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New Information / Communication Technologies:
Their Role In Education

By

Kiran Karnik
CONFERENCE ON THE IMPACT OF NEW INFORMATION TECHNOLOGY ON BROADCASTING, NATIONAL ECONOMIC AND SOCIAL STRUCTURES
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NEW INFORMATION/COMMUNICATION TECHNOLOGIES
THEIR ROLE IN EDUCATION

By
Dr Kiran Karnik,
Director, Consortium For Educational Communication
India
NEW INFORMATION/COMMUNICATION TECHNOLOGIES : THEIR ROLE IN EDUCATION

Kiran Karnik*

The Technologies

Over the last two decades or so, a number of new technologies and techniques have resulted in the creation of a stream of products and services that may be classified as "new" information/communication technologies (NICT). A distinguishing attribute of these is their often synergistic (sometimes converging) relationship with each other, and a special feature has been their very rapid spread across the globe and within each country. For the purpose of this paper, we include the following as technologies pertinent to NICT:

- photocopying
- video recording
- facsimile
- "personal" computers (PCs) and computerised data bases
- E-mail and computer networks
- satellite telecommunication, including mobile communication, and satellite broadcasting
- receiving equipment for satellite transmissions

Some of these (e.g., photocopying) have been in use for many years. What is "new" is their present form, spread/accessibility and user-friendliness. Table 1 summarises this aspect.

*Director, Consortium for Educational Communication, NEU Campus, Aruna Asaf Ali Marg, New Delhi 110 067.
### TABLE 1

<table>
<thead>
<tr>
<th>TECHNOLOGY</th>
<th>PRESENT (NICT) FORM/FEATURES</th>
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<tr>
<td><strong>Photocopying</strong></td>
<td>- Lower costs, colour capability</td>
</tr>
<tr>
<td></td>
<td>- Wide-spread</td>
</tr>
<tr>
<td></td>
<td>- User-friendly</td>
</tr>
<tr>
<td></td>
<td>- Higher throughputs</td>
</tr>
<tr>
<td><strong>Video recording/Playback</strong></td>
<td>- Cheaper, reliable</td>
</tr>
<tr>
<td>(home use)</td>
<td>- Programmable (with timer)</td>
</tr>
<tr>
<td></td>
<td>- Standardised format (VHS)</td>
</tr>
<tr>
<td><strong>Facsimile</strong></td>
<td>- Lower costs, plain paper</td>
</tr>
<tr>
<td></td>
<td>- &quot;Intelligent&quot; features and user-friendly</td>
</tr>
<tr>
<td></td>
<td>(including dial-up at fixed times, storage, multiple destinations, etc.)</td>
</tr>
<tr>
<td></td>
<td>- Synergy with expanding telecomm network</td>
</tr>
<tr>
<td></td>
<td>- Synergy with PCs (fax card)</td>
</tr>
<tr>
<td><strong>Personal Computer</strong></td>
<td>- Much lower costs, user friendly</td>
</tr>
<tr>
<td></td>
<td>- Becomes a communication terminal with addition of a modem</td>
</tr>
<tr>
<td></td>
<td>- Synergy with facsimile technology</td>
</tr>
<tr>
<td></td>
<td>- High storage, easy retrieval of data</td>
</tr>
<tr>
<td></td>
<td>- Platform for multi-media</td>
</tr>
<tr>
<td></td>
<td>- Provides - via telecomm network - access into data bases or networks</td>
</tr>
<tr>
<td></td>
<td>- Remote computing</td>
</tr>
<tr>
<td></td>
<td>- Desk-top publishing (DTP)</td>
</tr>
<tr>
<td><strong>Computerised data bases</strong></td>
<td>- Vast storage capabilities</td>
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<tr>
<td></td>
<td>- Easy and user-friendly access</td>
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<tr>
<td></td>
<td>- Low/no cost for data</td>
</tr>
<tr>
<td></td>
<td>- Wide range of fields/subjects</td>
</tr>
<tr>
<td></td>
<td>- Synergy with PCs, telecomm network, VSATs</td>
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TECHNOLOGY PRESENT (NICT) FORM/FEATURES

E-mail
- Low cost, wide availability
- User friendly
- Bulletin boards, special interest groups
- Synergy with PCs, telecomm networks

Satellite telecommunication
- High power satellites
- Global reach, including point to multi-point
- Digital/analog data
- New techniques for optimisation
- Lower costs, high reliability
- Flexibility, large capacities
- Mobile communication
- Easy interface to PSTN through gateways

Satellite broadcasting
- High power satellites: use of FSS bands for broadcasting
- Trans-national broadcasting
- More channels; digital compression techniques
- Portable up-links
- Use of higher frequencies and power for DTH broadcasts

Satellite reception equipment
- Cheaper, smaller, less complex - VSATs, TVROs, DTH terminals
- Rugged, reliable; less maintenance needed
- Multi-function (e.g., data + voice+video), multi-frequency, multi-satellite
  (steerable/motorised feeds/antenna)
- “Talk-back” capability
While these technologies have been used in a large variety of fields and activities, we are limiting the scope of our discussion here to the field of education.

Education

As the world moves towards a knowledge-based society, the crucial importance of education becomes ever clearer. In developing countries, the emphasis is on basic education—including literacy—since this is vital to their progress. It is not only an important input for economic growth, but is also a necessary element of participatory democracy. In developed countries, the infrastructure and systems to assure basic education are already in place. Their focus is, therefore, on higher and continuing education, and this is necessary if they are to maintain their "competitive edge". In both categories of countries, there is growing recognition about the critical role of education. In recent years, major international agencies too have accorded priority to education—the UNDP, through its Human Development Reports and, of late, The World Bank too.

Traditional means of education suffer from some major lacunae, including the following:

(i) expansion generally means a dilution of standards and a lowering of quality;

(ii) despite this, expansion through conventional means is slow and unable to meet the expectations and needs;

(iii) conventional methods inevitably reach the disadvantaged, last—thereby perpetuating educational inequality;

(iv) the syllabus is often outdated and, therefore, of little relevance in today's world.
(v) for specialised courses, conventional methods are not cost effective.

In large developing countries, in particular, expansion and the quantity/quality relationship are both difficult issues. It has become increasingly clear that conventional means/systems can no longer meet the needs. It is here that NICT enters, as a potential solution.

Distance Education and NICT

Distance education, in its modern form — using electronic media and some elements of NICT — was pioneered by Open University in U.K. Using broadcasting, audio/video tapes and “contact sessions” to supplement print material, it sought to provide education of a quality comparable to that of the conventional universities. The appeal of the concept, and its success, spawned a large number of similar open universities across the world. With advances in NICT and its wider reach, the use of these technologies for distance education is growing.

The rapid obsolescence of knowledge requires that individuals have to make special efforts to stay up-to-date. This needs means that can collect, process and disseminate information very quickly. TV and radio meet this criterion best. Also, learning has to be at the pace and knowledge-level of the viewer. This implies the use of viewer-controlled technologies. This need is further accentuated by the fact that the viewer would like to learn at a time convenient to him/her. Apart from other reasons, this clearly indicates that continuing education has necessarily
to be based on distance-learning modes. The need of earning while learning is another factor that is bound to make distance education the preferred form of the future.

However, use of NICT for education need not be limited to higher education alone. In fact, in developing countries, the problems and difficulties are far greater at the levels of basic literacy, primary education and school drop-outs. Taking quality education to these segments of the population is a priority, and NICT can play a major role in this.

In rural areas, in particular, and to reach dispersed learner-groups, NICT is of great relevance. Continuing education and refresher courses for para-medical staff, agricultural extension workers and school teachers are examples of important groups that are dispersed in rural areas and often cut off from means of upgrading and updating their knowledge. Equally, there is need for organized courses for farmers, craftsmen and entrepreneurs in rural areas, especially to help them cope with the changing context and to take advantage of new findings and opportunities. NICT, can provide efficient and cost-effective means for such courses.

Distance Education: Operational Examples

As specific examples of distance education, and the role of NICT as part of this, the following paragraphs briefly outline some uses in India. While its large size (in terms of both population and area) does differentiate it from most other developing
countries, there are many situational factors that are very similar.

At the primary school level, educational TV programmes are produced for children in the 5 to 12 years age-group in five different languages. Production is done in seven different locations and coordinated by the Central Institute of Educational Technology (CIET). These are broadcast over the respective regional network (covering the particular language zone) by uplinking the programmes to the INSAT spacecraft and using the earmarked transponder for each regional network. The VHF network then receives and retransmits them.

At the school level, there is also a formal distance education programme run by the National Open School. Its use of media is yet limited, but it has plans to use both radio and TV in a major way.

Distance learning at the University level is mainly the responsibility of the Indira Gandhi National Open University (IGNOU). It produces and transmits TV programmes for 90 minutes each week on the national network, using the INSAT system. The programmes are an integral part of the wide range of courses offered by IGNOU, and are supplementary to the printed material and contact sessions.

The biggest educational user of the media is the Consortium for Educational Communication (CEC). It broadcasts – in English and Hindi – 11 1/2 hours a week of enrichment programmes (not
directly linked to the syllabus) for undergraduate students. The programmes are produced in 14 Media Centres in various universities and broadcast over the national TV network via the INSAT satellite as the University Grants Commission's **Countrywide Classroom**.

A recent addition to distance education - and a likely pointer to the future - is a commercial course on computers run by an Indian company and broadcast over a trans-national satellite channel uplinked from Hong Kong.

**Recent Experiments**

In the last few years, some experiments have been undertaken in India with the aim of increasing the effectiveness of distance education. These have been experiments in applications, organisation and systems rather than in technology per se. The main thrust has been to add an interactive element to the one-way mode inherent in broadcasting. The experiments have been pioneered by the Indian Space Research Organisation (ISRO), working with various partners for different applications.

All these experiments have used the one-way video, two-way audio mode. The outgoing video and audio (TV signal) has been uplinked from a studio through an earth station (both together comprising the "teaching end") to a satellite. Reception is by a TVRO - linked to one or more TV sets in a classroom (the "receiving end"), or to a TV transmitter for rebroadcast and final reception by TV receivers within the coverage area (see Figure 1).
FIG. 1. NETWORK CONFIGURATION FOR SATELLITE-BASED INTERACTIVE BROADCASTING NETWORK FOR TRAINING.
Viewers, in this interactive mode, can ask questions which will be first received at the "teaching end" and then broadcast "live" over the network. Similarly, the answers given by the experts at the "teaching end" are also broadcast "live". The questions can come to the teaching end by two different methods: directly via satellite, using a "talkback terminal" located at the receiving end, or through the normal telephone network (PSTN) by making a long-distance call (dedicated lines are too expensive for such an application).

Such a mode is ideally suited for training, but can also be effectively used for general distance education. In India, it has been tried out so far for the following: (i) training of adult-education instructors; (ii) training of industrial workers (supervisors); (iii) course for distance education students and interaction with contract programme tutors; (iv) continuing education course in management; (v) farmers and extension workers training; (vi) training for bank officials; (vii) training for functionaries working on women and child development programmes; (viii) college students enrichment programme.

All these experiments, except two jointly with CEC/UGC, have been in a "closed user group" form in which the network was limited to designated nodes and reception was through TVRO terminals. The CEC experiments were on the general TV network, and the programmes could be received by a TV set anywhere in the country. There are advantages and disadvantages in both modes, and the choice is best determined by the particular application - which
defines the target group and the objectives. Similarly, the mode of "talkback" or call-in (whether through a direct satellite terminal or via PSTN) depends upon the application and the group involved, but here other factors also matter — e.g., availability and reliability of the PSTN, number of locations and calls, duration of calls etc.

In some of the experiments, fax was used to supplement the telephones, and this worked very well.

An interesting experiment called Classroom 2000 was conducted by CIET for school children. A few selected schools were equipped with a computer, and key-pacs for students. The computer was connected to a central computer at CIET through modems and the telecommunications network. A lesson was broadcast over TV, and at specific junctures, the students were asked to answer multiple-choice questions. They answered on their key-pacs and these answers were routed via the school computer to CIET. The central computer immediately presented to the teacher a visual analysis of answers of all students. Thus, the teacher was able to get almost "on-line" feedback about the students level of understanding. This enabled the teacher to decide whether to proceed to the next step or go back and once again explain the previous topic. This would make teaching far more effective.

The most recent experiment, done by CEC — jointly with ISRO and IGNOU — involved a nine-day package of programmes on a single theme: an Interactive Telecourse on New Communication Technologies. On each day, a pre-recorded video programme of about 20
minutes was broadcast from Ahmedabad via the INSAT spacecraft. This was rebroadcast by the total national network of 550 plus TV transmitters. At fifteen centres around the country, special/organised viewing arrangements had been made. On the first five days, after the telecast of the video programme, viewers from these 15 centres called in (using the PSTN) with questions. These were received at Ahmedabad and directly patched to the uplink so that the question could be heard by all viewers through their TV sets. An expert panel at Ahmedabad then answered each question, "live" on air. On the last four days, the studio numbers were announced and viewers anywhere in the country (i.e. in addition to the 15 "organised" centres) could ask questions. The response was phenomenal, and the telephone switchboard at the studio was completely blocked by the flood of calls. In addition, a large number of questions came via fax, and a few by E-mail.

It is noteworthy that such a response was forthcoming though no arrangement could be made for a toll-free number - i.e., callers were paying long-distance call charges, and that too at full rate (due to the time of broadcast). Part of the reason may, of course, be that this was the first nation-wide call-in programme. Research on the effectiveness of the experiment is on and the results are yet awaited. However, in terms of response and enthusiasm, no further research is really required.

As a result of these experiments and in recognition of the role of NICT in education, the government has decided to allot -
for an initial period of two years — one transponder on the INSAT II B spacecraft (which is already operational) for education and development. This will, in particular, include interactive courses/uses. A "teaching end" is already operational at IGNOU. This consists of a small TV studio, linked to a satellite uplink station (a transportable one is presently being used). Since the transponder is in the extended C-band, special TVRO terminals will be needed for reception. IGNOU has already installed 20, and it is proposed to get other institutions to set up many more, with mutual cooperation ensuring location-diversity so as to maximise reach.

Meanwhile, ISRO is developing special satellite "talkback" terminals, so as to serve locations where the PSTN services are of low quality.

The first major experiment using this system will be done in February, 1995 in the State of Karnataka, to train newly-elected women members of the Panchayats (rural self-government institutions, that form the third tier of governance in the country).

To summarise, while the operational education programmes in India are yet using only satellite broadcasting, in the last two or three years experiments have been done using a wide variety of NICT, including:

- satellite broadcasting
- satellite telecommunication
- TVRO and satellite talkback terminals
- PCs
- fax
- E-mail (to a very limited extent)
- combinations of the above

It seems clear that many of these will become routinely operational in a few years, if not earlier.

Future Uses and Potential of NICT in Education

The use of broadcast media in education is now common in many countries. Depending upon size and other factors, some are using satellite broadcasting. In this case, reception is generally centralised in any given area, and further dissemination is through cable systems or by rebroadcast from VHF/UHF transmitters. However, newer technologies — both on spacecraft and on the ground — are blurring the distinction between so-called direct-to-home (DTH) and community/cable head-end reception through TVRO terminals. As a result, increasing number of households have their own individual satellite reception dishes. At the same time, coded pay-TV channels and compressed-video digital channels may once again tilt the balance towards cable-based reception since these require investments in decoders. Also, channels delivered from multiple satellites require either more sophisticated receiving systems or multiple dishes. This too would work in favour of cable-based systems rather than DTH. Most important — especially for education — is the fact that new high-capacity cable systems (generally using optical fibre) are being conceived and planned as interactive ones.
The element of interactivity is important for education, since true education is not possible without it. Distance learning systems have traditionally done this through contact sessions with tutors. Technologically, the attempt has been to create a "virtual classroom" by introducing interaction through call-in systems (via PSTN or satellite talk-back terminals). It is likely that in future such on-line interaction may be largely replaced by systems using text (e.g., fax, E-mail) or by voice mail. This will provide time to collate questions, to locate appropriate visuals etc. for the answers, while maintaining a substantial part of real-time spontaneity.

Apart from PSTN or VSAT (satellite talk-back terminals), it is likely that increasing amounts of interactivity will, in fact, use the cable systems. This is, of course, feasible only when the experts are available locally — i.e., at the cable head-end. Such interaction would, therefore, not be able to altogether replace the flexibility (of location) that can be provided by PSTN. Interconnectivity through VSATs, while providing direct access to the "teaching end", restricts the number/location of question-asking classrooms, since each has to be equipped with a VSAT.

Non-broadcast NICT too are likely to see increasing use. Apart from video systems (whether tape, disc or even memory chips), which are already in extensive use, computer multi-media is a field that has great potential. Already, interactive multi-media courses have been designed and found to be extremely effective. At present, the economics of this medium limits its use.
However, decreasing costs of hardware, and bigger markets for courseware are likely to result in economic viability. Interactive multi-media is best used with one learner to a terminal. Apart from the consequently high cost per learner, its reach will be limited, and hence its applications are likely to be for specialised courses.

Access to data banks is likely to be a major learning tool in the future. Data banks will soon have greater intelligence and be transformed into knowledge banks. Like expert systems, these would help a learner "navigate" through a topic/subject at his/her pace, with branches into related areas that may capture the learner's fancy. Thus, learning is likely to become more non-linear (and hence more natural as well as more interesting). For example, a student of relativity may get interested in Einstein's life and from there branch off into the history of the time, into the origins of the World War I; the mention of Sarajevo may intrigue him/her into finding out more about the present problems in Bosnia. Finally, he/she would hopefully go back to Einstein and relativity (as in Physics). Such "meandering" may have to be provided for in the courseware, and may well re-shape present models of education and of specialisation.

NCT will ensure that such access to data banks will soon be in a multi-media mode — i.e., the learner will receive text, graphics, audio, animation and full-motion video on his/her terminal.
Like the present (experimental) video-on-demand systems for movies, it is feasible to have a course-on-demand system for education. This will enable a learner to call up any course (or topic within it) that s/he wants at any convenient time. The full material, in multi-media form, will be "dumped" into the learners terminal and s/he can then view/hear/read it at any suitable time. Thus, distance learning will continue to use video, audio and print, but this can now all be contained in one medium — a CD-ROM, for example.

More far-fetched — but technically feasible — are ideas of using so-called "personal communicators" (like the APPLE Newton) or satellite mobile communication systems (like INMARSAT's proposed system P) for taking interactive education to field functionaries.

Some Implications

It is clear that NICT are already playing a major role in education, and that their potential use in future will be even greater. NICT facilitate the extension and out-reach of education. To the extent they succeed in taking high-quality education to disadvantaged people and to remote areas, NICT do have a democratising effect.

As technology advances, the ideal of "learning what you want, when you want, where you want, and at your own pace" becomes possible, and life-long learning is no longer just a slogan. As noted earlier, this will necessitate a change in the
mind-set of educationists and course designers. The non-linear features of new learning systems must be fully exploited, so that they are congruent with our own (non-linear) mental processes. This implies a moving away from narrow specialisation to a new era of a more broadly educated person — what one may classify as a moving forward to a new "renaissance person". Is this desirable? Should we facilitate such a move or seek to thwart it? These are issues that merit a great deal of discussion.

Another major implication is the move towards far greater self-learning. With sophisticated courseware, the need — from a solely subject-learning point of view — for contact sessions will be minimal. Learning-in-isolation has its advantages for introspective and spiritual purposes, but is such decrease in human contact desirable? Also, will machine-learning compensate for the mutual learning that takes place in group situations? Will such learning in isolation result in a lack of human feelings, in humaneness?

Increasing privatisation and commercialisation of education is an evident trend world-wide. To this, technology has added a new dimension: globalisation, through trans-national satellite broadcasts of distance education programmes. Though this is just beginning, it is a trend that is likely to continue. The implications and effects of this — especially for developing countries — need to be carefully examined. There are also larger issues about cultural diversity vs. homogeneity that need consideration.
While NICT throw open a vast field of opportunities in the education sector, the above issues, with regard to the future, need to be studied and debated. It is only through this that we can shape and configure appropriately the technologies that will, in turn, shape future generations.
Notes and References

1. Throughout this paper, the term New Information/Communication Technologies or NICT has been used, rather than separating the technologies of information and communication. This is because, in the author's view, the increasing convergence of the two is going to rapidly blur the distinction.

2. The concern of developing countries about literacy and basic education was re-emphasised at the Education for All meeting of nine large, developing countries in New Delhi in 1992, following the Jomtien Conference (1990) on Education for All.


4. Distance education programmes in the Asia-Pacific region are covered well in Distance Education in Asia and the Pacific (2 volumes), Asian Development Bank, Philippines, 1987. See also Distance Education in SAARC Countries (Ed. Guha Biswas), National Open School, New Delhi, 1992.
5. See *New Horizons in Distance Education* (ed Bakhshish Singh), Uppal Publishing House, New Delhi, 1995.

