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Learning of Science and Technology through the Distance Mode: Opportunity for Continuing Education at the Work Place

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A number of radical changes have been taking place in the fields of technology and education, offering new opportunities and necessitating new strategies. The distance mode of education has achieved considerable success in the teaching of humanities courses, and employs multiple media. The teaching of science subjects has more dimensions and demands other inputs, particularly laboratory oriented; technology subjects require even more inputs. This paper discusses the principal features of several models around the world. The structure and programmes of the Indira Gandhi National Open University are discussed in detail. It is concluded that the distance mode offers a valuable learning opportunity to working professionals.

INTRODUCTION

THE UNPRECEDENTED rate of technology modernization in recent years needs no emphasizing. Indeed, these technological changes, which are coming with no more warning than the morning's headlines, are now demanding a twofold futuristic role on behalf of a worker at the work place: (i) to adapt to observed innovations in technology; and (ii) to create conditions under which technology can be developed, efficiently utilized and properly managed and controlled in the interests of increased productivity and economic and social development.

On the one hand, this offers to the technical education system a new learner group, hitherto unattended; on the other hand, it suggests the need for reorienting programmes of scientific and technical education to meet the continuing and further education needs of employees at all levels.

Simultaneously, the world is experiencing an electronics and information technology revolution, which, in turn, has offered distance learning as a new educational and cost-effective technology for flexible, open learning systems, which are consistent with the requirements of continuing education.

Indeed, it is in the context of this interesting option for education and training of in-service personnel which open learning offers, that the teaching of science and technology through the distance mode is now acquiring attention the world over.

In what follows this paper deliberates on this question of developing teaching organizations for person-centred learning of science and technology through the distance mode.

DISTANCE TEACHING OF SCIENCE AND TECHNOLOGY COURSES: ISSUES

While teaching of humanities courses through the distance mode with a heavy emphasis on printed texts and interaction through writing and recordings of the spoken word has a more ready acceptance, when it comes to science and engineering courses, those who regard face-to-face teaching as an integral part of education find it difficult to accept distance learning.

This is particularly because over the years teaching of science is seen more as teaching of both a body of knowledge about ourselves and our environment, and a method of enquiry. In other words, teaching of science is viewed to comprise (i) knowledge which presents facts, compares and classifies them, measures and estimates and shows links; and (ii) an exploratory activity which may be regarded as an art or craft with room for chance, imagination, intuition and strategy as well as the more traditional pattern of Problem 1–hypothesis–experiment–result–problem 2.

The above has necessitated the now-universal requirement of laboratory experiments and project-based activities in the teaching of science courses, and the question is how this requirement can be incorporated in the learning of science through the distance mode.

The teaching of engineering and technology subjects has still further dimensions as, in addition to experimental, exploratory and problem-solving skills, the teaching of engineering also requires developing systems capabilities among learners for contributory participation in mission and goal-oriented and team-based, time-bound tasks.

While in conventional institutions one can ensure the above learning components through practicals, workshops, industrial experience, home projects and final-year projects, independent study, etc., the question is how to achieve these learning objectives as a student learns engineering and technology courses and programmes from a distance.

RESEARCH FINDINGS

Bloom's taxonomy classified learning objectives under the categories of affective, cognitive and psycho-motor domains, all of which are important when it comes to teaching of science courses and, particularly the engineering and technology courses which are to train the student in the art of making things possible.

When it comes to teaching such science and engineering subjects through a distance mode, there are, of course, problems. For example, as discussed by Holmberg, some psycho-motor objectives such as surgery or the capacity to handle dangerous chemicals and machinery do not lend themselves to distance study. This appears to be a particular limitation in certain subject areas.

Further, most criticism of distance education focuses on its effectiveness in the affective domain, which is concerned with values, attitudes and beliefs that are 'caught' rather than 'taught', the argument being that they can only be 'caught' in a social context and that this element is often not provided in distance teaching systems. Literature, however, reports that teaching in the affective domain requires a form of communication with a strong appeal to the emotions, and suggests television, radio, novels and drama as particularly successful in this respect.

In spite of above observations, on the whole, the researched findings in distance education suggest that most subjects across affective, cognitive and psycho-motor domains can be taught by distance means.

More specifically, researchers report that while cognitive objectives and those affective objectives that are concerned with academic socialization (unprejudiced search, etc.) and some psycho-motor objectives (skills in drawing, calculating) can even be effectively attained through non-contiguous components under a distance mode, the contiguous face-to-face interaction, as under a distance mode, could be meaningfully utilized for other learning requirements, such as the following:

1. Practising psycho-motor skills in laboratories and under similar conditions; also verbal skills through personal communication.
2. Facilitating the understanding of the communication process and human behaviour.
3. Encouraging attitudes and habits of relevance of study.
4. Mutual inspiration and stimulation of fellow students.
5. Training in co-operation.

MEDIA SELECTION: MODELS THE WORLD OVER

It is these findings and the success of the United Kingdom Open University (UKOU) that have offered the basis for the selection of media for distance learning of science and technology courses.

More specifically, the media spectrum of print, study centres, face-to-face tuition, radio and television and video-tapes and audio-cassette tapes normally constitute the core media components for studying in the distance mode.

For teaching of science and technology courses, distance teaching institutions are further augmenting these core media components as per the requirements of the particular courses and programmes to be taught in the distance mode. In what follows these augmented media components as adopted by representative institutions with particular reference to distance teaching universities are briefly described.

The United Kingdom Open University

The UKOU offers a general BA degree in the science stream and a BA programme in technology in the engineering stream. The unique features of these degrees are that they are broad-based and have open access, i.e. there is no minimum entry qualifications. The university also offers B.Phil., M.Phil. and Ph.D. degrees for students of the science stream and a PG diploma and an M.Sc. and research programmes for the engineering stream.

In the science and technology courses under these programmes, in addition to the core media components listed above, the UKOU makes use of the following media components: home-experiment kits for laboratory experiments, course-based or discipline-based summer schools under residential terms/schools, computing elements either at home or at summer school, study centre or day school, or in the form of access to scientific calculators and, in some situations, to computer terminals, computing kits, and project work, along with additional learning components like field visits, outdoor fieldwork, computer-assisted instruction, week-end schools with essential attendance, access to sets of drawing instruments, access to a personal computer with MS-DOS for hard systems project option, access to set books in addition to print material, etc.

Where there is a requirement for an open-ended problem-solving ability, as in the case of technology education, the programme even has a full credit, i.e. a nine-month course in a 'Technology Project' which is characterized by extensive course planning to emphasize learning objectives in project identification, planning, design and implementation stages, which are so crucial to training in technology problem solving.

Thus, planning for this course begins almost one year before the learner registers for the course, and includes the learner identifying the problem he/she wants to work on (thereby ensuring learner stake), the OU department doing the first screening and, if approved, sending a staff-tutor to the region to identify the proper tutor.

This is followed by the tutor and learner together preparing a draft proposal, giving a project outline, which in turn is assessed by the OU department for acceptance, and a faculty member is appointed as a supervisor.

When the project course actually begins the tutor–learner–supervisor trio work in unison, with the tutor and learner getting together locally for face-to-face sessions. The project course ends in a report and the learner appears for an oral examination at the study centre, in which the tutor and the supervisor are present. The assessment is 10% for the initial report when the actual work starts, 10% for the interim report, 60% for the final report and 20% for the oral examination.

Central China Television University

If the UKOU offers general BA degrees in science and in technology streams, the Central Broadcasting and Television University of China (usually called the Central China Television University—CCTU), which started in its present form in 1978, offers degree programmes in engineering. The CCTU began these programmes first in mechanical engineering and electronics. Other areas the University plans to pursue are civil engineering, chemical engineering, industrial management, etc.

In implementing its science and technology courses under these degree programmes, the CCTU follows a semester system with a total of 40 weeks of teaching a year. Regarding the selection of media for imparting these courses, CCTU makes use of the core media components mentioned earlier, excluding video-tapes and audio-cassette tapes. The use of radio is also very limited, with television playing the major part in education.

Finally, to account for laboratory experiments, the CCTU ensures 'access to laboratories at centres'.

In this programme implementation the CCTU is assisted by 28 local television universities (LTUs), which are responsible for registration and organization of students.

Allama Iqbal Open University

While the CCTU offers degree education in engineering, the Allama Iqbal Open University (AIOU), Pakistan conducts distance education in science and technology in terms of the needs of functional education for individuals who want to acquire and extend knowledge and skills for direct use in their work and their homes, with the associated aim of assisting community development. Thus, the emphasis is on preparation of non-assessed courses for literate farmers, householders and field-assistants, and the course areas used are vegetable growing, plant protection, tractor repair and maintenance, farm machinery, home management, farm management, etc. To facilitate this learning, the AIOU makes use of essentially the core media components, excluding video-tapes and audio-cassette tapes.

University of Air

The University of Air (UOA) Japan, established in 1984, also offers a general degree with 'major' area options, which include specializations in understanding nature (science) and in industry and technology. The media selection in fact revolves around core components only, with the addition that print material also comprises textbooks and 'class-room' instruction is imparted at study centres.

Sukhothai Thammathirat Open University

Perhaps a unique media choice is to be found in the case of the 'Nursing' programme offered by the Sukhothai Thammathirat Open University (STOU), Thailand. This programme, which aims at upgrading employed professional and technical nurses, has a requirement of 'practice' in nursing for 4–6 h/week or 60–90 h/semester.

The STOU has proposed that its students, who are working either in government or non-government hospitals, should get their nursing experience from their routine work with relevance to the courses.

As a result, the STOU has media components of (i) nursing self-practice, which is implemented at the work place in terms of the routine work requirements of the learner; (ii) selected case study practice, which is in terms of practice of specified topics in the specified course, which the learner must do in his/her own time at the place of work and maintain a record book which is signed by an in-charge nurse; (iii) intensive nursing practice, which the learner has to perform at local study centres at the identified hospitals under the supervision of professional instructor nurses who are required to assess the learner performance; and (iv) professional enrichment workshops, where students who are about to complete the programme are required to have a comprehensive professional experience through participating in problem-solving group discussions related to their studies.

Indeed, it is this selection of media for distance teaching of nursing that has the elements of: work places playing the role of workcentres, thereby enabling the employer to give individualized learner support under the distance mode; industry collaborating with the distance education system in programme implementation by offering work-centre support and by participation in student assessment; and introduction of group-assessment-based learning components in distance education. This, as one can see, has been possible as the STOU has opted for collaborative networking by employing organizations in its programme implementation.

Open University of Sri Lanka

Another interesting case of media selection is to be found in the case of the Open University of Sri Lanka (OUSL). Founded in 1981, the OUSL offers a B.Sc. programme in science and programmes in engineering leading to certificates, diplomas and degrees.

To be specific, for teaching of science and technology courses, the OUSL normally makes use of core media components except that television and radio and video-tapes and audio-cassettes are not central, and emphasis is on audio-visual aids. Perhaps the most unique feature of the OUSL is that to account for laboratory and workshop needs, the University has a workshop facility on the campus and has its own laboratories on the Campus and at regional centres.

Apart from this, particularly for engineering courses, which the University offers under its Bachelor of Technology degrees in civil, mechanical, electrical and electronics and computer engineering and under its PG Diploma/Master of Technology programme in construction management, the OUSL also makes use of media components of fieldwork, day school/tutor clinics and industrial training.

It will be of interest to add a few words about the industrial training component at this stage.

The programme in engineering at the OUSL comprises a diploma in that discipline. To complete the diploma, a learner has to complete certain training requirements, both basic and specific. While basic training, which is a pre-appenticeship training, is completed at the University's workshops, the specific training is undertaken in the chosen field in industry. This industrial training is structured to develop the right personal qualities of the trainee linked with practical experience and application of their theoretical knowledge into practice. A major contribution to achieve this goal comes from the close supervision of the trainee by the supervising engineer of the training establishment.

The OUSL implements this media component with assistance from the National Apprentice and Industrial Authority of Sri Lanka.

There are other distance teaching universities around the world, such as Athabasca University, Canada, which has toll-free telephone access for students from anywhere in Canada; and the distance teaching universities of Costa Rica, Germany, Israel, Spain, etc., which also offer science/technology courses, using media selection packages often along the lines of the UKOU. However, it is not the intention of this paper to describe all such institutions and all such media packages. What is submitted is that there have been certain interesting features of these packages, some of which are identified here, and all these and other media components provide a very useful basis for any new and further efforts in distance teaching of science and technology courses.

PROGRAMMES IN SCIENCE AT THE INDIRA GANDHI NATIONAL OPEN UNIVERSITY

It is against the backdrop of these efforts that the Indira Gandhi National Open University (IGNOU), founded in 1985 and now with a massive distance teaching infrastructure of over 150 faculty, 700 technical and administrative staff, 8000 counsellors and 213 study centres, in 1991 initiated its three-year B.Sc. degree programme in physics, chemistry, life sciences and mathematics. Students who have successfully completed 12 years of schooling in the science stream are eligible for admission to this programme. Presently, this programme, with a yearly intake of about 1400 students, has 29 study centres spread across the length and breadth of the country.

More specifically, the first year of the B.Sc. programme comprises foundation courses of 24 credits and 8 credits in elective courses (total 32 credits), while in the second year one has to take 32 credits of courses from elective packages from a chosen science discipline. In the third year, a student takes 16/24 credits from elective and 16/8 credits from application-oriented courses, making a total learner load requirement of 32 credits. Thus to complete a B.Sc. degree, one has to complete a course requirement of 96 credits.

Regarding the choice of media for teaching of science courses, the IGNOU uses core media components with the addition of audio-visual methods (course on elementary mechanics) and residential terms for laboratory experiments. There are in all three lab courses in physics, three in chemistry and three in life sciences.

More specifically, a laboratory course is organized at selected centres for a continuous period of one week (with 10 h of work/study per day) for a 2-credit course, and two weeks for a 4-credit course. Attendance on the lab course is compulsory and student performance is evaluated during the course itself.

Thus, as can be seen, the B.Sc. programme of the IGNOU has unique features in that the foundation courses provide broad-based education, electives offer specialization, and the curriculum also provides opportunities to study application-oriented courses like writing for radio, marketing, feature writing, etc. Further, unlike the conventional system where laboratory courses are administered throughout the year, laboratory courses are phased during suitable periods (such as summer or autumn vacations) so that in-service persons can take-up the B.Sc. course without difficulty.

The IGNOU has further plans to develop programmes and courses in science areas, including a certificate/diploma programme in discipline/interdisciplinary areas, a master's programme in science (M.Sc.) and a research programme (M.Phil./Ph.D. programme) and individual/joint research programmes. The certificate/diploma/M.Sc. programme will have a modular approach, and thereby course-based admission. In other words, students will have a certain menu of courses from which they can choose whatever they want. As regards the target group, apart from the present student input under the B.Sc. programme, the science programmes and courses plan to aim at primary school teachers, technicians working in laboratories, technicians in related industries like electronics, pharmaceuticals, statistical survey departments, etc.

PROGRAMMES IN ENGINEERING AT THE IGNOU: A PLANNING CONSTRUCT

With science programmes moving in the direction of training employed manpower, it is only natural that engineering programmes and courses planned by the IGNOU have complete employment-orientation in identifying the target groups, in formulating the courses, in designing the structures and in implementing the courses.

The following presents briefly the salient aspects of this programme development in engineering and technology areas at the IGNOU.

Employment-related programmes

In engineering and technology areas, the University has planned to develop employment-related continuing education programmes aiming at increased job potential and economic advantage for the learner. The programmes are to be at the tertiary level.

The learner group

In the first instance, the programmes are to target learners who are technical diploma holders of a polytechnic (i.e. three-year technical diploma education after 10 years of schooling) and are employed.

Thus, against the above minimum qualifications, the learners will represent:

1. Existing workforce.
2. First entrants to the work place.
3. Those desirous of a second chance of learning, i.e. elderly (aged) working population.
4. Those in need of training for technology upgrading.
5. Those with potential for emerging employment areas.

Participation by employer groups and industry

In concrete terms, the University proposes to identify specific areas in engineering and technology for programme development in consultation with employing agencies at central and state levels including governmental, public and private sector organizations and professional bodies, so as to reflect in the curriculum design the functional education and training needs of the targeted learner group at the work place.

Subsequently, the University visualizes that these and other industrial organizations and professional bodies and their professionals/experts will participate with the University in the tasks of preparation of instructional material for a functional curriculum and also in its implementation by offering study centre and workcentre facilities, thereby making the programme preparation and implementation endeavour a participative outcome between the University and industry.

Regular and recognized study centres

Study centres constitute a very important media component for the distance learning of engineering and technology courses. To ensure quality education, the University maintains strict academic, manpower, equipment, infrastructure and space norms at study centres, which are mainly of two types: regular and recognized.

Regular study centres are those that are implemented either at the premises of the University or at the premises of institutions/industries/organizations which give space to the University free of charge, all other capital, learning material and recurring expenditure being borne by the University.

Against this, recognized study centres are 'sponsored' centres which give infrastructural and manpower resource sponsorship, while academic responsibility remains with the University.

Regular study centres for engineering and technology programmes

In view of the specialized requirements of student support services in engineering courses, the study centres for engineering and technology programmes will be implemented at locations where the University has its regular study centres as above, assisted by workcentres established by the University at engineering colleges or equivalent institutions and at appropriate industrial premises or industrial sites or at training establishments or other centres of employer agencies or at centres of professional bodies, as the case may be.

In other words, the University would ensure a strong and more than adequate teaching learning resource base at each study centre location through networking of inputs from local institutions.

Workcentre at an engineering college

While the regular study centre offers the student support service in terms of providing administrative assistance, space for counselling, audio-visual equipment and a library, the workcentre at an engineering college or equivalent institution would provide support service for the engineering and technology programme under consideration in terms of access to academia as tutors/counsellors, laboratory, technical drawing facilities, a subject library, a computer facility, etc.

Specifically, counselling is one of the important face-to-face teaching/learning components of distance learning. In view of the committed nature of engineering education, this component carries special significance in engineering programmes at the IGNOU. Thus, for programmes in engineering and technology, the counselling is planned to be implemented through week-end contact programmes held at intervals of one to two months depending on student load.

During these contact programmes/sessions, which are extensively monitored by the School of Engineering and Technology for quality counselling, the tutor/counsellors from the faculty of the engineering college and from other local resource persons would conduct counselling sessions, and the learners would receive audio-visual instruction where necessary, refer to a technical library, have access to computers, drawing boards and laboratory demonstration facilities, appear for workbook examinations, receive feedback on periodic assignments, etc., as the case may be.

Workcentre at an industrial site

As regards workcentres at industrial premises or industrial sites or at training establishments or other centres of employer agencies or at centres of professional bodies, these would provide the learner with support service for field-oriented functional courses under the programme in terms of access to: practising professionals as tutors/counsellors, a technical library in field-related topics, feedback on work-related functional assignments, audio-visual equipment, a technical drawing facility, site equipment and site-testing facility, and, where possible, a computer workstation facility, as per the needs of self-learning.

Like workcentres at engineering colleges, workcentres at industrial work sites would be also implemented during week-end contact programmes/sessions.

It is through such counselling sessions at subcentres established at appropriate industrial/work sites that, as indicated above, field professionals, drawn from the collaborating industry and from other local resource persons, would assess students for field/work-related functional assignments based on the following:

1. Knowledge about work practices—analysis of difference betwen standard practices taught through print material and actual work situations.
2. Application of knowledge to work situation—case studies.
3. Practice of knowledge in a work situation, where feasible.

It is to facilitate the above kinds of learning components that the workcentres at industrial/work sites would be organized to offer the educational inputs at the IGNOU as mentioned above.

Individualized employer support for a learner employee

Finally, as the engineering programmes are addressed to learners who are employed, the University recognizes that, more often than not, the employing organization of a learner will not be a regular study centre or subcentre of the University. However, the said employing organization may be in a position to offer to its learner employee some of the support services as at a study centre or at workcentre, e.g. individualized access to professional(s) of the organization as tutors/counsellors, access to a technical library, computers, access to site, etc.

Further, in respect of functional, field-oriented courses under the programme, the employing organization of the learner employee may also be in a position to assign to the learner 'functional assignments' as mentioned above (including practising the knowledge learnt in real work situations), and participate in learner assessment.

Programmes planned

It is against this backdrop of programme development that, consistent with the national needs of human resource development, the University has identified the manpower training needs of employment sectors of 'construction' and 'irrigation and water management' as its first priority to launch the following programmes in July 1994:

- Advanced Diploma in Construction Management (ADCM).
- Advanced Diploma in Water Resources Engineering (ADWR).

While the student input for the ADCM would come from those with a three-year Diploma in Civil Engineering from a polytechnic and employed, students for the ADWRE would be those with a three-year Diploma in Civil or Agricultural Engineering from a polytechnic and employed.

Each of these are two-year programmes, though, the first batch is expected to take three years to complete an Advanced Diploma.

Tables 1 and 2 give the courses in these advanced diplomas.

As mentioned earlier, these advanced diploma programmes will subsequently lead to B.Tech. (Civil) degrees to be launched in due course.

Media selection for employment-related education

It is against the above programme development strategy that the University then visualizes the following media spectrum for distance learning of engineering and technology courses.

- Self-instructional printed course material packages.
- Workbooks.
- Assignments for assessment and feedback.
- Work-related functional assignments.
- Field projects.
- Project work.
- Face-to-face interaction at study centres/workcentres with academic counsellors drawn from universities, industry, R&D centres and professional bodies.
- Practicals at designated study centres.

Table 1. Courses in ADCM

		Credit
First year		32
ET 101	Mathematics	6
ET 105	Physics and Chemistry	8
ET 202	Engineering Science—I	6
ET 204	Materials Science and Engineering Materials	4
ET 301	Engineering Arts and Analysis—I	4
ET 501	Soil Mechanics and Foundation Engineering	4
Second year		32
ET 521	Building Construction	8
ET 523	Construction Supervision and Repair and Maintenance of Buildings	8
ET 524	Principles of Engineering Management and Economics and Construction Management—I	6
ET 522	Concrete Technology and Construction Techniques	4
ET 581	Elective—I (any two topics from Category A[a])	4
ET 571	Laboratory—I	2
	Total credits	64

[a] Elective Package: Category A
A Testing for Quality Control (2).
B Inventory and Stores Management (2).
C Computer Applications in Construction Management (2).
D Steel Fabrication (2).
E Building Services (2).
F Mechanical Equipment in Construction (2).
Note: numbers in parentheses show credits against course topic.

Table 2. Courses in ADWRE

		Credit
First year		32
ET 101	Mathematics	6
ET 105	Physics and Chemistry	8
ET 201	Engineering Science	8
ET 531	Earth and Soil Science	6
ET 501	Soil Mechanics and Foundation Engineering	4
Second year		31
ET 532	Hydrology and Ground Water Development	6
ET 533	Open Channel Flow and Irrigation Engineering	8
ET 502	Strength of Materials and Structural Analysis	8
ET 534	Principles of Engineering Management and Economics and Systems Method and Water Resources Planning	8
ET 573	Laboratory—I	1
	Total credits	63

- Supporting audio-video programmes.
- Telecast of video programmes on national network (Doordarshan).
- Broadcast of audio programmes by All India Radio (selected stations).

The IGNOU's efforts toward programmes in engineering and technology through distance mode do not stop here. To begin with, the University plans to incorporate time flexibility in advanced diploma and degree programme structures by offering appropriate certificates and advanced certificates in functional areas as intermediate exit points for students before the advanced diploma and degree, respectively. In a similar vein, the University also has a proposal to give course certificates. Further, other areas in engineering and technology, like maintenance management, etc., are also being explored for programme development.

Apart from this the IGNOU also offers a one-year diploma in Computers in Office Management, which was launched in 1991, and is offering a diploma programme in computer applications at the post-graduate level from July 1994. Further, the University is also launching from July 1994 a B.Sc. degree in nursing. This programme of $2\frac{1}{2}$ years will have its practical components organized at existing medical/nursing colleges and hospitals attached to them.

A LEARNER-CENTRED INSTRUCTIONAL SYSTEM FOR ENGINEERING EDUCATION THROUGH A DISTANCE MODE: A CONCEPTUAL FRAMEWORK

Implementation of such a media package to facilitate distance learning of engineering and technology courses would call for a learner-centred educational organization linking education and work.

In what follows this section enumerates various subsystems and their teaching/learning components, detailing a conceptual framework for such an educational organization.

Teaching/learning organizations
Educational technologies

- Print material.
- Mass media.
- Audio-visual cassettes.
- Suggested reading.

Examinations

- Periodic assignments.
  —tutor marked/computer marked.
- Work-related/based functional assignments.
- Work-books.
- Term-end examinations.
- Project report.
- Seminar/group discussion.
- Inspection/viva/interview.
- Competency/skill/proficiency tests (futuristic).
- Natural observation at work.

Teaching methods

- Systematic reading.
- Assignments.
  —Periodic.
  —Work-related, functional.
  —Work-based tasks, functions.
- Gap lectures.
- Practicals
  —Skills at work.
  —Lab skills.
- Project.

Identification of learning experiences

- Work practices.
- Work tasks.
- Skills for work.
- Gap lectures.
- Lab skills.

Learning environment
Regular study centres, and workcentre at an engineering college and/or in industry

- Counselling (tutor/counsellor).
- Work-related counselling (employer participation).
- Audio-visual cassettes.
- Library.
- Project report.
- Seminar.
- Gr. discussion.
- TMA (open written answers: short/long essays).
- CMA.
- Functional assignments.
- Computer programme.
- Preparation.
- Term-end exam (collation of learner performance data).

Residential term

- Gap lectures.
- Practicals.
  —Lab skills.
- Examination.
- Skill tests.

Learner's own environment

- Systematic reading.
- Listening to radio/television programmes.
- Periodic assignments.

Workcentre in industry

- Work practices.
  —Difference from what is learnt in courses.
  —Analysis.
  —Report.
- Work tasks.
  —Extracted examples from work.

Learner's own work environment

- Individualized employer support for a learner employee in terms of counselling, functional assignments and access to physical facility.
- Work tasks.
  —Application of what is learnt in courses.
- Work output (futuristic).
  —Product
  —Design
- Assessment.
  —Inspection/viva/interview.
  —Natural observation at work.
- Skill simulation at work.
  —Competency/proficiency/skill/computer programming (futuristic).

Delivery system

- By post.
- Radio and television broadcasts.
- At study centres and at workcentres.

CONCLUSION

The subject matter of imparting science and technology courses through a distance mode has infinite possibilities, which naturally have to be weighed against the requirements of academic rigour and the constraints of the delivery system. However, as presented in this paper, the distance mode of education offers a unique method to meet a very important and urgent need of continuing and further education at work places. An imaginative networking of pedagogic resources available from every possible end is going to make this mind-boggling task a challenging reality. Responding to such a task would then have all the drama of best of the intellect, hands and technologies coming together for a very purposeful social action.

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Continuing Education of Working Professionals—A Case Study of India

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A questionnaire-based survey, recently carried out by the Indian Society for Technical Education to determine the needs of industries in terms of continuing education, identified 114 areas, and also recommended that the modules should be of 15–30 h duration. In order to implement this objective, the Ministry of Human Resources Development has initiated a project entitled 'Continuing Education for Working Professionals'. To achieve the intended objectives, four models have been identified. In order to quantify the impact of these programmes on national development, the International Association for Continuing Engineering Education has approved a project. It is necessary to network institutions not only nationally but also internationally, particularly among the developing countries in the region.

PREAMBLE

THE All India Council for Technical Education (AICTE) and several education commissions have stressed the promotion of continuing education. In this connection the Indian Society for Technical Education carried out a short survey to find out what are the needs of industries in terms of continuing education. The industries were very specific in their needs; they identified 114 areas in which they thought continuing education should be provided. They also suggested that the continuing education modules should be of short duration, i.e. 15–30 h modules, and as far as possible the courses should be run in the evenings. Keeping this in mind, a project was approved by the Ministry of Human Resource Development, Government of India, in February 1988. This project was titled 'Continuing Education for Working Professionals'.

THE PROJECT

The world today faces a rapidly changing environment. The challenges are pronounced in thrust areas such as microelectronics, computer technology, automation of industrial operations, CAD/CAM, sophisticated instrumentation systems, optimization of resources, use of unconventional sources of energy, etc.

With the knowledge explosion taking place, a person leaving the portals of an institute after acquiring a degree or a diploma will be deeply affected by the effect of obsolescence within a period of 10–15 years. Programmes will, therefore, have to be developed for educating all those who desire to keep themselves abreast of modern developments in their subject areas.

With the rapid rate at which technologies are changing and the still faster rates at which new technologies and disciplines are emerging, in-service technical personnel as well as employers are desperately in need of organized systems which could assist them in periodically updating their knowledge and professional skills. The demand for opportunities to develop expertise to enable movement from one stream or level to another will increase. A sound system of continuing education for employers has, therefore, to be developed to provide ample opportunity of life-long learning.

There are a large number of small-scale industries and tiny industries in the areas of electronics, computer software and other important sectors. Similarly there are professionals in the unorganized industrial sector. It is essential to provide an opportunity for such professionals to update themselves.

Keeping these things in view, the Ministry of Human Resource Development, Government of India, launched a continuing education project—UPDATE—for working professionals (in February 1988), offering continuing education programmes through carefully designed modular courses in critical as well as emerging areas of engineering and technology. The infrastructure and expertise available in our technical institutions, professional societies and training institutes will be effectively used in organizing suitable programmes in continuing education aimed at the identified target groups of working professionals in different regions of India.

THE MISSION

The task of the project was to overcome obsolescence of knowledge of working professionals in the field of engineering and technology.

THE OBJECTIVES

1. Assessing the future needs of different sectors of the engineering profession.
2. Preparation of course materials for continuing education; offering programmes at institutions, industries, professional societies.
3. Planning, implementing, co-ordinating, monitoring and reviewing the impact of the programmes and applying corrective measures suitably.

THE METHODOLOGY

The total methodology that has evolved (Fig. 1) is addressing itself to handling a larger cross-section of working professionals in the Indian context, using a cost-effective and need-based approach, starting from the identification of the need, identification of the expert group, development of course materials and provision of continuing education to the user system through an institutional network and operating in a closed loop, providing possibilities for reorientation.

ORGANIZATION OF CONTINUING EDUCATION IN DIFFERENT REGIONS OF THE COUNTRY

The list of the course materials that are developed and that are being developed was sent to all the technical institutions in the country, requesting each of them to identify the course materials of interest and to organize the continuing education programmes with support from the institutional faculty, resource persons from industries and at least one expert from the national expert pool who has prepared that particular course material. Then the feedback from each individual course is obtained to find out whether any reorientation is required and this information is passed on to the expert groups who have prepared the course material so that the course material can be re-oriented according to need.

THE PRESENT SCENARIO

Through this methodology of approach and also through the type of interaction with several industries, four models of continuing education were evolved, catering to the needs of the user system.

This model (Fig. 2) caters for the needs of governmental organizations like public works departments, power corporations, electricity boards, etc. During the interaction with the governmental system it was found that especially in the state of Karnataka alone there are 13,000 engineers who are associated with the public works department. It was felt that these people should be sent in batches for short-term courses. To handle this particular aspect, depending upon the strength of the institution in a particular thrust area, the institutions to cater for the continuing education support in a particular area were identified. The expert group from this institution, by utilizing the course material developed by the national expert group, handle that particular course for these

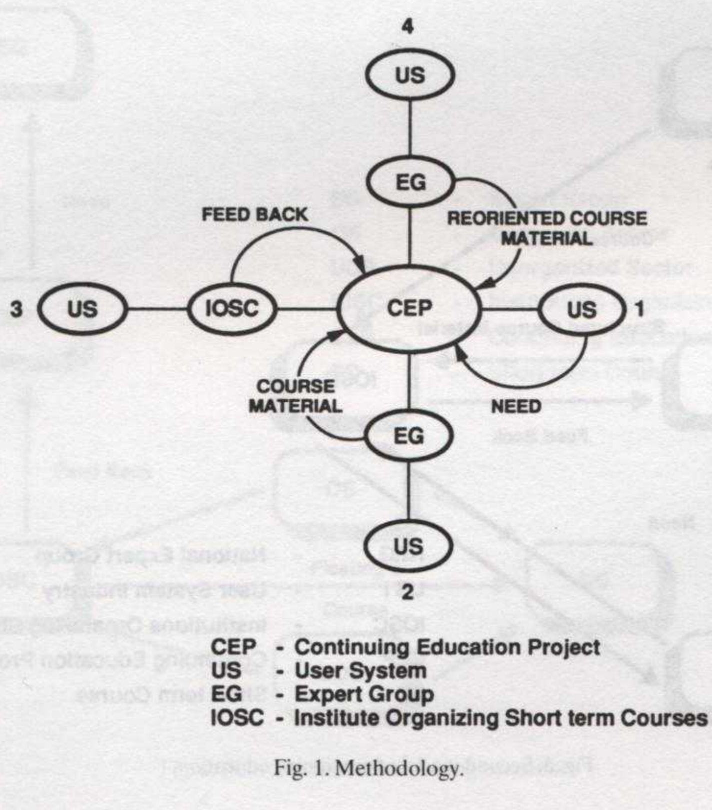

Fig. 1. Methodology.

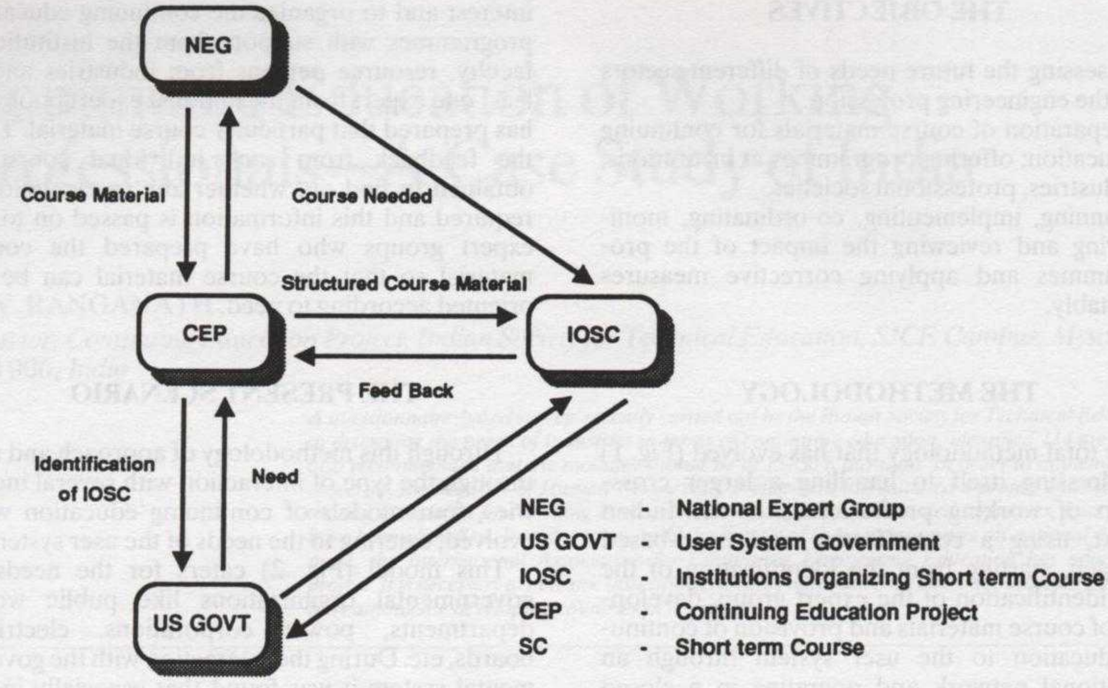

Fig. 2. First model of continuing education.

working professionals in-house. All the courses are in terms of modules of 15–30 h.

This model (Fig. 3) caters for the need of a particular industry, which needs a course exclusively for their own employees, either in-house or at a centralized location. After identifying the individual needs of the industry the course will preferably be handled in-house. The national expert group available will handle the course in-house. If the course has to be centralized the expert group will be brought down to the continuing education centre of the relevant institutions, and the course will be handled by the institution experts along with one or two national experts.

This model (Fig. 4) caters for the requirements of large industrial concerns which can organize self-study programmes culminating in interaction with an expert group. This model can cater to a large

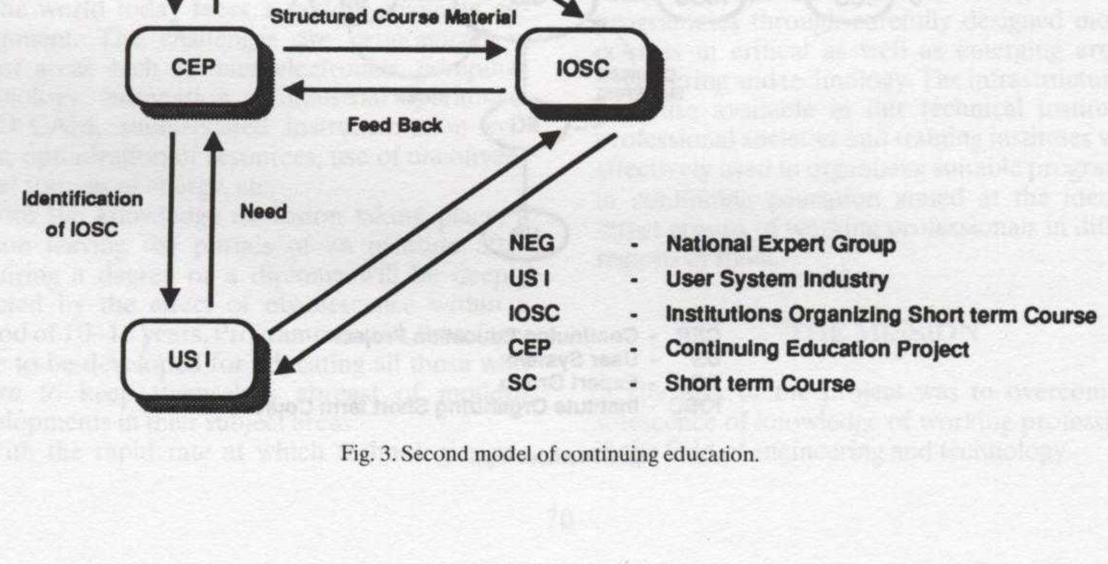

Fig. 3. Second model of continuing education.

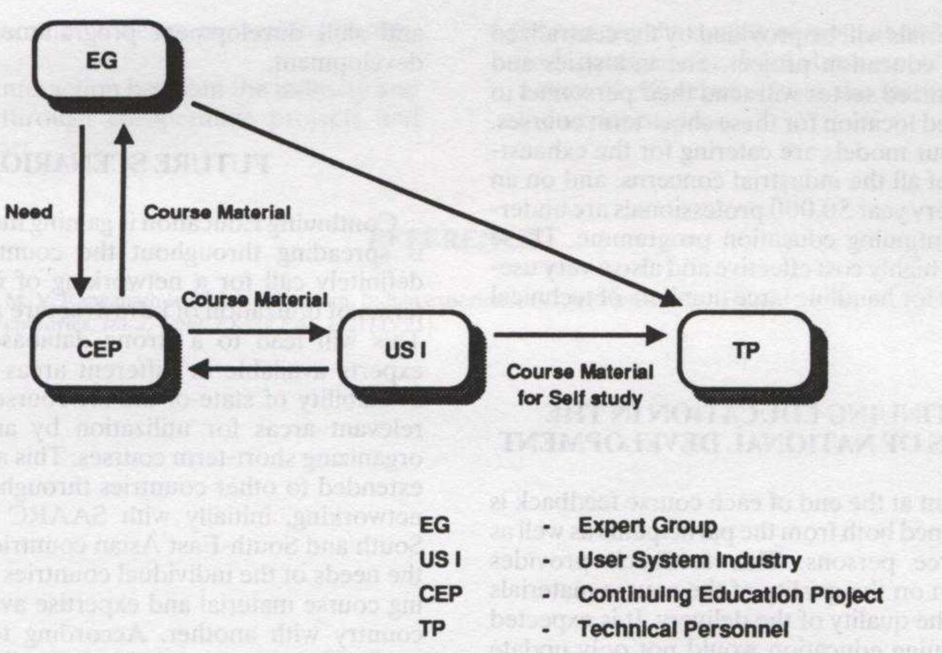

Fig. 4. Third model of continuing education.

cross-section of technical personnel. Large industrial concerns will identify the needs of the particular course and this course material will be given to the individuals for self-study for a duration of 8 weeks. At the culmination of this period of self-learning, one or two experts who have prepared this course material and also experts in the field will be brought to interact with this group for better understanding of the inputs and for clarification. This is becoming very popular in the large industrial sectors because of the low cost and high reach capabilities.

This model (Fig. 5) caters for the unorganized sector and also where large industries, for particular topics, cannot send many people, but input is essential for a limited group. The individual institutions of excellence will find out the needs of these industries and will propose short-term courses for

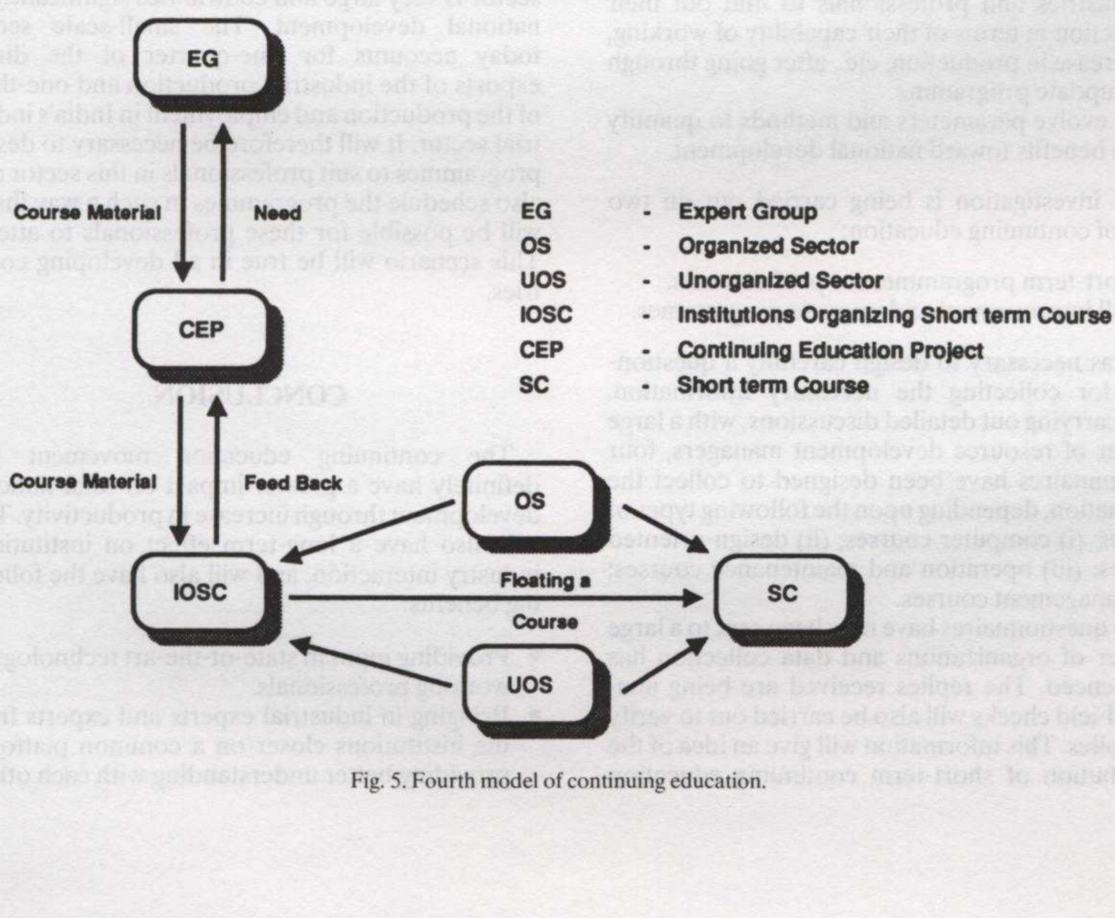

Fig. 5. Fourth model of continuing education.

which materials will be provided by the centralized continuing education project. The industries and the unorganized sector will send their personnel to a centralized location for these short-term courses.

These four models are catering for the exhaustive needs of all the industrial concerns, and on an average every year 50,000 professionals are undergoing a continuing education programme. These models are highly cost effective and also a very useful solution for handling large numbers of technical personnel.

CONTINUING EDUCATION IN THE PROCESS OF NATIONAL DEVELOPMENT

At present at the end of each course feedback is being obtained both from the participants as well as the resource persons. This feedback provides information on the quality of the course materials as well as the quality of the delivery. It is expected that continuing education would not only update the expertise of professionals but also contribute to the national development in terms of improvement in productivity, better care of equipment, better human relations, etc. At present there is no measurable method to quantify the contribution of continuing education to national development.

In this connection the International Association for Continuing Engineering Education (IACEE) has approved a project entitled 'Continuing Education Project—Evaluating and Quantifying its Contribution to National Development'. This project proposes:

1. The preparation of a questionnaire to be sent to industries and professionals to find out their reaction in terms of their capability of working, increase in production, etc., after going through an update programme.
2. To evolve parameters and methods to quantify the benefits toward national development.

The investigation is being carried out on two types of continuing education:

1. Short-term programmes for professionals.
2. Skill improvement and upgrade programmes.

It was necessary to design carefully a questionnaire for collecting the necessary information. After carrying out detailed discussions, with a large number of resource development managers, four questionnaires have been designed to collect the information, depending upon the following types of courses: (i) computer courses; (ii) design-oriented courses; (iii) operation and maintenance courses; (iv) management courses.

The questionnaires have now been sent to a large number of organizations and data collection has commenced. The replies received are being analysed. Field checks will also be carried out to verify the replies. This information will give an idea of the contribution of short-term continuing education and skill development programmes to national development.

FUTURE SCENARIO

Continuing Education is gaining momentum and is spreading throughout the country. This will definitely call for a networking of institutions in terms of utilization of infrastructure and expertise. This will lead to a strong database of national experts available in different areas and also the availability of state-of-the-art course materials in relevant areas for utilization by any institution organizing short-term courses. This activity can be extended to other countries through international networking, initially with SAARC and Central, South and South-East Asian countries, identifying the needs of the individual countries and exchanging course material and expertise available in one country with another. According to the sample feedback that we are getting from all the industries benefiting from the continuing education project, we feel that there is a greater input of this particular project in the direction of national development through enhancement of the understanding of working professionals in state-of-the-art technology and its use to increase productivity within the industrial concerns.

In India there are a number of industries that fall into the category 'unorganized sector' (small-scale sector), each of them staffed by one or two professionals. Such people frequently find it very difficult to leave their workplace and attend update education programmes. However, this unorganized sector is very large and contributes significantly to national development. The small-scale sector today accounts for one-quarter of the direct exports of the industrial production and one-third of the production and employment in India's industrial sector. It will therefore be necessary to design programmes to suit professionals in this sector and also schedule the programmes in such a way that it will be possible for these professionals to attend. This scenario will be true in all developing countries.

CONCLUSION

The continuing education movement will definitely have a greater impact on total national development through increase in productivity. This will also have a long-term effect on institution–industry interaction, and will also have the following benefits:

- Providing input in state-of-the-art technology to working professionals.
- Bringing in industrial experts and experts from the institutions closer on a common platform, providing better understanding with each other.

- Providing more confidence to working professionals.
- Enhanced interaction between the industry and institution through co-operative projects and R&D support.
- Enhancing the quality of input at undergraduate and postgraduate level, because of the interaction of the experts from the institutions with industrial experts.

REFERENCE

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