DOCUMENT RESUME

ED 083 798 EM 011 481

TITLE Interpretation of Positions and Points of View Expressed by Experts in Response to Specific Questions.
INSTITUTION United Nations Educational, Scientific, and Cultural Organization, Paris (France).
PUB DATE 29 Apr 70
NOTE 20p.

EDRS PRICE MF-$0.65 HC-$3.29
DESCRIPTORS *Computer Assisted Instruction; Computers; Cost Effectiveness; *Developing Nations; *Educational Technology; Environmental Influences; Flexible Progression; Human Resources; Inservice Teacher Education; Instructional Materials; Pilot Projects; Program Evaluation; Staff Role; Teacher Education; Time Sharing
IDENTIFIERS *UNESCO

ABSTRACT

A detailed statement of ideas expressed during and after a UNESCO Consultation on Computer-Assisted Instruction (March 16-19, 1970) prepared for the information of UNESCO experts is presented in this report. After an overview of the report, a brief section which reviews some of the remarks made by the experts about computers, educational technology, and developing countries is offered. The remainder of the report consists of the points of view expressed in discussion which have a bearing on 14 questions put to the participants by UNESCO about: exploitation of unused computer capacity, cost of use at present and in the future, the first application--levels and courses, flexibility and adaptability in learning exercises--trends in the United States, materials development and testing, the availability and applicability of prepackaged systems, inservice teacher training, mass applications contrasted with micro systems, transferability of instructional materials and procedures, computerization of courses, teacher training for courses assisted by computers, resource personnel, environmental factors, and timing for the initiation of a pilot project. (Author/SH)

EM

29 April 1970

U N E S C O

CONSULTATION ON COMPUTER ASSISTED INSTRUCTION

Paris, 16-18 March 1970

INTERPRETATION OF POSITIONS AND POINTS OF VIEW EXPRESSED BY EXPERTS IN RESPONSE TO SPECIFIC QUESTIONS

C O N T E N T S

A. Overview

This detailed statement of ideas expressed during and after the consultation has been prepared for the information of Unesco experts and others invited to comment and advise on computer-related projects. The document as assembled from notes accumulated before, during, and after the three-day session in March is not suitable for general distribution; nor should it be relied upon as a single reference for specific decisions about individual projects. Notes have been included to indicate where and how it could be revised and elaborated when wider dissemination or new decisions are being considered.

The other two documents coming out of the consultation are more suitable for distribution and decision making. "General guidelines for instructional use of computers" includes comment on management, operations, costs, materials development, evaluation, introduction into schools, and transfer of findings from one project to another. In response to the program proposed by Spain, Unesco staff and a consultant prepared "Proposals for further investigation in Spain for a possible teacher training project." The more detailed statement which follows should provide background and supporting arguments of interest to the informed user and critic of the other two documents. In fact, it should not be used without the other two documents since the recommendations which appear there have not always been reproduced in the background notes which follow.

Before reading a summary of answers to the 14 questions put by the Unesco Secretariat, the reader may wish to review some of the remarks made by the experts about computers, educational technology, and developing countries. These ideas have been assembled in an outline format (pages 3-4) which is easy to skim but lacking in detail.

The domain of computer use under consideration is described in Attachment III. Use of the label "CAI" has been avoided except where the meaning (in the limited sense of computerized tutorial or the broad sense of any computer use) is clear. Failure to describe the reference of the acronym is confusing to those who are not familiar with the specific applications and systems for which reference is implied, especially when costs, student attitude, and teacher role are being discussed.

Beginning on page 5 the points of view expressed in discussion which have a bearing on the questions put to the participants by Unesco are listed in the approximate order in which the questions were considered during the consultation; original question numbers are given in parentheses after each question heading. Comments made in other contexts were moved to the question-sets with which they seemed to be most closely associated.

The group perceived its purpose to be to provide some basis for Unesco response to inquiries from Member States, and for decisions about one or more projects now being formulated. This report of the consultation includes judgments about the present state of the technology, some projection of capabilities and needs, suggested planning assistance for the project in Spain under consideration, and a list of resources for future consultation both general and specific, i.e., information sources, technical experts, etc.

B. Characteristics of the situation

1. Characteristics of a computer with implications for its role in instruction

   a. Speed of execution of very simple operations such as compute, compare, move, and transfer.

   b. Automatic access to information coded as numbers, text, structures, and procedures.

   c. Rather constrained communication with users since information must get in and out of computers through relatively limiting devices.

   d. Hence, computers help with repetitious tasks having slight variations.

   e. Information and procedures must be well structured; and data are coded on entry, often at a keyboard for economy, and output is usually limited to text or simple graphs.

In general: computers (and information processing systems) provide a physical counterpart for the concept of "procedure" which each year gains increasing importance in education, vocations, and daily life.

Hence, suitably programmed computers provide a vehicle for self-test of procedures as the learner conceives them, and a self-check on his understanding.

More than that, information processing and display systems provide a means for pursuing creative work ordinarily considered beyond the realm of procedure, algorithm, and deduction.

This list of characteristics might be expanded and elaborated by Zinn with the benefit of a critical reading by Donio and Brown.

2. Characteristics of educational technology, with implications for developing countries

   a. Kinds of educational technology show great variability with respect to cost, reliability, requirements for expert maintenance, portability, local production of materials, and other factors.

   b. Models for development of learning materials are more important than the materials themselves.

   c. Requirements for (and difficulties of) local participation need discussion.

This list of characteristics might be expanded and elaborated by Stolurow with the benefit of a critical reading by Leith and Silberman.

3. Characteristics of developing countries with implications for educational technology

   a. Tiers Monde countries can be extremely different on very general factors:

(1) Economically advanced or deprived.

(2) Technologically strong or not.

(3) Perhaps lacking in specific technology, e.g., input/output devices for computers.

(4) Increasing, leveling, or decreasing population.

(5) Level of training of teachers.

b. A very large proportion of a Tiers Monde country's very small budget goes into education, but with relatively little effect on quite sizeable problems.

(1) Notice that in the USA, although a small proportion is spent on formal education, very large amounts are spent by individuals and families on education-related supplies and activities: toys, sports, hobbies, entertainment, etc.

c. The technological gap between developing and developed countries is increasing every day.

(1) Computers and information sciences are contributing to this gap, perhaps one-hundred fold.

d. Absolute numbers of illiterates are increasing in many countries because of population growth. The number of untrained teachers increases in a corresponding way in spite of teacher training programs.

e. The authority role for a teacher is typical in many countries by tradition.

f. Many teachers have little general education, no training in teaching, and little knowledge of the subject being taught.

g. Educational problems are so severe in some nations, and increasing at such a rate, that some action must be taken, and some effort made to apply technology at optimum points in the system.

(1) It is important to try for a multiplier effect, working with: teachers and the trainers of teachers, materials development, information systems, and self-spreading programs.

(2) Educational programs might make radical changes bypassing the evolution of new techniques and practices apparent in developed nations.

This list of characteristics might be corrected and elaborated by experts within Unesco.

C. Positions and points of view on questions put by Unesco Secretariat

The questions drafted by Unesco staff in advance of the consultation (see Attachment V) provide the framework for summary of discussion and points of view. The wording of the questions has been reduced to topical phrases, and the arrangement has been altered to represent the sequence followed in discussion (original question numbers are given in parentheses). Additional material was added by the rapporteur and individual participants after the consultation; suggestions are included for yet further elaboration.

1. EXPLOIT UNUSED COMPUTER CAPACITY; PLAN FOR SHARED USES (#1)

a. Present machines and mode of access are not suitable.

The number and nature of the computers in Tiers Monde countries are not sufficient for operating a major education program, although perhaps they are sufficient for some pilot programs.

Many of the present machines cannot have time-sharing added except at considerable expense and without assurance of reliable operation. Machines and uses would have to be carefully matched.

After the pilot phase is completed, the educational system cannot be expected to continue on its own funds and available technicians.

b. Schools' use of spare time on commercial installations in USA and UK has on the whole been unsuccessful.

Certain mixtures (of foreground and background) are ideal in theory but have not worked out, at least with the older hardware (e.g., I/O and CAI at Penn State; data analysis and CAI on IBM 1500; administrative processing and CAI on RCA 70).

Spare time use begged from a bank or other commercial institution has led to student-teacher frustration when the school's work has to be set aside at the end of the month and cut back overall as the bank's utilization increases.

c. The cost of adding equipment to existing systems for tutorial computer use may be prohibitive; some computational and problem solving may be practicable.

Tutorial uses generally require:

- terminal devices (including audio-visual capability) and terminal controllers;
- mass storage and channel capacity;
- computer clock, interrupt control, storage protection, and other special hardware;
- features for time-sharing and educational uses.

d. Difficulties and advantages of spare time use.

As implied above, simultaneous use by schools and businesses is not readily implemented on existing systems; some systems have been engineered and installed just for multiple users pursuing different purposes.

Priorities of the primary user (owner) cause problems. When time is donated, educational uses should be selected for their relation to the work of the primary (and priority) user.

Student "jobs" can be prepared on peripheral equipment and run on the computer in low use hours, e.g., at night. Curriculum materials and aids can be generated at night for off-line use as ordinary printed copy.

On-line tutorial uses can be serviced through a commercial installation if the owner is willing to give priority to the school at convenient times, for example, if he will turn over the entire system for use by the school between 12 noon and 3:00 p.m. each day.

e. Transmission.

(1) Phones within a city must be extremely reliable to support remote computer terminals without frustrating users by random errors and disconnections. Minimum standards are not met in many "developed" countries.

Tests can be run to determine the error rate and other problems which might arise.

It is possible to lay special lines over short distances dedicated to the distributed instructional system.

In some cases, radio, video cable, or microwave facilities may be available for shared use.

(2) Cost of inter-city phones is prohibitive except for carefully engineered systems with considerable processing capability and data storage at the site of the user terminal.

Special rates may be given for a time, or service provided free by the phone company, but then what?

Eventually satellites should bring costs way down; microwave is a possibility for some areas sooner.

f. Special-purpose, stand-alone systems, perhaps mobile.

"Minicomputers" were introduced by Digital Equipment Corporation (DEC) a few years ago and have revolutionized the market and altered communication considerations. These machines can be purchased for $5,000 to $15,000 and will do a considerable amount of useful processing in support of a single typewriter or graphic terminal. For about $50,000, 16 or more simultaneous users can be supported (if none have large storage demands).

Prices continue to drop; small but general-purpose computer processors at $2,000 are soon to be announced. Computer storage also is becoming less expensive; bulk storage of information is a requirement of many instructional uses, especially tutorials which depend on large amounts of text. Simple cassette recorders will provide tape storage at very low cost which can be conveniently transported by the user.

Some of the minicomputers can be carried easily in the back of a car, subjected to bumps, heat, and humidity during mobile use, and exhibit amazing durability.

Sound design of an educational system using minicomputers probably would provide for back-up with a large computer and central file. Minicomputers would "call in" when additional processing power or new files were needed. New information can also be provided by mailing minicassettes to the computer sites.

An outline of devices and media for student access to computers was drafted by Zinn as a guide to resources for computer education and is included as Attachment I. Zinn or another consultant should assemble current cost figures and other details on these various means of access for use by Unesco.

2. COST OF USE AT PRESENT AND IN THE NEAR FUTURE (#2)

The cost depends so much on the mode of use and the manner of analysis that it can only be misleading to quote general figures or even specific ones with only partial descriptions. Nevertheless, some information is given here on the assumption that an expert will be consulted before this information is put to use in any specific situation.

a. Per student hour of "instruction" (on-line contact)

	"Guestimate"	Present Range	Future (About 5 Years)
hardware and system software (purchase and maintenance; lease or rental)	$2	($.25-$30)	$.20
operating staff: technical and educational, (in connection with terminal use)	$2	($1.50-$40)	$4
curriculum development per instruction hour	$1,000	($20-$10,000)	$200
when ammortized over small numbers, e.g., 100 users before revision or replacement of the material	$10		$2

	"Guestimate"	Present Range	Future (About 5 Years)
when large numbers, e.g., 1,000 users today and 10,000 in the future	$1		$.02

b. Means for reduction of cost:

Increase number of simultaneous users on system.

Provide background use which maximizes work accomplished by system without interfering with on-line student use in the foreground.

Reduce storage and processing requirements of exercises by storing on microfiche and selecting with computer or special-purpose device.

Distribute curriculum development costs over more students by:

planning and management;

economic inducements to authors and institutions to "sell" to others;

means to facilitate transfer to another user site, e.g., machine independence or documentation.

Arrange for use by 2 to 6 students at one terminal, interacting beneficially while together using about the same amount of computers' resources that one might use alone.

Encourage some of the on-line users to move off-line if their needs can be served as well in that mode. Much of simulation, problem solving and text processing activities can be done in off-line mode; much of tutorial and drill material can be presented in AV or printed formats.

c. Per "student-hour-of-learning" is a better measure of cost. That is to say, analysis of costs should recognize learning objectives achieved per unit of cost.

Although most discipline areas lack unambiguous units, the essence of the matter is learning accomplished.

Measure of achievement permits comparison of economics of off-line and on-line uses.

d. "Side effects" such as attitude towards discipline, education, and technology shape a cost analysis. The computer may make quite significant contributions well worth the additional costs if the attitude of students is significantly improved.

e. Minimum cost necessary to get started. Figures could be obtained for a number of low-cost projects in the USA and presented with complete descriptions of budget and activities. One borrows time on another computer and never gives many students experience with the computer; another leaves most of the programming up to the students and teachers but provides convenient access to the machine for ample periods of time.

In considering the costs of introducing educational technology, some attention should be paid to the value of learner time: the cost of schooling, the delay of his productive contribution to the country, and the personal inconvenience experienced by the individual.

An expert should be asked to forecast the decreasing costs of computer resources in the context of educational use requirements. Rand Corporation in Santa Monica, California, has a study in progress which may include such a forecast. In any case, Roger Levien, of System Sciences at Rand, should be consulted before action is taken to initiate a new study.

3. THE FIRST APPLICATION: LEVELS AND COURSES (#5)

Among the many ways to approach this question:

a. High need in the country for training:

Technicians

Teachers

Professionals

b. High-cost training, e.g., special technical jobs requiring one-to-one tutorial:

Reduce cost through computer tutors or other automated devices.

Perhaps more important, extend trainee's access to information and his opportunity to practice while learning.

c. Characteristics of subject areas that might be taught by computer:

Low rate of change, such as in language instruction.

Measurement of performance is possible and confirmation of good performance facilitates learning, as in language pronunciation or experimentation with physical systems.

Information processing facilitates understanding as in

math without arithmetic, or

physics without calculus.

d. Special populations aided by computer contributions:

Young children who have not yet acquired many learning skills.

Illiterate adults requiring aids to school learning.

Those deficient in some sensory modality or psychomotor skill.

Professional training, in which information processing (for decision making, etc.), is very important.

Learners lacking in motivation for training, at least in the context of present classroom practices.

e. Relevance of computers to the course of instruction.

Administrative uses.

Training computer users, technicians, and other information processing specialists.

Training other technicians on (perhaps special-purpose) systems.

Educating teachers in information sciences (computers).

f. Indirect use in development of new learning materials which need not be delivered directly by computer.

A laboratory for development, providing data on performance and a means for rapid revision before further testing.

A tool for checking the suitability of text, for example, through indices of readability, comparison with lists of technical terms, etc.

g. Indirect facilitation of the introduction of new technology into education.

Direct instruction of new teachers regarding computer uses and contributions to education and society.

General education in the community for parents, employers, and "elders."

In summary, the rate at which computer uses are being introduced into the classrooms of developed countries is not now known, and adoption rates vary for different kinds of uses. One casual forecast follows. Training in computer use for a few is likely to come early; education about computers in society will follow soon for many; specific uses in mathematics and sciences (and later the humanities) are inevitable but may be slow in coming. CAI on a wide scale will be achieved last because:

a. Computer tutorial is the most expensive per student or course; and other ways exist to achieve the objectives sought by CAI. That is, the computer is not [illegible] delivery of [illegible] material, but one cannot [illegible] maintain a library of information processing tools without [illegible]

FLEXIBILITY AND ADAPTABILITY IN COMPUTER-BASED LEARNING [illegible] COMMENTARY ON TRENDS IN THE USA (#[illegible])

a. Uses today tend to give more control to the learner, even on [illegible] tion of drills, than was [illegible] a few years ago. The [illegible] proportion of computer use in schools today encourages student initiative in simulation games, model building, or problem [illegible].

b. Exercises have become less prescriptive, now leaving to the learner to decide whether he needs more practice, will benefit from examining some supplementary explanation, or can skip the next section of the author's prepared sequence.

c. The variety of options available to teachers and students is increasing now that systems previously dedicated to tutorial CAI are being expanded to include other modes of use, and a great proportion of new projects on instructional uses of computers are beginning on general-purpose systems having facility for problem solving and information retrieval along with program-controlled tutorial.

d. Learning exercises are being programmed to be more interactive in the sense that the user can interrupt the program if, for example, he believes it to be providing him with too much detail; or he can test out a partially formulated idea and get some useful, although partial, response from the computer to use as a basis for further work.

e. The computer role as an aid or helper appears now to be at least as important as the role of examiner or drill master previously set for it.

f. The affective domain of outcomes is receiving more thoughtful attention now. Lesson designers are no longer trying to make the computer appear human by incorporating the student's name and otherwise bein "chatty," but are attending to the interests and attitudes the student may express.

g. What some have called the "tyranny of content" in courses and materials is being replaced by greater attention to acquiring procedures and skills which shall be of more general use than specific facts.

An expert might be asked to review current uses in the context of Tiers Monde needs, and the opportunities for large gains in education through technology applied to encourage significant qualitative changes in goals and means.

5. MATERIALS DEVELOPMENT AND TESTING TO DATE (#4)

a. Levels, subjects, and languages of major efforts in the USA.

Math and reading for 6-11 year olds developed at Stanford University using TSA assembly language for the PDP-1 (and more recently a PDP-10).

Remedial math for 18-20 year olds entering college developed at the University of Texas using Coursewriter II and a "general notation" for authors.

Second language instruction in German for 18 years plus developed at IBM Watson Research Center and SUNY at Stony Brook using an experimental Coursewriter and later Coursewriter II. Stylized exercise forms make this course and other course material developed at Watson Research Center by this technique easy to transfer to other systems.

Second language instruction in Russian for 18 years plus developed at Stanford University using TSA and assembly language for the PDP-1 (more recently a PDP-10).

Second language instruction in Russian for 18 years plus developed at the Department of Defense Language Training Center at Monterey using stylized forms (assembled in Coursewriter II).

Diagnostic tests and guidance in physics for 18-20 year olds entering college developed at Florida State University using Coursewriter II.

Refresher course in the "new math" for teachers developed by the Pennsylvania State University using Coursewriter II.

When it becomes important to know about nearly all work done (the list above is only a sample), two or more of the information sources in Attachment II should be contacted. For interpretation of effectiveness studies, a consultant who is well informed about instructional uses and evaluation should be recruited (See Attachment IV).

b. Effectiveness and cost relative to alternatives.

In general, computer use is more costly than alternatives although for some modes of use and some topics of study, there exists no reasonable alternative to student use of a computer.

A number of the evaluative and comparative studies report a saving in student time. Because researchers persist in global comparisons of "traditional" with "experimental" (finding "no significant differences"), decisions to change continue to be made without the benefit of experimental findings. Comparisons can be made which are useful in the decision process; the researcher who wishes to make a contribution must adopt an engineering or developmental orientation.

A few studies report greater achievement, especially for the "disadvantaged" student, that is, those who do not study effectively by themselves, or do not respond to the teacher in the classroom situation.

Usually the comparisons between computer mo and non-computer alternatives (text, film, lecture, etc.) have not allowed the alternative the same careful analysis of objectives and means, or some other motivating component such as three-person games. That is to say, the contribution of the computer component in particular has not been singled out yet.

The philosophical framework of some computer uses (e.g., for creative activity on the part of students and teachers) does not allow for objective evaluation, at least within that framework. Assessment can be done by "judgement of experts" or by construction and application of objective measures of outcomes by an outside observer.

c. Implications for developing countries.

Few, if any, of the existing learning materials can be adapted for use in developing countries.

Introduction of technology and a well-engineered curriculum appears to be an effective way to bring about change now, but it is probably not necessary to use computers to accomplish those aims.

6. PREPACKAGED SYSTEMS: AVAILABILITY AND APPLICABILITY (#11)

a. IBM 1500 Instructional System with 32 terminals (although many uses overload the system with 12-16 simultaneous users). Math drills are available from IBM, and various courses from different R&D projects, a few of them mentioned in the interpretation for Question #5. Many of the curriculum packages prepared for the IBM 1500 will be listed in one of the course abstract files mentioned in Attachment II. The 1500 is research-oriented and relatively expensive per hour of student use; IBM delivered about 25 systems. A current view of how it might be adapted for "production teaching" could be obtained from Bunderson (University of Texas, see Attachment IV).

b. Math drills have been delivered in New York City Schools using an RCA 70 Instructional System designed to handle about 200 teletype terminals; up to 150 have been serviced simultaneously so far. RCA's 71 Instructional System was just delivered to Waterford Schools in Pontiac, Michigan, and will support about 50 terminals with audio playback and visuals projection. Some projects running drill materials from an RCA 70 have since acquired some number of PDP-8's which can service 16 to 32 terminals for much less per student hour than the single large system, in part because the PDP-8 software is set up to do just the drill format. One such package, prepared by Information Control Systems, Ann Arbor, is in use in the McComb County Schools, Mississippi.

c. Other firms offer CAI software for their machines; among them are Univac Division of Sperry Rand, G.E. (General Electric), Honeywell, and Control Data Corporation. Small general-purpose systems with an educational orientation have been offered by Digital Equipment Corporation, Hewlett-Packard, and others.

d. Information about some new systems can be obtained directly from the designers working at universities and non-profit institutions. H. Dean Brown, of Stanford Research Institute has described a single terminal on a minicomputer which can be used by more than one student at a time (about $15,000 purchase price). Donald Bitzer is constructing for the University of Illinois a giant system (4,000 terminals or more) using a large CDC machine; his present operating system is based on a CDC 1604.*

*This section should be filled out and brought up to date, perhaps by Zinn, Stolurow, or Donio.

7. IN-SERVICE TEACHER TRAINING (#6)

a. Some examples in the USA.

The Pennsylvania State University CAI project, in collaboration with the Pennsylvania State Department of Education, moved an IBM 1500 Instructional System around the Appalachian region of the eastern U. S., providing a refresher course in mathematics for teachers. The equipment spends seven weeks at each site before moving on. In the fall of 1970 they hope to drive the same system around in a van.

A project in Oregon has an IBM 1130 in a truck to bring computing directly to students as well as the teachers of mathematics.

The Digital Equipment Corporation PDP-8, and others of its size, have been carried about with a single typewriter terminal in the trunk of a car for demonstrations and training.

The INDICOM Project in the Waterford Schools, Pontiac, Michigan, perhaps has done more training of teachers than any other single project. Each year about 40 teachers in the system work during the summer (and extra hours during the school year for extra pay) to learn to use computers for instruction and to prepare computer-based learning exercises themselves.

b. Potentials.

Presumably remote-access computer systems will distribute the best self-instruction materials to any part of a country, circumventing the usual barriers of teacher time, travel, expense of, and limited availability of master teachers (live), and failure of unsupervised trainees to follow through with self-instruction booklets.

Effective computer-based learning exercises for in-service teacher training should be the best means of developing a favorable attitude among teachers in the field toward the new technology. If they learn and enjoy and perceive the economies, they will be more likely to adopt the innovation for their own classes.

In-service training might be established by a "bootstrapping" technique: a few teachers in the first class themselves become "trainers" under the supervision of the original "trainer," and so on, spreading out through a school system.

c. Problems.

In-service (and pre-service) training will not succeed without a change in organizations: crucial factors are the reward system for teachers, the supervision in the field, and the opportunities for students to benefit from the individualization achievable through the new technology.

In-service training programs in the USA rarely show measurable success. Pre-service training may be a better investment of limited resources; classes of the present teaching force might be reached directly through improved libraries (learning resource centers), special activities (math, science, and computer clubs), and remedial training (community training centers).

Resistance of practicing teachers (and established administrations) can be considerable. It may be more practical to begin new institutions, which can incorporate innovations (and promote change through the entire educational system), than to struggle with existing institutions.

8. MASS APPLICATIONS CONTRASTED WITH MICRO SYSTEMS (#7)

The responses to question #5 include references to at least three systems of considerable size, the RCA system for up to 200 simultaneous users (installed initially in New York City), the IBM Field Engineering System, and the proposed 4,000 terminal system for the University of Illinois. Specific implications of these (and applied use of smaller systems) for a very large-scale effort in the educational system of a developing country should be obtained from a consultant given that particular task.

All large-scale systems have been justified for other than the training or education accomplished. The New York City project (with RCA) is a pilot experiment to identify the problems and demonstrate the possibilities. The IBM Field Engineering operation provides administrative data and more detailed learner records than possible with the same material in printed format. Training components of the airline reservation systems concern the very equipment and procedures already in use by the operator day-to-day.

9. TRANSFERABILITY OF INSTRUCTIONAL MATERIALS AND PROCEDURES (#10)

a. Computer language.

Differences in language often have obstructed translation of a procedure, even from one dialect of Fortran to another. However, this barrier can be overcome through proper documentation of the procedure, the use of meta-compilers and extensible languages, and the separation of the curriculum information (data file or instruction content) from the procedure program (presentation strategy). Actually, translation between languages is the least of the problems of transferring learning exercises from one area and institution to another.

b. Hardware-software configuration (the system).

If the use of one system exploits very lavish display and response capabilities for the student, translation of programs to lesser systems requires new judgement about how best to present a message or accept a response.

One system may provide for communication among terminals, attachment of special auxiliary equipment, and other functions now ordinarily available in current instructional systems. Research-oriented systems should be expected to be in some sense "beyond" the capabilities of operational systems; and, therefore, the most current work may not be transferable to existing operational systems.

Donio might be asked to develop a detailed statement of translation problems at the technical level (character codes, control codes, records formats, data structures, supervisory systems, etc.) with a reading by Zinn.

c. Substance and procedure.

The crucial factor is acceptability of foreign materials for students, teachers, parents, etc. The objectives and (in particular) the means may need to be adapted in each new situation. For example, the critical, questioning attitude developed with one group of learners may not be acceptable in another country--sometimes such differences account for failure of materials transported from one classroom to another in the same school system!

According to the assumptions (and related research findings) of instructional technology, one should not expect materials developed for one group of learners to work for another without new trials and perhaps revision in each new situation--with each new group of learners.

The difficult problems of translation from one language to another (e.g., idiom, connotation, and context) are small when compared with the problem of translating structural elements and methodological approaches. Studies are in process (e.g., one involving Canada, England, and Japan coordinated by Unesco); and one may hope that translation from one non-technical society to another will encounter fewer problems than from a society already complicated by technology.

For some disciplines (and for some learners), the construction of a discipline-oriented system is practical as a framework in which educators (including local teachers) build their own lessons, and students construct exercises and demonstrations for each other. Although attractive for an economically and technologically developed country which is rich in educational resources, this approach appears to be of limited use in a developing country attempting education reform on a large scale.

10. COMPUTERIZATION OF ENTIRE COURSES OR JUST PARTS OF COURSES (#8)

The computer is an expensive page-turner and device-controller. Most learners are able to manage individually quite effective use of books, tape recorders, and simple movie viewers; and these media comprise a large part of an instructional package. In fact, computer control has (at least in some exploratory studies) interfered with effective use of essentially non-computer media.

The computer-based system may be cost-effective for entire course presentations where high need (e.g., technical and professional training) combines with learner deficiencies (e.g., low motivation, sensory deficiencies, and conceptual chasms). Of course, the computer will usually be an artificial aid and should, as part of the training procedure, be replaced in such cases by factors which will operate for the handicapped person in the real world: sensory feedback ordinarily available in daily living, motives connected with useful rewards, and conceptual structures to perform and continue learning without the computer crutch.

Although many schemes must exist for identifying courses and particular learning exercises where computer contributions may prove significant, few have been verified or discussed in publications and technical reports. Zinn uses a checklist in consultation with faculty at his university (including items such as discipline relevance, procedure base, feedback required, data base, frequency of revision, alternative means, etc.). An expert might be commissioned (see Attachment IV) to review the identification (and development) techniques used by Zinn, Stolurow, Leith, Silberman, Donio, Brown, and others and to assemble a composite guide with interpretations by the individuals referenced.

A complete analysis of the computer contribution to entire courses will include the costs and success of whatever teacher training may be necessary to support effective use of the computer in separate components of a course which might otherwise remain isolated and ineffective. Effectiveness per unit cost will sometimes be greater if curriculum components not ordinarily benefiting from computer presentation are included along with others in a single package so that success of the total curriculum need not depend on human intervention.

Most full courses deal with substance which is essentially human, or for which discussion with other persons is a desired end. Therefore, it is difficult to conceive of situations where entire courses will be presented entirely by machine without interaction with adults designated as tutors, discussion leaders, counselors, or teachers. Perhaps sufficient interaction follows from typical conversations with peers, parents, and acquaintences. However, the teacher can in some limited sense represent the outside world in which the learner is expected to use his new knowledge and skills acquired through interaction with automated, self-instructional devices.

11. TRAINING FOR TEACHERS IN COURSES ASSISTED BY COMPUTERS (#9)

The training, of course, varies with the approach taken. At one extreme, the teacher participates in the preparation of the materials and exercises; and the training problem is pushed back to the stage of preparing the teacher for computer use and curriculum preparation. At the other extreme, the entire instructional process is taken over by the computer and associated software; and the manager of the system only needs to keep teachers and others from interfering. Typically, teacher training is a problem where curriculum packages and other aids are introduced into existing systems.

Part of teacher training for effective computer use should consider computers and information sciences in general and in suitable roles for instructional technology in education.

Probably modification of the incentive structure within a school will change the teaching activity and effort of various contributors to student learning more than in-service teacher training. Revised salary structure and perhaps bonuses provide incentives, but released time is also necessary to allow time to prepare for innovations. At present, attempts to innovate usually are penalized by the incentive structure.

12. RESOURCE PERSONNEL (#3)

a. General considerations.

Visiting resource persons who play a significant role in operations in a Tiers Monde country generally would stay a minimum of one year. A university professor ordinarily would wish official leave from his own institution (in order to return after one to three years). Some individuals might be obtained for an innovative project through joint agreements between institutions in two different countries.

In addition to professors, an innovative project should tap available managers and technicians from business and industry and effective teachers at the "grass roots" level in the educational system of a technologically developed country.

Probably the system planners and technicians will be found more readily than those capable of planning and writing new curriculum materials.

A project cannot count on finding resource persons in sufficient numbers from other countries, nor can continuity be maintained if persons from outside frequently rotate through the project. Selection of a strong skeleton staff and an aggressive training program should receive immediate attention.

b. Strategy for installation of equipment and systems.

A "leap frog" or "bootstraps" approach can help proliferate effective innovations. Although the first installation team may depend almost entirely on expert outsiders, it should include potential local experts and participating observers from the next likely site for introduction of the technological innovation. The nucleus of an effective installation team will then move to the next site, with fewer outsiders required, and with participating observers from still other likely sites.

Initial training and indoctrination might be at sites of technological innovation in other countries through internships and other working arrangements. Then as each new project in a Tiers Monde country helps others, reliance on personnel from outside the country is diminished.

c. Directories.

A directory of persons in the USA could be assembled by Zinn or Molnar or another expert with broad knowledge of the field and its personnel. A few very select (and probably short-term) consultants are suggested in Attachment IV.

13. ENVIRONMENTAL/ECOLOGICAL FACTORS (#13)

a. Pedagogical.

The computer-based material cannot be introduced as an independent element of a course; one must consider other components, the context provided by other courses, and the longer term implications of computer use.

Success of computer components may depend on preparing teachers to complement and add to the learner's work with the machine.

CAI (in the sense of program-controlled tutorial) appears to be more likely to be adopted by teachers and students who understand computer functions and uses, especially in an environment where technology is uncommon. A general "literacy" with computers also leads to the introduction of computers as discipline-relevant tools for learning and teaching.

b. Man-machine conditions and reactions of users.

Some media and some uses of computers are more prone to rigidity and to preserving present practices. The report of a Ford Foundation study on Instructional Television points out the problem of a new technology only crystalizing what had been done before. Drill and tutorial modes of computer use are especially susceptible to this error.

c. Sociological and anthropological factors.

Significant computer uses should also recognize the role of the teacher and parent and peer. Does the self-study experience help the learner to work more closely with his teacher; is the learner proud to show this new device to his parents; do they support him in its use, etc.?

Effective leadership for imaginative use of technology must be fostered. The established authority structure may not recognize or accept those teachers most able to lead. How are innovators to identify the potential leaders who may be "young mavericks," and encourage them without seriously disrupting the system?

Acceptance of computer technology for learning and instruction may be furthered by first promoting computer "literacy" among the teachers and administrators. That is, the innovative program should include early in its time schedule an introduction to computer functions and uses for all educators who will be involved, especially in an environment where such technological aids previously have not been known or used.

Introduction of the computer as an aid in the instructional process may be most easily achieved by introducing the computer first as an aid in the study and practice of the discipline or topic. In other words, the teacher-scholar might first see the relevance of computers and information processing in his discipline (or scholarly work in general), and then more readily accept automated assistance with some parts of the instructional program.

d. Linguistic.

Learning and using a computer language may help the same student study with other "formal" languages (in mathematics and sciences). The computer can be used by a learner to test his understanding of language and procedure in various disciplines.

Working within the constraints of a computer language may help a student to understand the nature of "natural" languages and to appreciate the need for them in spite of ambiguity and indefiniteness.

e. Educational psychology and child development.

Computer technology should help rather than hinder those who wish to attend to the diverse needs of individual children. However, when technology is misapplied, it may produce undue attention for fact instead of process, group norm instead of individual achievement, and omnipotence of machines instead of an improved view of self.

f. Administration.

For all the advantages of the systems approach to administration and planning, the label has been misapplied, at times, to justify an overly rigid scheme for management, covered by an elegant and logical statement of goals and procedures. Sometimes the casual even "sloppy" application of systems' principles proves more adaptable to local situations and more effective for local administrators.

14. <u>TIMING FOR INITIATION OF A PILOT PROJECT</u> (#14)

The state of instructional technology and computers, the problems of education, and the impact of computers on society are such that the initiation of pilot projects is quite desirable.

Conditions for initiation of a project in a particular country are given in general in the guidelines, and in particular in the statement about the proposed project in Spain. Both these documents have been provided separately.