SCIENCE EDUCATION IN THE OPEN UNIVERSITY: A NEW CHALLENGE FOR DEVELOPING COUNTRIES

by

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1. INTRODUCTION

It is indeed an irony that although the advancement of communication science in general and of micro-electronics in particular has turned the dream of teaching at a distance into a reality, science education has not yet been the main stay of the programmes of most of the Open Universities of the world which are employing the techniques of distance education. It is worthwhile emphasizing at the beginning that besides Open Universities, even conventional universities in some parts of the world including Australia, Canada, UK and USA use distance education and act as Dual Mode Institutions (i.e. on-campus mode for normal classroom teaching and off-campus mode for distance teaching for students sitting back in their homes or work-places). In fact, all State Universities in the USA have a Continuing Education/ Distance Education branch. Thus, while talking of Open Universities we shall use the term 'distance education' to include both Open Universities and Dual-Mode Institutions.

Before we discuss the tools and techniques of distance education for the rapid advancement of science education in the developing world, it would be appropriate to overview the technological innovation that made distance education possible. The overview is specially necessary in view of the fact that both public and private sponsors of distance education in the developing world have the need to understand the minimum technological commitments they have to make at a time when the concepts of 'information super-high way' and 'cosmic village' are gaining ground rather fast.

In some countries of the world, a rudimentary form of distance education was available even in the nineteenth century in the name of 'correspondence courses'. The printing press and the surface mail (the first commercial aeroplane was made available only in 1919) were the principal vehicles for communication; radio was also used occasionally for providing instructions. But the real breakthrough in distance education came through the introduction of what we call information technologies which, are, of course constantly being evolved to date; the harbinger of information technologies was a solid state semi-conducting device called 'transistor' which was discovered only in 1948. Soon after its appearance, it began to be commercially exploited. Many things happened; the electronic components started diminishing in size, their weights decreased, a large number of them could be packed in tiny volumes – they became portable. What was formerly a valve was replaced by a transistor – later, a large number of these and other semi-conducting devices were accommodated in a chip called IC (integrated circuit) – from IC came the transition to LSI (large scale integration) then to VLSI (very large scale integration) and VVLSI (very very large scale integration). The 'Solid State' became the state of living peoples, the world over. Today more than one hundred thousand of electronic devices can be packed into a micro chip only $1'' \times 1''$ large – obviously there is no messing around with connection of components through electrical wires! Connections are, of course, made through sophisticated etching techniques. As a result of further developments of micro electronics, for example the development of microprocessor in the seventies, mainframe computers were replaced by minicomputers and the minis in turn by the microcomputers. Today a PC (personal computer) on the desk top or even the laptop can do more things than could be done with mainframe computers occupying large rooms. This reduction of size, weight and also costs of electronic components was exploited rapidly in space technology, in communication and in the world of entertainment. Their use in the world of education came a bit late. But when it came, it came with unimaginable potentials. Very large numbers of students could now be taught at a distance and in a number of open learning ways through the despatch of printed and audio-visual materials. Later, through the development of photonics as already evinced in lasers and fibre-optics and its combination with electronics, the information technologies have been further perfected and are wonderfully poised for use in teaching through interactive distance communication. Today, the classroom has been turned into a virtual classroom and reality into 'virtual reality'. The technological developments are being highlighted here only to make the point that today distance teaching on large scales has been made possible only through the combination of electronics industry with education. Open Universities which are employing the techniques of distance education are often regarded as educational industries. Now let us look at the tools and techniques of the trade.

2. TECHNIQUES OF DISTANCE EDUCATION

The techniques for imparting distance education which are being used by different countries in varying proportions of technology mixes can be put together in what can be called Tables of Techniques (See diagrams after the references). Greville Rumble and Walter Perry have put together a short list of communication medium used in DE (Rumble *et al*, 1987) .

In connection with the use of techniques for distance education, two points must be emphasised strongly :

a) Although the same information technologies may be used by different countries, the subject matters taught are usually country-specific and situation specific. The same subject is presented differently in different lands because of cultural diversities. However, the courses in mathematics and science are fairly culture-neutral, the examples chosen could , however, be culture-specific. Thus, in order that materials prepared on culture-neutral subjects can be exchanged between different institutions of the world, the examples chosen should be as universal as possible.

b) It may not be prudent for every country to use the same technologies; the high technologies that are being evolved in the area of information technologies are paving the way for an information super highway all right but the developing-country traffic on this highway may not be without problems. The distance and open learning institutions in the developing countries cannot have access to these high technologies unless they are affordable and manageable. The reduction of cost of the high-tech equipment would go someway towards making them available to the wealthy few but the vast majorities of the rural population could not dream of having access to PC's and E-mail. Thus, the introduction of high-tech equipment in distance education may cause a greater in-equity in access to education. Education must not be brought to the level of a business commodity, after all. Moreover, besides affordability there arises the question of management of information modules and systems. It is one thing to buy them from business houses and use them blindly. It is quite another thing to know how they work and to be able to unpack some of these technologies for generation and dissemination of knowledge. The much talked of intellectual property copyright does not, however, encourage the sharing of technological know-how. Incidentally, it was pointed out both at the meeting of the standing committee of presidents (SCOP) of open universities organised by the ICDE (International Council for Distance Education) at Saratoga Springs, New York in October 1994 and also at the seventeenth world conference of the ICDE held at Birmingham in June 1995 that the intellectual property copyright is not really compatible with the clarion call to the peoples of the world to join the Information

Super Highway through the use of high-tech information system. While on the one hand, it is the demand of time that the peoples of the world are networked with each other as one single family sharing the resources of the same planet, on the other there should be substantial attitudinal changes in the minds of people living in the developed countries towards sharing the know-how of the new educational technologies on a global basis.

Talking of new educational technologies it was stressed by many that information by itself is not knowledge and that sophisticated technologies should not necessarily be equated with sophisticated education. What is most important is not the technology but the "message" that is conveyed through the technology. It is the quality of the message that determines the quality of education. And who can deny that printed material which constitutes the main stay of distance education can still be the deliverer of the most sophisticated of all messages in any given area of learning. This brings us to the greatest challenge to be taken up by the managers of distance education in the developing countries - namely the challenge of writing text books for distance education which are understandable on first reading. This challenge can be met not necessarily by the best scholars but rather by very innovative subject specialists who working with a team of instruction psychologists, producers of audio video materials, graphic artists etc. can come up with high quality teaching materials. Thus, as far as printed materials are concerned, two things are important- the quality of content and the quality of production. Again, in the area of production, new technologies which have substantial cutting edges and which do not directly concern the students, should be used with all readiness. The old-styled printeries are soon disappearing giving way to Desk Top Publishing (DTP). This new technique of producing printed materials has also made the task of editing and revising the text much easier. If one examines the powers of DTP combined with the use of A-V tapes and also the use of Radio and TV broadcasting as practised in developing and even in some developed countries, one is amazed to find out how much can be achieved with how little.

Talking in the context of Bangladesh Open University (BOU) which came into being in October 1992, no technologies other than DTP, A-V tapes and Radio and TV broadcasts have been used. The way in which BOU differs from other open universities is that in the BOU the emphasis on non-formal (i.e. non-credit) education especially in the areas of basic science and technology is almost as great as on formal education (degree diploma, and certificate courses). BOU has so far enrolled students in 5 formal programmes of study (Bachelor of Education, Certificate in English Language Proficiency, Certificate in Management, Diploma in Management and Secondary School Certificate). Radio broadcasts for 30 minutes every day in the evening and TV broadcasts for twenty-five minutes, in the evening, for five days in a week are being used to supplement the printed materials and more importantly in imparting non-formal science education in such areas as health & hygiene, nutrition, agriculture, poultry, livestock, energy, environment etc. The idea here is to raise the consciousness of people and their level of understanding in their own area of working so that they, without having any degrees, can also become partners of development. A list of formal and non-formal programmes of BOU programmes are enclosed in Appendices 1-2. Academic programmes of Allama Iqbal Open University in Pakistan (1993 1994) and of Universitas Terbuka in Indonesia (1995) are given in Appendices 3 and 4 respectively for indicative purposes.

The response of the public to open university education has been phenomenal. If numbers are at all any indicators, the number of enrolled students in the BOU which is only 5 years old stands at more than 70 thousand. The annual enrolment in this university already surpasses the annual enrolment of all universities in Bangladesh taken together. When the infrastructural developments of BOU are all completed, it is expected that BOU will soon find itself as a member of the mega universities of the world (with student enrolment of over 100,000). Incidentally, by the end of 1994, the number of students in Terbuka Universitas had reached 350,000; the enrollment in Allama Iqbal Open University, according to 1993 figures ranged between 150,000 and 200,000. In the Indira Gandhi National Open University (IGNOU), the total enrollment of the students in 1994-95 was 242,000 with an estimated annual intake of 91,400. The demands of the people should now be matched by appropriate logistics in place. The opening of a special channel for educational TV could boost the scenario especially for non-formal education.

The demands for distance education should not at all, eclipse the demands for education in conventional universities. Each year, large numbers of students passing out of the colleges sit for admission tests in the universities. The number of students that are admitted are in many cases less than ten percent of the number of students who sit for the admission tests. To cite one instance, the 1995 statistics for Dhaka University admission tests shows that an estimated 214 thousand students appeared in the tests for an intake of twelve thousand students in different programmes of study - the percentage of the left-outs being about 94%. Not only do these students get disappointed, their frustration slowly builds up a social unrest. These problems can be solved to a large extent by using the concept of dual mode institutions introduced earlier in Australia, USA (Markowitz, 1990), Canada (Knapper,1992), South Africa (Higgs, 1995) and many other countries.

The audio and video teleconferencing systems are just beginning to enter into the educational arena of even the developing countries. Both single and dual mode institutions can use them for meaningful real time instructions between the teachers and the learners and may compensate for the absence of face to face teaching. With reduction of costs of the electronic systems, audio and video teleconferencing could become a normal activity of the dual-mode institutions and the real class room could turn into a virtual classroom.

3. ROLE OF DISTANCE EDUCATION IN THE RAPID ADVANCEMENT OF SCIENCE EDUCATION IN THE DEVELOPING WORLD

Now that we have discussed in some detail the tools and techniques of distance education in the contexts of both Open Universities and Dual Mode Institutions we are now in a position to address the needs and functions of such universities for advancement of science education in the developing world.

One more classification would be in order. Since mathematics happens to be the language of many of the branches of science, we shall use the term science education to include mathematics education as well.

The problems inherent in the teaching of science at secondary, higher secondary and tertiary level in the developing world are more or less known; these are mainly (a) lack of competent science teachers (b) high student-teacher ratio and (c) lack of meaningful laboratory facilities. To top all of these is the lack of a strong political will of the government to use science and technology as an instrument of change. Let us now see how each of these problems can be solved through the use of distance teaching methodologies. The central character in a good science education system is a strong science teacher who should know not only science but also how to teach. Thus, the problem of teacher training in science and mathematics especially at the secondary and higher secondary level of education should be given sufficient thought. The problem is further accentuated by the fact that many persons take to teaching only as a last resort for the earning of a livelihood. And in most of the developing countries there is no centralised recruitment procedure which would assess the teaching aptitudes and potentials of the applicants for the teaching of science. The authorities realise only after a few batches of students have been used as guinea-pigs, that the teachers need a thorough training both in terms of knowledge of the subject as well as the pedagogy of teaching. But then the problem is that no matter how ill-equipped the science teachers are, they cannot be sent to conventional teaching institutions for purposes of reorientation as this would call for a supply of substitute teachers. The training has to be provided 'in situ'. And this is possible only through the employment of distance teaching technique for preparation of special packages for teacher training in science. But what should these packages consist of? Obviously the packages should contain printed materials (which should aim at updating the scientific knowledge of the teacher in a certain field) and audio-video materials which should demonstrate clearly how a subject should be taught in a very interesting manner.

As is known, there has been an explosion of information an almost every field of science and it is becoming virtually impossible to keep pace with the latest scientific developments. Thus, the emphasis should be on the fundamentals of a subject and the teachers of science should be strongly encouraged to build on these fundamentals. The success of a science teacher would be judged not by the amount of scientific information he or she has been able to disseminate to the students but by whether as spirit of enquiry has been enkindled within the students' mind. The most important thing in science teaching is to create an ability of the student to ask the right question at the right time. Thus, while writing the printed material part of the packages for science teachers, utmost care must be exercised by the writers in order to ensure that science teachers through their teaching can help the student develop an analytical frame of mind. No wonder, students who have been able to do so do quite well even in a number of non-laboratory jobs of social significance.

The purpose of the audio-visual part of the distance education for science teachers should be to highlight to the teachers, how much can be done with how little. True, science is not just talking; science is 'doing things', science is verifying the way nature behaves. So, one needs some minimum gadgets to understand the doings of science. The pity is that even very simple kits like test tubes, magnets, power supplies, simple measuring equipment are not available in the great majority of schools in the developing world, colleges and universities are not doing well either. Scientific apparatuses existing therein are in many cases just an apology for scientific equipment. Urgent steps must, of course, be made to correct the situation. But, in the meanwhile, teachers must be trained to do more with less. And this is exactly where audio-visual tapes (suitable for public broadcasting as well as for viewing at home or in the tutorial centres of Open Universities) can be employed in order to demonstrate how the meagre material resources already existing in the students' own home work environment can be exploited in order to explain some of the established findings of science. For examples, a pond with which students in many parts of the developing world are so familiar can be shown to be a living laboratory containing some of the local flora and fauna. Many biological lessons can be driven home to the students by simply analysing the happenings in the pond. A well prepared video tape depicting real-life situations in the pond can be a source of inspiration to the teachers and students; even the walking of insects on the surface of water can provide a good example of the surface tension of water. Nature abounds with such exhibits. An example from the physical science would make the point even clearer. We all know that the emission of sound is preceded by some vibrations. For this, a tuning fork is usually seen as an ideal kit. But the lack of it should not demoralise the science teacher. He can use other means; a mango seed which children in the village use as a whistle will just do the trick. When a child blows through the narrow hole in the mango seed, the air column in the hole vibrates resulting in the emission of sound. The beauty of the video tapes is that when one child sees another use the mango seed as a whistle in the video, he feels he is doing it himself. Thus, the science teacher should be taught how to use ingenious methods and materials in order to arouse the curiosity of students in science. Such a philosophy may not always work at the higher levels of education (e.g. University level) where the emphasis could be on the accuracy of measurements upto a few places of decimals. But as far as science teaching at the school and college level is concerned, there are many areas where the emphasis is not so much on accuracy as it is on the demonstration of the working of science in practical life and environment. All one needs to know here is that things work out in the right direction.

Innovation in the teaching of mathematics also seems to be in high demand. The present method of teaching mathematics throughout the developing world is a very dry and uninteresting one. It just fails to attract the young boys and girls to the world of mathematics which is indeed a very fascinating one. Students learn mathematics mostly because they have to pass the examination (mathematics is either a minor or major subject for many undergraduate students). If only they could be made to understand the very natural linkages of mathematics with inert and living matter, mathematics could be just fun and delight. And one does not have to toil too hard to create interest in the subject; mathematics is everywhere; all what a mathematics teacher has to do is to find out the connections of mathematics to life and environment and to demonstrate those to the students in an appealing manner. Audio-visual methods used in distance education could be of particular value in this connection. Let us consider, for example, a video of a family at the breakfast table. The teacher who could act as the father or the mother could ask the college going son or daughter to look at the top surface of the milk in a long glass. It would, of course, be circular. Now as the glass will be titled, the surface would be elliptical. On more and more tilting of the glass, the ellipse would be highly eccentric and would be drawn out into a pair of straight lines. The teacher could then say that this is a practical demonstration of a mathematical result namely that a highly eccentric ellipse degenerates into a pair of straight lines. Thus, mathematics can be taught though fun and delight.

So far we have discussed the training of teachers of science (including mathematics) using the techniques of distance education. We should now address the issue of credit based undergraduate and graduate programmes in different branches of science which are usually pursued in conventional universities. This issue immediately invites a question about laboratories.

4. WHAT SHOULD BE THE LABORATORY ARRANGEMENTS FOR TEACHING SCIENCE IN OPEN UNIVERSITIES ?

Teaching science without the students performing laboratory experiments is unthinkable. It is usually thought that there is no substitute for hands-on experience. But the organisation of formal laboratory facilities could become quite a difficult task for an Open University. Further, if the student is required to come to the Open Universities' own laboratory quite frequently then the openness of the Open Universities would be less and less manifest. What then is the way out?

An interesting idea for science teaching in Open Universities would be the following: Open Universities need not set up their own laboratory facilities; they could enter into collaborative agreement with conventional universities to the effect that students of an Open University could use the laboratory facilities of the conventional ones during the long holidays of the latter. Such arrangements would not only foster a spirit of collaboration between Open Universities and conventional universities but also ensure the optimum utilisation of the existing resources of a country. The only problem with this kind of solution is that students would be required to do hands-on work rather intensively during a certain period of time instead of distributing the work through out the year. The Open University of Sri Lanka has been adopting such a procedure for the practical work of its B.Sc. (Engineering) students. The programme is one of the strong points of Sri Lankan Open University. Interestingly enough, the University has also set up its own laboratories where the working students have to come and work intensively for a continuous period of time.

The formal credit based programmes of BOU are at present only in the areas of computer application and nursing. The non-formal science programme which forms a strong point of BOU extends in many areas of technical significance.

The B.Sc. programmes of IGNO has been launched from the year 1992. It is based on credit system (1 credit = 30 study hours) and has been launched on a pilot basis in 30 study centres. (see Appendix 7 for the courses offered in the B.Sc. programme). The study centres are generally located in existing educational institutions an normally function on all holidays and Sundays and in the evenings of working days.

One can think of some variations in procedure for conducting laboratory work for the science degrees. UK Open University has devised its own home-based experimental kit which contains some handy equipment as well as some chemicals. Students can do the practical work sitting back in their homes or work places. Students buy a kit box when they are registered with the Open University. The kit box costs quite a bit and hence many poor countries of the developing world may not find it advisable to introduce such kits unless they are cost effective.

The other approach would be the computer simulation of practical work. Although students in the developing countries do not generally own computers, the latter are becoming more and more available in the educational institutions. Open universities of any developing country may introduce computers in the Regional and Local study centres of that country. Already, microcomputers have found their way into the student's laboratory courses and many experimental arrangements have been interfaced with microcomputers. The latter have assumed the role of a numerical laboratory and have emerged as a third method for investigating nature complementing traditional experimental and theoretical work. Although different softwares have already been developed depending on the nature of experiments, the choice as to which experiments should be linked with computers and which should be performed in the conventional way depends on the convenience and taste of the laboratory teachers. But some guiding principles for involving computers would nevertheless be desirable, although these may not be agreed upon by all scientists. However, the point on which they may not disagree is that the computer is an excellent tool for simulating complex events which are rather difficult to visualise. There, computations would be really experiments. For example, fluid dynamics is a field in which numerical computation can play a great role due to the non-linearity and hence analytic intractability of the governing equations. Here, computer displays not only make comparisons with laboratory data much easier but are also useful in getting at the fundamental physics of wave interactions, surface instabilities, vortex generation and other phenomena that may be involved in the flow. Displays allow the enormous amount of raw data that a numerical experiment produces within the central processing unit of the computer to be communicated to the researcher in the form that the human visual system and the brain are best adapted to appreciate. The numerical simulation of a gas jet penetrating a dense medium is a good example and can be dealt with in some detail in order to bring home the point that the environment created by computation and graphics can simulate complex phenomena.

Judging from the above examples, one of the principles for computer applications in science teaching could be that such applications should be more profitably made to complex situations which are intractable or to those situations where a conceptual visualisation of a phenomenon is difficult to obtain. In spite of the advocacy made for computer simulations of experiments, the insistence on some forms of hands-on experience must, however, be made, wherever possible.

5 (a) NON-FORMAL SCIENCE EDUCATION

So far we have dealt with the training of science teachers and also with the imparting of credit based formal science education. But a great advantage of the Open University system is that it can address itself to the very simple scientific and technological needs of the vast majorities of the people living in the rural areas. Today, radio has become a household affair and TV sets are also penetrating into the community centres of many developing countries. Keeping this in mind, open universities can broadcast useful information of a sort which will benefit the people very directly in the areas of health and hygiene, nutrition, agricultural practices, , poultry and livestock, pisciculture, forestry, fuel and energy, environment etc. Here, the idea could be to bring the University to the people and transfer some valuable knowledge and skill to them in the work which they have doing over hundreds of years. If a little extra knowledge and skill improves their own work, and if production of things increases, then they could be rightly called 'partners in development'. Indigenous work of the womenfolk could also be encouraged through the use of media technologies.

Another advantage of the non-formal science education is to promote the public understanding of science. Politicians, bureaucrats as well as managers of science and technology in almost all parts of the developing world need to understand how the culture of science should be managed and also how science and technology can be used as a powerful instrument for change. Today many video tapes are available around the world which be used for conveying the public utility of science as well as for making the state-of-the art presentations in many of the frontier areas of science and technology eg. Micro-electronics, bionics, genetic engineering, the human brain etc.

The Commonwealth of Learning at Vancouver, the UNESCO at Paris and the ISESCO at Morocco could be requested to act as some sort of information clearing house for the educational videos that have been prepared so far. These tapes could be used by the countries of the developing world directly or with some adaptation if there is at all any cultural shock encountered in the videos.

5 (b)THE BANGLADESH EXPERIENCE

From the point of view of the media, Bangladesh has the advantage that it has only one national language, Bengali. So, the language problem which exists for many large countries with a multi-lingual population does not exist here. A systematic presentation of science programmes on Bangladesh Television is not of distant origin. Towards the late seventies, a fortnightly science series called 'Bigyyan Bichitra' (The Varieties of Science) was introduced. The largest listener groups for this programmes were students and the non-specialist public. This series continued for about 6 years and I had the opportunity of conducting more than 100 programmes on this series. After an intermission of about a year, this series was replaced by another titled 'Notun Diganta' meaning New Horizons. This 45-minute fortnightly programme continued till recently. As is implied by its title, this series aims at presenting the latest frontiers of science in simple commonplace terms. In spirit and content, it was very similar to the science programme "OMNI" conducted on American television.

The most astonishing experience that I have bad while conducting the series is that we usually underestimate our public. When I conducted my first science programmes on TV, I had the fear that most people would simply not be interested in this. Coming from Bangladesh, a land traditionally known for its love for songs and poetry, I thought the audience might switch off their sets when the science programme would come on. But to my utter surprise, I discovered that I was wrong. The general public did like the science programmes and the appreciation from all walks of life was on the increase. I occasionally asked the viewers 'Why do you' like this TV series'? The answer I got was mostly this 'We are living in an age of science. But we did not get any exposure to modern science in our life. So what can be more rewarding than to watch a science programme on TV and learn about a topic which touches our life and environment?' Such reactions obviously give the impression that the general public do have interest in science and it is the responsibility of the TV performer to see that this interest is not only sustained but also gradually enhanced. This calls for meticulous attention to a number of aspects, the most important of these being the art of presentation.

In order to create a core of articulated performers for the visual media, one has to try the same performers and the same programme producers a number of times so that they can watch and polish their performances. Thus, over the last few years, there have been in Bangladesh a number of speakers who can communicate well with the masses in their own areas of specialisation. This certainly can be termed as a direct dividend of the information technologies.

6. SHARING GLOBALLY THE SAME TEACHER THROUGH THE INFORMATION TECHNOLOGIES

Now the information technologies can transfer the great men of science in both the developed and developing countries to people irrespective of their geographical locations. Once an area of science education is chosen the task would be to select some of the best teachers in the field and have their lectures embodied either in the audio-video tapes or on the internet which can be globally viewed. The task would be to frame a syllabus and choose the best teachers in the world to produce the written materials and record the lectures on audio-video tapes and also arrange for transmission though internet. In a given country the Open University could act as a clearing house for sharing this information between different educational and research institutions in the country whose information technologies may not have been well-developed. At the present moment there are two possible inhibitions in many minds which are presumably preventing the global use of a science teacher. The first of these is that many might think that it would be a one way flow namely that the developed countries of the world would be teaching the developing countries all the time. This is not true. Although the developed countries have greater facilities and consequently higher status of Science and Technology teaching, the fact remains that in many areas of learning namely Mathematics, Statistics, Physics etc. there are outstanding science teachers in the developing countries also. It is just that they have not had any opportunities so far to open up before the world. Information technologies would give just that opportunity. In fact, through a global search, the flow of wisdom would be two ways. Otherwise, God would be West centred and He is not. The second inhibition is about cultural infiltration. Many fear that even a science teacher from advanced West could through his information media exposures export alien culture. There may be an element of truth in it. However, the problem is not beyond combating. One can always make local interventions and make the subjects as culture-neutral as possible.

While talking of cultural invasion, a point that plagues my mind and possibly that of many others is why such question of infiltration should arise only in the world of education and research and not in the world of entertainment in which figures like Michael Jackson, Madonna and many others are reigning supreme on a global basis.

It is about time that we face these questions and start sharing teachers between the developed and the developing countries. There is a question of language. But as the world is structured today, English has a great potential for being used globally. Thus with all the information technologies of dubbing, subtitling or even making interventions in local languages, the language problem is not an insurmountable one. Thus without dishonouring the general thesis that the mother tongue is the best medium for imparting science education of all kinds, great science teachers should be shared among the developed and developing countries to achieve to remove inequities of knowledge between nations.

7. CONCLUSION

In conclusion, one must point out the future challenges which have to be faced by the techniques of distance education in meeting the demands of science education in the developing world. 'Large numbers' is just one challenge, other challenges are more of a social and conceptual type. The post second world societies in many countries have undergone traumatic changes in terms of both the speed and direction of life. Rapid technological developments have further accentuated these changes. The social changes have, in turn, brought about paradigm shifts in education. Universities are no longer mere ivory towers. Time demands that universities undergo structural changes in order that educational needs of the society are met. Today, every section of the society is coming up with its characteristic needs; the industries need special training for skill-development of its workers, the manufacturing companies want special educational programmes for the promotion of their products and processes, the private sector has demands for packaged educational programmes in such areas of social demands as health, hygiene and nutrition; poultry livestock and fisheries, fuel, environment etc. People want science education in any subject area that affects their life and environment. It is now also the growing demand of the people that they can have access to different types of science education at different ages; all this would need a flexibility in educational methodology. Unfortunately, the traditional universities, because of the rigidity in their management structure, have not yet been able to demonstrate this flexibility. In this connection I feel tempted to reproduce a humorous remark which was made by Dr. Frank Newman, President of the Educational Commission of the USA at the seventeenth conference of the International Council of Distance Education at Birmingham in June 1995: "Reforming a conventional university is as difficult as removing a grave; there is no internal help." This remark only highlights the paradigm shifts in education that have to be taken note of by all educational institutions; the techniques of distance education have made the shift possible. Flexibility in the learning process is the cry of the society now. Distance and dual-mode institutions must respond to this social call through the use of affordable information technologies; while using technologies for distance education, the only caution they should remember is that it is the message for the society which is the most important thing and not the conveyer of the message.

Thus, the technologies of the Open University system should be used as very powerful tools for creating an educated citizenry (reasonably conversant with science and technology) in all the developing countries of the world. This is indeed a challenging task for the developing world which must be met in order that it can use science and technology as an instrument of change and acquire a respectable place in the committee of nations in the twenty first century.

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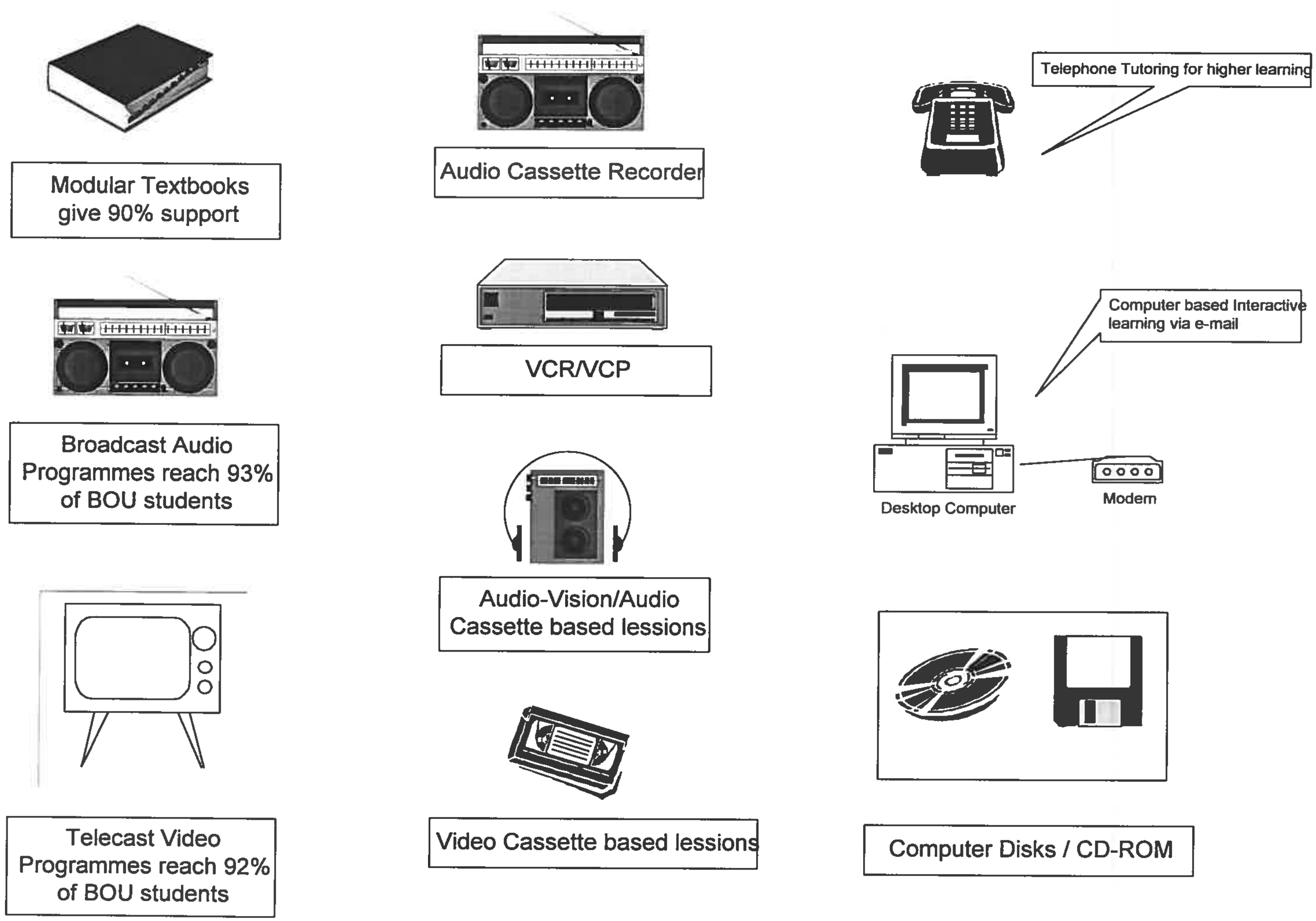
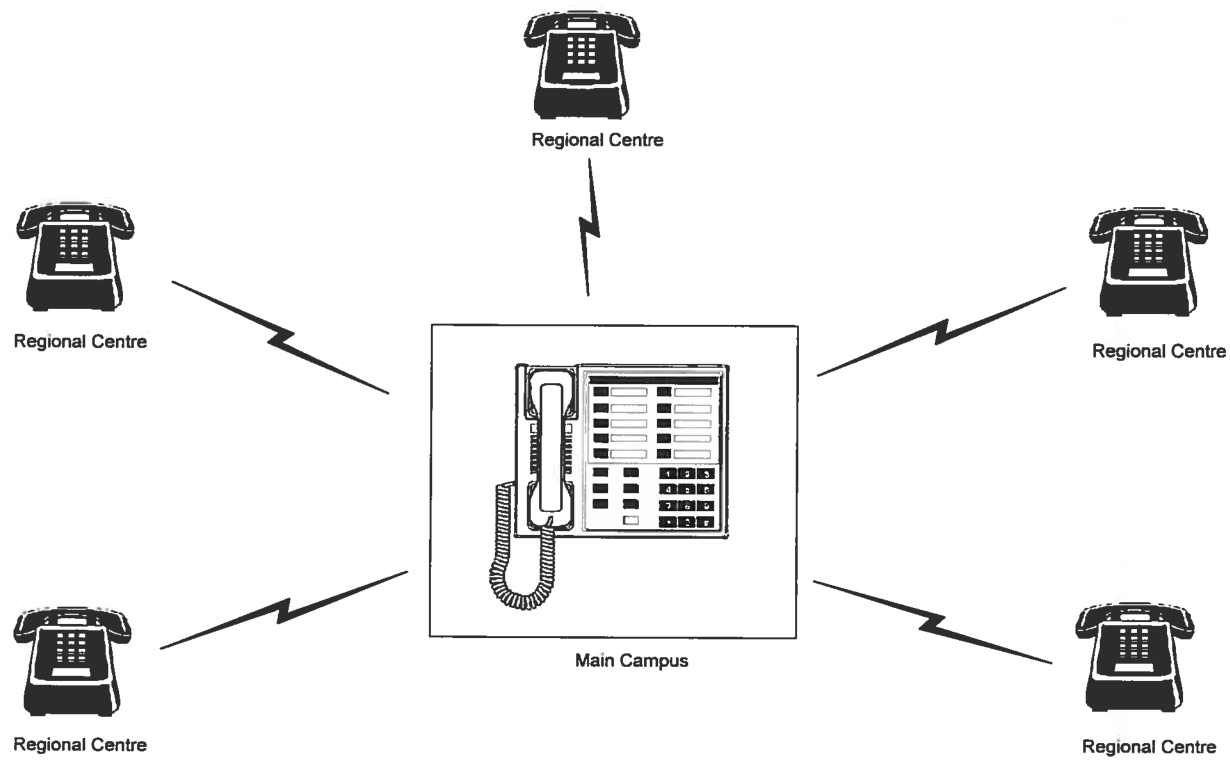
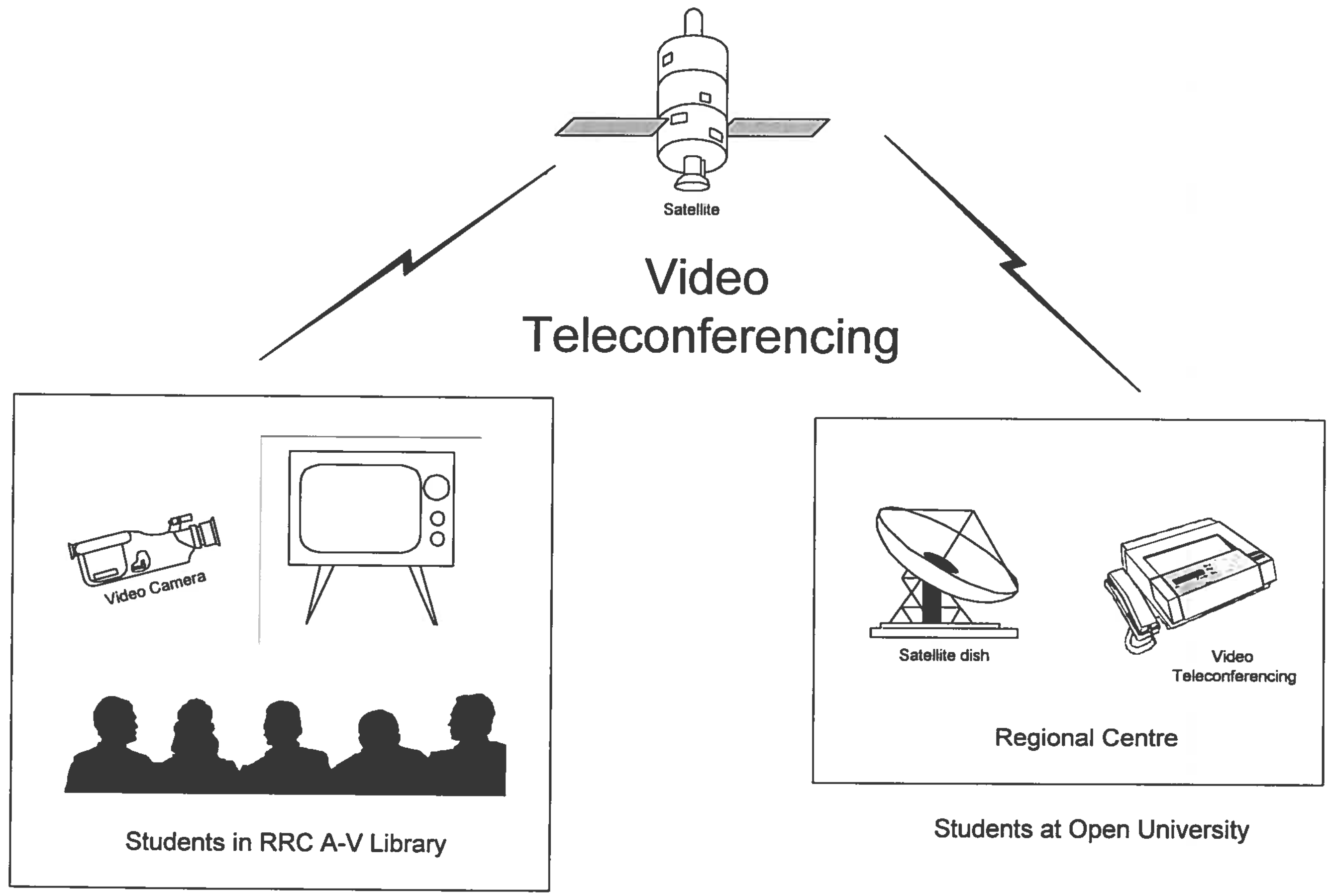
Learning in home-based environment



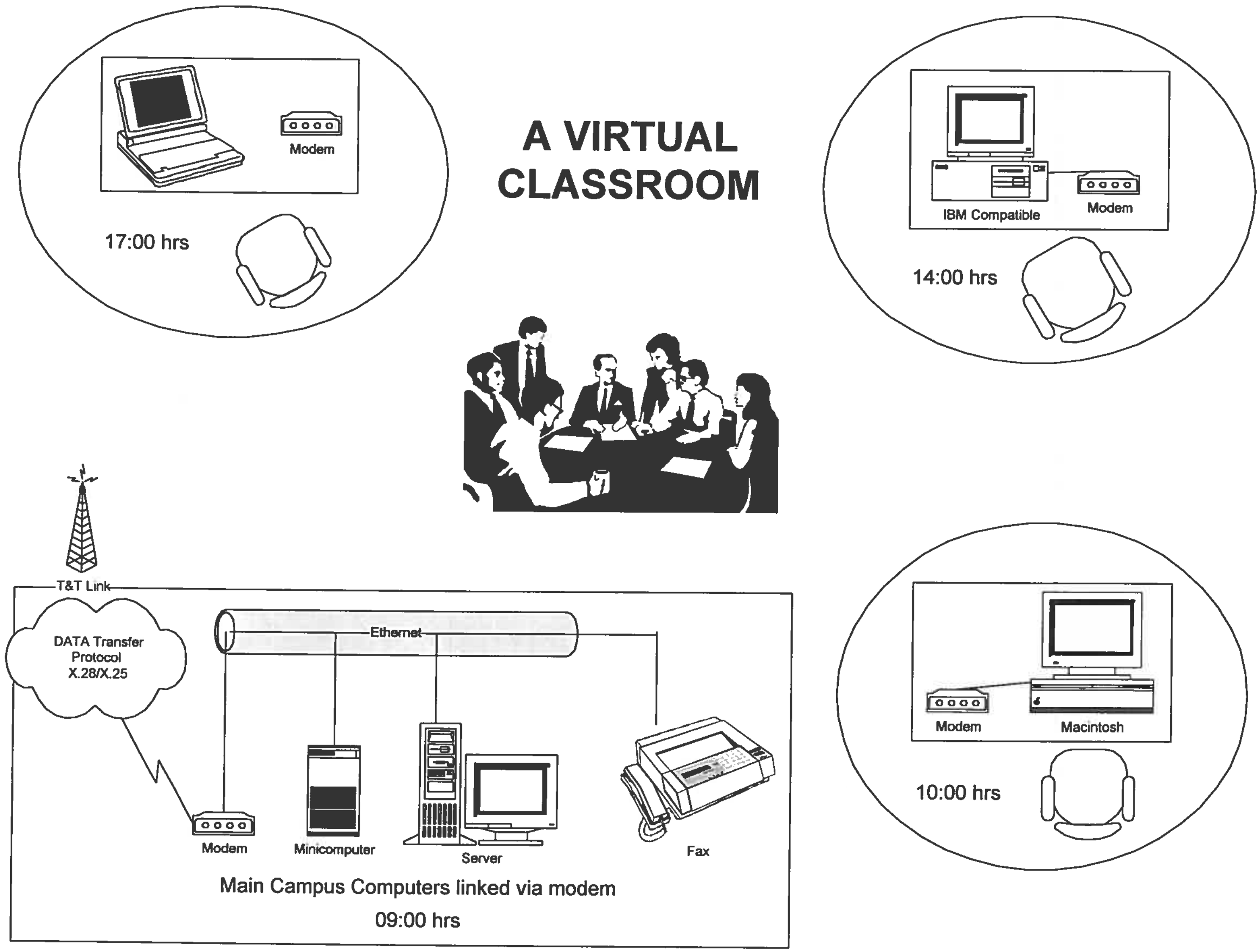
Regional Centre Based Learning Environment



Audio Teleconferencing



Reginal Centre Based Learning Environment


A VIRTUAL CLASSROOM
Modem
17:00 hrs
IBM Compatible
Modem
14:00 hrs
Modem
Macintosh
10:00 hrs
T&T Link
DATA Transfer Protocol X.28/X.25
Ethernet
Modem
Minicomputer
Server
Fax
Main Campus Computers linked via modem
09:00 hrs

Appendix 1

List of Formal Programmes of Bangladesh Open University

School	Programme	Level	Year of Launching
Open School	Secondary School Certificate (SSC)	*Cert.*	Jan, 1995
	Higher Secondary Certificate (HSC)	*Cert.*	July 1996
School of Agriculture and Rural Development	Certificate in Agro-processing	*Cert.*	July, 1996
	Poultry and Livestock	*Cert.*	July, 1996
	Pisciculture and Fish Processing	*Cert.*	Jan, 1997
	Certificate in Agriculture	*Cert.*	Jan, 1997
School of Education	Bachelor in Education	*Bach.*	July, 1992
	Certificate in Education	*Cert.*	Jan, 1992
	Master in Education	*Master*	July, 1997
School of Social Science, Humanities & Language	Bachelor of Arts	*Bach.*	July, 1996
	Certificate in English Language	*Cert.*	Jan, 1994
	Proficiency (CELP)	*Cert.*	Jan, 1996
	Certificate in Arabic Language	*Batch.*	July, 1996
	Proficiency (CALP)		
	Bachelor in English Language Teaching (BELT)		
School of Business	Diploma in Management (DM)	*Dip.*	Jan, 1995
	Certificate in Management (CM)	*Cert.*	Jan, 1995
	Bachelor of Commerce	*Bach.*	July, 1996
School of Science & Technology	Diploma in Computer Application	*Dip.*	Jan, 1996
	Bachelor of Nursing	*Bach.*	July, 1996

Appendix 2

List of Non Formal Programmes of Bangladesh Open University

School	Programme	Year of Launching
Open School	Basic Science & Mathematics	1992
School of Agriculture and Rural Development	Agriculture Pisciculture and Fish Processing Afforestation & Horticulture Poultry & Livestock	1993
School of Business	Bank Loans & Marketing Management	July, 1995
School of Business and School of Agriculture & Rural Development	Preparation & Preservation of Food	Jan, 1996
School of Science & Technology and School of Business	Health, Nutrition and Population Studies	Jan, 1994
School of Science & Technology and School of Agriculture and Rural Development	Irrigation Management	Jan, 1996
School of Science & Technology and School of Education	Maternity & Child Care	Jan, 1995
School of Business and School of Education	Environment	July, 1995
School of Social Science, Humanities & Language and Open School	Religion & Ethics	Jan, 1995

Appendix 3

Programme Offerings in Allama Iqbal Open University, Pakistan

S. No.	PROGRAMME(S)	S. No.	PROGRAMME(S)
1.	Integrated Functional Literacy Programme	2.	Basic Functional Education Programme (BFEP)
3.	Primary Education (Abridged)	4.	Matric (Women)
5.	Primary Teachers Certificate (PTC)	6.	Primary Teachers Orientation Course (PTOC)
7.	Certificate in Teaching (CT)	8.	Daftri Urdu Certificate for Federal/Provincial Government Officers
9.	Elementary Arabic	10.	Arabic Teachers Training Course (ATTC)
11.	Agricultural Courses (Functional Non-Credit)	12.	Non-Credit Functional Courses (Industrial Arts)
13.	Intermediate	14.	B. A.
15.	B. A. (Mass Communication)	16.	B. Com.
17.	B.B.A.	18.	B. Ed. (General)
19.	B. Ed. (Arabic)	20.	M. A. (Special Education)
21.	M. A. (EPM)	22.	M. A. (TEFL)
23.	M. B. A.	24.	M. Sc. Pakistan Studies
25.	M. Ed. (Special Education)	26.	Certificate in Librarianship
27.	Post-garduate Professional Certificate in Business Administration	28.	Post-graduate Diploma in English Language Teaching (ELT)
29.	Diploma in Teaching as an International Language	30.	Diploma in Special Education
31.	Diploma in TEFL	32.	Diploma in EPM
33.	Diploma in Computer Applications (DCA)	34.	Diploma in Computer Maintenance (DCM)
35.	M. Phil Iqbaliat	36.	M. Phil Islamiat
37.	M. Phil Urdu	38.	M. Phil (Education)

Appendix 4

Programme Offerings in Universitas Terbuka, Indonesia

Faculty of Education

1) Degree Programme (S-)

Teaching Bahasa Indonesia; Teaching of English; Teaching of Mathematics; Teaching of Chemistry; Teaching of Biology

Each Programme is designed for teachers possessing D III diploma in a relevant subject.

2) Diploma II (D II)

Teaching Bahasa Indonesia; Teaching of English; Teaching of Mathematics; Teaching of Chemistry; Teaching of Biology

Each Programme is designed for teachers possessing D III diploma in a relevant subject.

3) Diploma II Programme for Elementary School Teachers including physical education teachers

This programme is designed to upgrade teachers so as to enable them to gain qualification equivalent to D II Diploma. There are two types of students, Government funded and self funded.

4) Diploma II Programme for teachers of religious education in elementary schools

This is a joint programme designed by UT, the Department of Religion at the University of Satyawacana, the Hindu Dharma Institute, and the College of Religion of Buddha Nalawa.

5) Diploma III Programme

Teaching of Mathematics; Teaching of Science

Faculty of Economics

1) Degree Programme (S-1)

Economics and Development study; Management.

2) Diploma II Programme (D II)

Supervisory in Industry and Services.

Faculty of Social and Political Sciences

1) Degree Programme

State Administration; Trade Administration; Development Administration.

2) Diploma II Programme

Taxation.

3) Certificate Programme

English; Computer and Information Technology; Enterpreneurship.

Faculty of Mathematics and Natural Sciences

1) Degree Programme (S I)

Applied Statistics; Mathematics.

2) Diploma III Programme in Agriculture

Agriculture extension Worker

3) Certificate Programme

Statistics Expertise

Appendix 5

Courses offered in the B.Sc. programme of IGNOU.

PHYSICS COURSES:	
Elementary mechanics	2
Oscillation & Waves	2
Laboratory - I	4
Mathematical Methods in Physics - I	2
Mathematical Methods in Physics - II	2
Thermodynamics & Statistical Mechanics	4
Electric and Magnetic Phenomenon	4
Laboratory - II	4
Optics (Physical & Laser)	4
Electrical Circuits & Electronics	4
Advanced Mechanics	2
Quantum, Atomic and Molecular Physics	4
Laboratory - III	2
Radio & TV Repairing (Application Oriented Course)	8
Total	48

CHEMISTRY COURSES:	
Atoms and Molecules	2
Inorganic Chemistry	4
Laboratory - I	2
Physical Chemistry	4
Organic Chemistry	4
Organic Reaction Mechanism	4
Laboratory - II	2
Laboratory - III	2
Biochemistry	4
Spectroscopy	4
Laboratory - IV	4
Laboratory - V	4
Analysis of Soil & Water with Emphasis on Pollution Control (Application oriented Course)	8
Total	48

LIFE SCIENCE COURSES:	
Cell Biology	4
Ecology	4
Genetics	4
Laboratory - I	4
Physiology	4
Developmental Biology	4
Taxonomy & Evolution	4
Laboratory - II	4
Animal Diversity - I	4
Animal Diversity - II	4
Laboratory - III	4
Plant Diversity - I	4
Plant Diversity - II	4
Laboratory - IV	4
Total	56

MATHEMATICS COURSES:	
Calculus	4
Linear Algebra	4
Mathematical methods for Sciences	4
Basic Algebra	4
Geometry	4
Abstract Algebra	4
Advanced Calculus	4
Differential Equations	4
Real Analysis	4
Numerical Analysis	4
Probability & Statistics (Application Oriented Course)	4
Operations Research (Application Oriented Course)	4
Total	48

Note: The total number of credits to be cleared is 96. 24 credits (8 credits in Language, 8 credits in Foundations in Science and Technology and 8 credits in Foundations in Humanities and Social Science) are compulsory. The student can exercise his choice for 72 out of 96 credits. For example, a student who wants to specialise in Physics can take all the 48 credits in Physics and 24 (72-48) credits in Mathematics. Doing 48 credits in a particular discipline will be considered equivalent to doing a major in that subject.