Chapter 11
Challenges and Opportunities for Teaching Laboratory Sciences at a Distance in a Developing Country

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Introduction

Education *per se* is widely seen as a necessary precondition for economic growth within the knowledge-based economies of early twenty-first century. Educating and training a vast population of people for both preparatory and in-service purposes is a huge and expensive venture, which is very difficult to manage in the developing countries due to budgetary constraints. This is further compounded when the education and training have to be delivered in scientific and technical subjects. Conventional systems of delivering science-based education and training have often failed to meet the current and anticipated demand for the skills in the said areas. Innovations in delivery systems must be part and parcel of the solution to the above-mentioned constraints, requiring further exploration. The use of distance and open learning methodologies is one such innovation. This is why the last century has witnessed the establishment of hundreds of distance learning institutions in both developed and developing countries like Bangladesh. The challenges and prospects for distance education in the developing countries have been studied by a number of researchers (Arger, 1990, 1993; Ramanujam, 2001; Fozdar, Kumar & Kannan, 2006; Jung & Latchem, 2007).

Bangladesh is a developing country (GDP growth rate 6%) with the highest population density (1,020 persons per sq km) in the world, excepting city-states like Singapore. About half of her population is struggling to survive as they are living under the poverty line. Illiteracy and a high dropout rate at all levels of education are major challenges in attaining sustainable economic development and thereby improving quality of life. Vocational and technical education provides employment-oriented knowledge and skills to the unemployed youth force. However, the current strength of conventional institutions satisfies only a small portion of the huge demand for such education and training. Moreover, the conventional system cannot provide training for people of all ages and from diverse locations, or satisfy demands for easily accessible alternatives such as open and distance learning.

To create an opportunity for the huge numbers of unskilled and less educated people, the Bangladesh Open University (BOU) was established in 1992 as the only public university to introduce different levels of education, ranging from junior secondary to higher education, through distance mode. Over the years, it has launched 21 formal and 19 non-formal academic programs under seven schools, namely the School of Agriculture and Rural Development, the School of Business, the School of Education, the School of Law, the Open School, and the School of Social Science, Humanities and Languages. For pedagogic delivery, BOU uses both the conventional face-to-face tutorial system based on the print module and electronic technologies such as CD, audio-visual cassettes, and radio and TV broadcasts. The response to BOU programs has been so phenomenal that current enrolment of students in each year (BOU Diary 2008, 271,630) is several times higher than that of any of the public and private universities in the country. Thus BOU has emerged as a new exemplar of the mega-university (Daniel, 1996). In several studies, it has been found that BOU education is flexible, cost-effective and of a standard comparable to that of the conventional universities (Anonymous, 2002; Islam, Rahman & Rahman, 2006; Islam & Selim, 2006a). However, scepticism has persisted as to whether current delivery methods are effective enough in imparting knowledge and practical skills to students attending science and technical courses that have substantial practical/laboratory works (Islam, 2007). Generally, infrastructure and facilities for laboratory experiments are not practically up to date and adequate even in conventional institutions in the developing countries. Obviously, hands-on experience is essential for effective transfer to students of technical skills which are often limited in distance education (Fozdar, Kumar & Kannan, 2006; Jung & Latchem, 2007). Several innovative approaches have therefore been proposed to overcome this barrier and do laboratory science in an environment that is flexible for learners (Rudd, 1994; Ross & Scanlon, 1995; Kennepohl, 2001; Boschmann, 2003; Casanova et al., 2006; Kennepohl, 2007; Nigam & Joshi, 2007).

It has been a concern of educators how to effectively deliver laboratory-based science and technology courses through distance mode. The aim of this chapter is to discuss the challenges and opportunities for effective delivery of lab-based and field-oriented practical science subjects through distance mode in the developing countries, with special reference to Bangladesh.

Distance education in Bangladesh

Distance education and correspondence courses are a hundred-year-old concept, initiated in the western world. The history of open and distance learning in Bangladesh (then East Pakistan) dates back to 1956 when the then Education Directorate distributed 200 radio receivers to educational institutions, which in turn led to the establishment of an audio-visual cell and later the Audio-visual Education

Center (AVEC) in 1962. Upon the creation of an independent Bangladesh in 1972, a pilot project School Broadcasting Program was undertaken during 1978–1980, which was later merged with AVEC to establish the National Institute of Educational Media and Technology (NIEMT). The NIEMT was later transformed into the Bangladesh Institute of Distance Education in 1985. Bangladesh Open University (BOU) was established in 1992 by an Act passed in the national parliament. The BOU Act 1992 stated the purpose of the establishment of the university as follows:

> …to spread multimedially instruction of every standard and knowledge, both general and scientific, by means of any kind of communications technology, to raise the standard of education and to give the people educational opportunities by democratizing education and to create a class of competent people by raising the standard of education of the people generally.

To bring education to the doorsteps of the people, BOU has set up 12 regional centres (RCs), 80 coordinating offices (COs) (Fig. 1) and nearly 1,000 tutorial centres (TCs) geographically distributed throughout the country. Although RCs and COs are BOU's own infrastructures, the TCs are situated at selected government and non-government institutions which have sufficient facilities and experts to conduct tutorial services for the students of respective BOU programs during weekends and holidays.

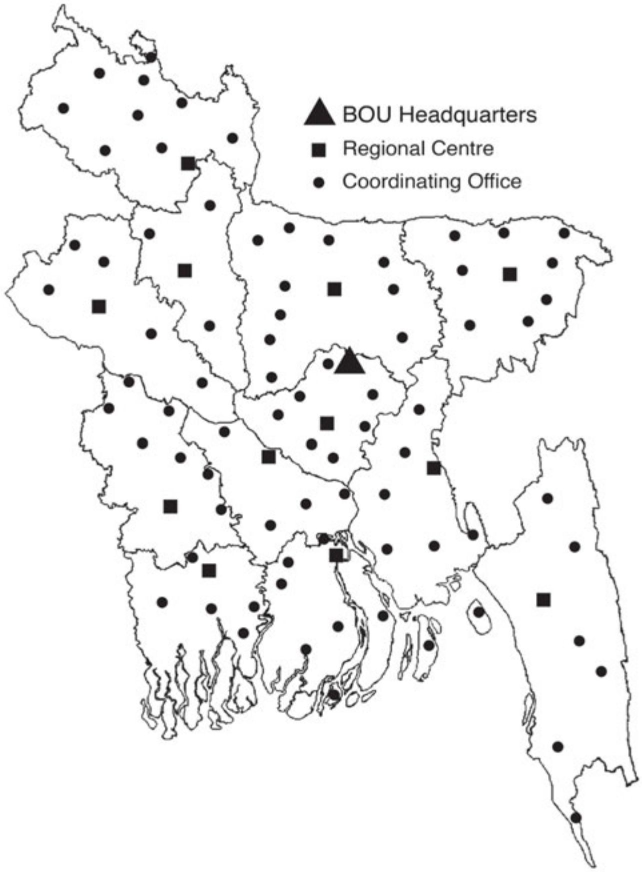

Figure 1. Locations of BOU's main campus, regional centres (RCs) and coordinating offices (COs) in Bangladesh map.

Materials development and delivery

Science programs in BOU

Out of twenty-one academic programs, seven programs, namely Bachelor of Agricultural Education (B.Ag.Ed.), Bachelor of Science in Nursing (B.Sc.Nurs.), Diploma in Computer Science and Application (DCSA), Certificate in Poultry and Livestock (CLP), Certificate in Pisciculture and Fish Processing (CPFP), Higher Secondary Certificate (HSC), and Secondary School Certificate (SSC), have substantial or minor science courses. The detail descriptions and trends of student enrolment in these programs are given in Table 1 and Fig. 2. Among these programs, three in agricultural sciences (B.Ag.Ed., CLP and CPFP) and one in health science (B.Sc.Nurs.) and another one in engineering (DCSA) have substantial practical or laboratory work along with theoretical lessons in almost in every course. So far several thousand students have successfully completed these science-based programs. The modes of delivery and student support systems in all science courses are more or less similar, and hence, these are discussed together. To give a detailed view of the whole process of the choice of media, preparation, and delivery of materials for teaching science courses, each component is discussed separately in the following sections.

Table 1. List of BOU programs having major or minor science courses with practical/lab work.

Programs	Year of launch	Level	Admission requirement	Min./max. duration (years)	Freq. of enrolment in a year	Semester[a] (total credit hours)	Practical or lab. activity needed
B.Ag.Ed.	1997	Bachelor	HSC/Dip.Ag.	3/6	Twice	6(95)	Major
B.Sc.Nurs.	2003	Bachelor	Dip. Nurs.	3/5	Once	6(100)	Major
DCSA	1998	Diploma	HSC or equiv.	1.5/5	Once	3(35)	Major
CLP	1999	Certificate	SSC or equiv.	0.5/2.5	Twice	1(16)	Major
CPFP	1999	Certificate	SSC or equiv.	0.5/2.5	Twice	1(15)	Major
SSC	1995	Certificate	Grad.8 or equiv.	2/5	Once	02(60)	Minor
HSC	1998	Certificate	SSC or equiv.	2/5	Once	02(72)	Minor

Data retrieved from BOU website (http://www.bou.edu.bd/SARD.html) on February 13, 2008. B.Ag.Ed., Bachelor of Agricultural Education; B.Sc. Nurs., Bachelor of Science in Nursing; DCSA, Diploma in Computer Science and Application; CLP, Certificate in Livestock and Poultry; CPFP, Certificate in Pisciculture and Fish Processing; SSC, Secondary School Certificate; HSC, Higher Secondary Certificate; Dip.Ag., Diploma in Agriculture; Dip.Nurs., Diploma in Nursing. [a]Each semester duration in all programs is 6 months except in SSC and HSC (1 year in each semester).

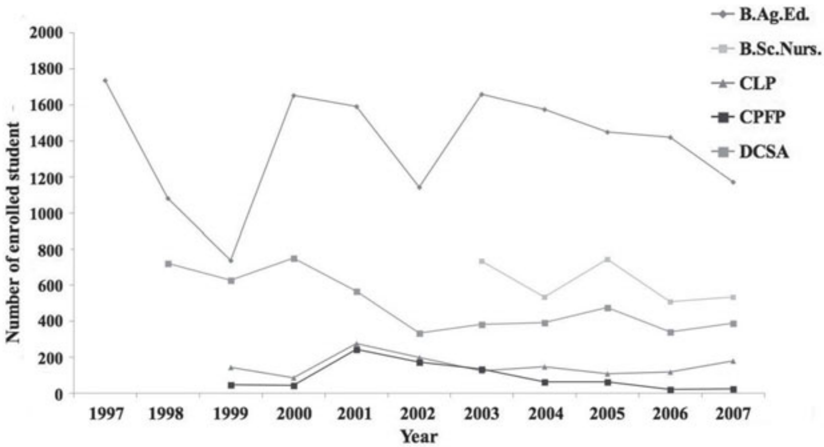

Figure 2. Annual student enrolment in BOU science programs. (Source: Student Support Services Division, BOU).

Media of delivery

Global Distance Education (DE) has progressed very rapidly during the last few decades.

Now DE is defined as the education system where learners are able to communicate and interact with voice, video, and data, in real time with their teachers and other learners through modern information and communication technologies (Islam, 2007; Daniel, 1996). Learning through electronic technologies and mobile electronic devices is popularly known as electronic learning (e-learning) and mobile learning (m-learning), respectively, and has been expanding most rapidly in the developed countries (Islam & Selim, 2006b; Islam, 2007). Although different universities have some common features in terms of distant delivery and its objectives, the actual actions vary greatly to meet specific local challenges. Faced with economic and infrastructural limitations, most of the universities in developing countries like BOU are still far behind in adopting all modern technologies to teach their distant students. However, BOU has adopted such technologies where they are affordable and easily accessible to its distant students. BOU is using (1) print; (2) radio and television; (3) audiocassettes; and (4) occasional face-to-face tuition to teach its learners (Islam & Selim, 2006b; Islam, Rahman & Rahman, 2006). It has not yet adopted the computing media and technologies (5th medium) for teaching due to costliness and poor access, but it has adopted a spectrum of four out of the five media and makes use of four technologies (Islam, 2007). Almost similar delivery methods are being used in Indira Gandhi National Open University in India to teach distant students (Fozdar, Kumar & Kannan, 2006).

In each science course, a printed course book written in modular format is provided to the students. Each book is divided into several units and each unit is further divided into 3–5 lessons. The lesson containing the practical or laboratory work is designed in step-by-step fashion with enough illustrations, drawings, and examples so that students can do exercises in their home environment and/or nearby farm/field. The practical/labwork—related lessons are added consistently together with theoretical lessons within the printed course books of the respective courses. To supplement print, radio and television programs (every day 25–45 minutes, which is expected to extend up to 4 hours in the near future) are broadcast through state-owned radio and TV channels. Students are invited to perform laboratory or practical work at their nearby tutorial centres (TCs) under the supervision of specialist tutors.

Print materials

Print is still a powerful medium in many open universities in the developing as well as the developed countries (Gaba & Dash, 2004). BOU has introduced a course team approach for developing effective printed course materials for distant students. Each course team comprises specialist course writer(s), editor, trained style editor, graphic designer, illustrator, audio-visual producer and anonymous referees (see detailed process in Fig. 3). An editorial board is responsible for the final approval of publishing materials for students. This approach has proven to be effective, but has also appeared to be complicated and time-consuming (Islam, Rahman & Rahman, 2006). Once the course is in operation, the university monitors the performance of the course books and begins to collect data on errors identified by the learners and the tutors. The university strongly encourages students and tutors to report errors and difficulties they encounter while going through the course materials during or immediately after the course delivery. The information or feedback is collected and analyzed by the concerned course teams of the relevant school. If significant criticism is found along with the positive reactions, the course is then revised and reprinted; otherwise, errata pages for the mistakes suffice. The BOU policy of developing a course book incrementally, refereeing its materials meticulously, inviting criticisms, collecting feedback, observing course presentation and assessment, correcting errors, and revising the whole work is designed to ensure that quality assurance is maintained (Islam, Rahman & Rahman, 2006). This traditional approach is nothing but a synthesis of the BS 5750 (i.e., quality loop) Approach and the Iterative Approach (Freeman, 1991), and the whole process has proven effective (Islam & Rahman, 1997; Islam, 1998).

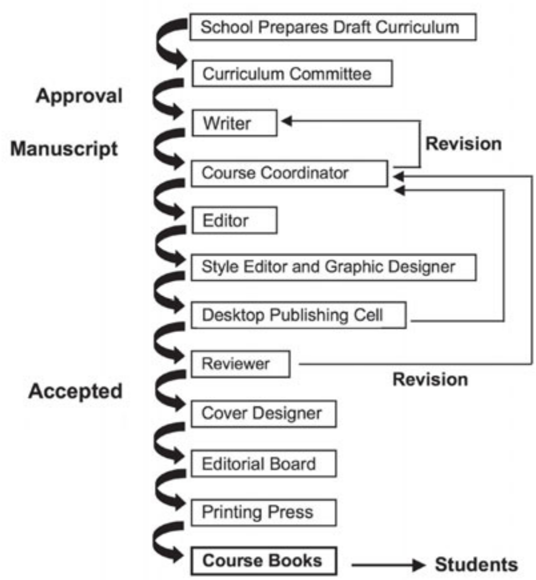

Figure 3. Schematic diagram of the processes of course book production in BOU (Islam, Rahman & Rahman, 2006).

A survey of student opinion revealed that the overall quality of BOU curricula and course books is rated good to very good as self-study learning materials (Anonymous, 2002; Rahman et al., 2005, Shah et al., 2005, Islam, Rahman & Rahman, 2006). Although BOU generally revises course books every five years, this interval was not found to be appropriate/effective in the science and engineering courses due to the continual and substantial influx of new knowledge in the areas of science and technology. The appropriate solution in the cases of science and engineering courses is to revise course books every two years. It has also been suggested that practical lessons should be revised more elaborately and written in a step-by-step manner with appropriate photographs, artwork, and suitable examples and print as a separate manual (Islam, Rahman & Rahman, 2006; Fozdar, Kumar & Kannan, 2006).

Audio and audio-visual media

As with course book production, strict principles are followed in audio and audio-visual productions (Islam, Rahman & Rahman, 2006; Islam, 2007). Evaluating the difficulty level and relative effectiveness of media, the school selects topics from different courses for audio and audio-visual production. The presenter is selected from in-house faculty and/or reputable academics from outside. The selected presenter prepares a script on the basis of a particular topic of the concerned course. The school checks the quality of the script and then sends it to the respective producer of Media Division. The producer arranges recording and editing of the materials with a media editor and then presents the edited program before a preview committee prior to its radio or TV broadcast. The preview committee consists of the following members: Director (media), Dean or his/her representative, subject specialist, video specialist, producer, program specialist, and one external member. If the committee approves, the program will go on air. Although audio cassettes are provided to supplement printed course material in some language teaching programs (English or Arabic — CELP, CALP), there are no audio cassettes for the science courses.

The quality of BOU radio and TV programs is rated good to very good by the students (Islam & Rahman, 1997; Islam & Islam, 2008). However, as one-way delivery is followed without any real-time discussion and interaction, these programs are practically contributing less in transferring knowledge and skills, especially in the science courses (Rahman et al., 2005). The thirst for instant response/solutions/suggestion/clarifications by asking questions and participation cannot be quenched by these two media. In addition, there are several other reasons behind the lower effectiveness of radio and TV programs in BOU. Access to TV and radio programs is to some extent restricted due the short daily interval of broadcasting by the government-owned TV and radio channels. A survey result further indicated other problems such as unstable supply of electricity, poor connectivity of TV and radio broadcasts in some remote areas, lack of prior information regarding the topic of the program to the students, unexpected variation from the scheduled broadcast time and insufficient number of programs per course. One of the suggested solutions is to make available those audio and audio-visual programs in RCs, COs and even TCs for the students' as well as for the tutors' use (Islam & Selim, 2006c; Islam, Rahman & Rahman, 2006). Some of those programs could be added in the course package on CD-ROMs. These attempts would surely improve the effectiveness of these programs in a cost-effective manner.

Face-to-face tutorial services for laboratory and practical work

Effective transfer of skills in any technical or science work to the students requires hands-on experience and human interaction. BOU has introduced face-to-face tutorial services in the designated TCs to support students in theoretical lessons and to perform practical experiments under the direct supervision of subject specialist tutors. Each tutorial session for practical/laboratory work is 55–110 minutes long, depending on the program. The tutors are appointed on a part-time basis, and are usually engaged in government or non-government organizations. They render academic services following a routine provided by the concerned school of BOU. Nominal logistic support is provided to the TCs to conduct practical and laboratory work; however, it varies from program to program. It has been found from students' examination records that their performances in the laboratory courses are very good, as they receive facilities, direct guidance, and feedback for practical work at the TCs. Students' participation in the tutorial session is not mandatory, and therefore, a high rate of absenteeism in the laboratory or field work is common (Rahman et al., 2005; Shah et al., 2005; Islam, 2008). It has also been found that students who did not attend the tutorial sessions failed in great numbers in the practical part of the examinations (Rahman et al., 2005; Islam, Rahman & Rahman, 2006). A high rate of absenteeism in tutorial sessions has also been found in distance education other developing countries (Fozdar, Kumar & Kannan, 2006).

The concept of freedom and individual choice for distant learners is an important driver for success. Although students get current hands-on experience in doing laboratory work under guidance of specialist tutors in the TCs, this approach is obviously quite inflexible and offers students little independence and freedom in their learning. Low attendance of BOU students in the tutorial sessions is a strong indicator that distant students need an approach that is flexible as to time, pace, geographical location, and environment. Therefore, innovative and flexible methods are needed for effective transfer of cognitive and practical skills in science courses at a distance (Fozdar, Kumar & Kannan, 2006). There have been numerous approaches to addressing this challenge, including using regional laboratory sites, concentrating laboratory sessions, and offering flexible hours (weekends and evenings), as well as employing computer simulations and remote laboratories (Kennepohl, 2001). Laboratory work performed by distance students in their home environment using appropriate kits or computer simulations was found to be more or less equivalent to on-campus experiments (Rudd, 1994; Ross & Scanlon, 1995; Boschmann, 2003; Casanova et al., 2006; Kennepohl, 2001, 2007). The high cost of kits and/or lack of student access to electronic devices are two major concerns in introducing these innovative approaches in developing countries.

Most of the practical lessons in agricultural sciences, such as seed germination testing, analysis of soil texture (sand/silt/clay) by the filed method, identification of nutrition deficiency in plants by leaf color chart, and identifications of weeds, insects, etc., can easily be done at home and nearby farms by following protocols written in the course books. However, nearly 30% students do not perform these works alone (Rahman et al., 2005; Islam, 2008). This is probably due to isolation and lack of motivation and scope for collaborative learning practices. To overcome this situation, it has been suggested that students' participation in the practical session should be encouraged by allocating 10–20% marks for attendance (Islam 2008). But this would certainly limit the flexibility and freedom of students. Several other reasons have also been identified for lower attendance in tutorial sessions such as transportation difficulties, engagement in personal matters, and costs. As BOU students do not receive any kits for practical work, a both tutors and students often appeal for increased facilities (materials, equipments, transportation) and duration of tutorial sessions. Insufficient support from the study centre as the cause of student withdrawal in a BSc program in IGNOU has been reported (Fozdar, Kumar & Kannan, 2006). However, face-to-face counselling in the study centre has been found effective in meeting the demands of distance learners in many developing countries (Fung & Carr, 2000; Fozdar, Kumar & Kannan, 2006).

Evaluation methods

To assess acquired knowledge and skills, an appropriate evaluation method is needed. BOU has introduced two types of evaluation for assessing students' performance. One is the tutor-marked assignment (TMA), a tool for continuous assessment, and the other is the semester-end examination. In science courses, questions for TMAs are usually practice-oriented. Each course is evaluated in terms of a total of 100 marks. The marks distributions for TMAs, theory, and laboratory or practical components are 10, 70, and 20, respectively. Marks allocated for laboratory works are further divided into three parts; 5, 10, and 5 for laboratory notebook, an experiment/job, and *viva voce*, respectively. All questions are prepared centrally by anonymous subject specialists and moderated by the examination committee under direct coordination by the respective school of BOU and printed and distributed by the controller of the examinations. However, evaluation of the practical/lab examination is done by two examiners (internal and external) during or immediately after the examination and sent to the controller of the examination through TC. As with the theory portion, a student must get a minimum of 50% of the marks in the practical portion in order to complete the course. Results are expressed in cumulative grade point average on a scale of 5 (Islam & Selim, 2006c). To maintain quality, all question papers are prepared by anonymous experts under the supervision of an examination committee in the respective school and then printed and distributed to TCs by the controller of the examination. Analysis of examination results of different science courses revealed that students who passed the laboratory or practical component generally passed in other components of the course. In BOU, transfer of practical skills in the laboratory courses is highly emphasized. The current evaluation method seems less flexible, and it takes a long time to conduct examinations in the TCs and publish results thereafter.

Challenges and opportunities in specific science programs

Science at secondary and higher secondary

In the SSC program, there is a compulsory integrated science course, while in HSC, there are three courses such as Biology, Chemistry, and Physics for science group students. Enrolment in these two programs is very high in Bangladesh (Table 1). As BOU selects the best government and non-government high schools or colleges as tutorial centres, facilities for laboratory work and the expertise of tutors are supposed to meet the national standard. However, so far no study has been conducted on how effectively BOU students are learning practical skills in science courses at the secondary and higher secondary levels.

Agricultural sciences

Agriculture is the mainstay of the national economy of Bangladesh. Nearly two thirds of the population of this country is engaged in agriculture. Therefore, it is agreed that agricultural and associated education should create effective human capital which is capable of increasing profitability in agriculture enterprise and that it should be able to create social capital (Rahman et al., 2005). Considering the socio-economic conditions and high dropout rates in both SSC and HSC levels, the School of Agriculture and Rural Development of BOU introduced three challenging programs in agricultural sciences. These three programs have been designed to provide essential know-how, skills, and professional knowledge for various categories of people interested in generating self-employment through crop, fisheries, livestock, and poultry farming and in participating in technology transferring activity through working in government and non-government organizations. The B.Ag.Ed. program was designed to gradually produce nearly 300,000 teachers who teach agricultural science in secondary schools or madrashas, while the CLP and CPFP programs are intended for skilled youths who will engage themselves in small farming by self-employment. A survey report revealed that most of the students are coming from rural areas with an expectation to create their own farms or engage in teaching and extension works in agricultural technology transfer after completion.

Current media and delivery methods in these programs were found to be effective in transferring knowledge but a little less effective than expected by students in transferring practical skills (Rahman et al., 2005; Shah et al., 2005; Islam, 2008). There are several reasons behind this phenomenon. The most notable one, mentioned earlier, is that all TCs are not well equipped and the materials and transportation facilities provided by BOU for laboratory work and visiting farms are not adequate. Obviously, student freedom and individual choice are very limited by pre-scheduled tutorial sessions in the TCs. However, overall performance of students in these programs is rated satisfactory as a significant number of the students have started farming or have engaged themselves in teaching after completion of the CLP and CPFP and B.Ag.Ed. programs, respectively (Rahman et al., 2005; Shah et al., 2005; Islam, 2008).

Health science

The B.Sc. in Nursing has been designed for diploma nurses who have completed three years post-diploma training in the hospital. There are about 16,000 diploma nurses (mainly female) and only about 1,500 graduate nurses for more then 150 million people in the country. In Bangladesh there is only one graduate College of Nursing at Dhaka with a capacity of about 150 students every year. But due to a number of reasons only 50–60 nurses can graduate from the college each year for about 1,200 diploma nurses coming out of 38 nursing institutes (Numan, 2001a, 2001b). Much emphasis has been placed on applied subject areas such as English, Applied Sciences, Nutrition, Behavioural Science, Maternal and Child Health Nursing, Community Health Nursing, Nursing Research, Administration and Management, Teaching Methodology and Project in Senior Focus Elective. This program has been developed with 52%

practical components in comparison to 48% theory components, with 25 courses.

In health science courses, each theory and practical course is evaluated in terms of a total of 100 marks. Each course has two TMAs of 15 marks each that are usually practice-oriented. The marks distributions for theory courses are TMAs 30, theory 50, and objectives 20. Marks allocated for practical courses are further divided into three parts: 60, 20 and 20 for continuous assessment, which comprises periodical laboratory work, ward activities, two to four prescribed assessments related to the course, an experiment/job at the final exam and *viva voce*, respectively. However, evaluation of the practical/lab examination is done by two examiners (internal and external) during the examination. A student must get at least 50% in each component of the theory and practical courses to pass/ or complete a course.

Computer science and application

This program is designed to produce skilled manpower in the ICT sector, which is expanding very rapidly in Bangladesh. Hands-on practical training is offered to students in the well-equipped TCs in government and non-government computer training centres and universities. As it is a practice-oriented technical program, attendance in tutorial sessions was found to be high.

Problems and suggestions for improvement

Bangladesh Open University has taken up the challenge of introducing several undergraduate, diploma, and certificate programs in agriculture, health science and engineering through distance mode in this resource-poor developing country. The responses to these programs have been phenomenal, as they are very cost-effective and flexible for adult learners (Fig. 2). There are several reasons behind the success and cost-effectiveness in BOU programs. These are (i) as a public university BOU has access to any government and non-government infrastructure and facilities without cost or with nominal costs and can engage specialists from any institution for tutoring with a small honorarium; (ii) it broadcasts programs free of cost through government-owned radio and TV channels which have coverage throughout the country; (iii) the demand for higher and technical education in Bangladesh is very high, as due to seat limitations only 4% of students get the chance to enrol in universities after their HSC; (iv) the degree/diploma/certificate of BOU is accepted by all as equivalent to that of any other public university; and (v) the faculties of BOU are highly qualified and obviously equivalent to those of conventional public universities. In spite of all these opportunities, scepticism has remained as to the flexibility and effectiveness of current media for laboratory science and practical work. Most of the current media offer only one-way delivery with limited freedom and individual choice for learning. Therefore, innovative approaches are needed to improve the current situation.

Although Bangladesh is a developing country with 50% of the population living below the poverty line, it is surprising to note here that access to cellular phones has increased tremendously in this land within the past decade. Subscribers to mobile phone companies now total nearly 30 million citizens of the country, irrespective of their income levels. Survey results have indicated that 50–70% of BOU students have access to a mobile phone (Islam, 2008). Obviously, an acceleration in the speed of access to modern ICTs in Bangladesh will happen due to mass acceptance of the government's visionary plan to develop a digital Bangladesh by the year 2021. However, BOU does not yet offer any mobile learning facility which is considered as a credible, cost-effective component of blended open and distance learning provisions, adaptable to an institution's needs and situation. Recently, all government-run secondary and higher secondary education boards offered students the opportunity to obtain their results through an automated short message service (SMS) immediately after the results are published. This approach was found very successful in Bangladesh. Obviously, learning through mobile phone (mobile learning or m-learning) is a personal, spontaneous, “anytime, anywhere” way to learn and enlarges access to education for all. It reinforces learners’ sense of ownership of the learning experience, offering them flexibility as to how, when, and where they learn. Therefore, as a leading body in distance education, BOU should conduct necessary studies to include the mobile phone as a tool for teaching students at a distance. Similarly, the Internet is also expanding rapidly in the country, which offers an opportunity for electronic learning (e-learning). It is therefore reasonable to inititate Web-based information dissemination for admissions and examination schedule and result publication, as has already been done in conventional universities. Studies are needed to develop innovative approaches for teaching science subjects through electronic media such as the Internet (e.g., e-mail, Web-based delivery) and computer that would be flexible and offer more scope for student-teacher and student-student interactions.

Conclusion

Teaching science at a distance is undoubtedly a challenging task in the developing countries. This report discusses how a mega-university in a resource-poor developing country like Bangladesh teaches science courses in different disciplines at a distance using some older generation media such as print, radio, and TV broadcasts and face-to-face tutorials. Although these media are less flexible, they were found effective in transferring both theoretical and practical skills in a cost-effective manner in the context of Bangladesh. Review of several studies identified the problems in the current system and proposed alternatives to mitigate them by applying innovative approaches, which may have practical implications in research and effective teaching of laboratory science through open and distance learning in the developing countries.

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