Communication Technology*, 8: 17-27.

Chauhan A. (2005). "Teaching of Zoology", *International Scientific Publishing Academy*, New Delhi.

Fozdar, B. I; Kumar, L. S. (2006). "Teaching Chemistry at Indira Gandhi National Open University", *Turkish Online Journal of Distance Education*, 7 (2), 80-89.

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

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*, 4(3).

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

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.

Naik J.P. (1978). Equality, Quality and Quantity-the Illusive in Indian Education. Mumbai: Allied Publishers.

UGC-DEB website: <http://www.ugc.ac.in/deb/> as accessed on 31/08/17.

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

## **Web Resources:**

<http://entrance-exam.net/list-of-colleges-offering-bsc-chemistry-through-distance-educationcorrespondence/> as accessed on 31/08/17.

<http://www.wbnsou.ac.in> as accessed on 31/08/17.