

Prospects in education

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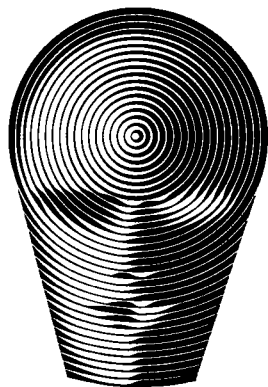
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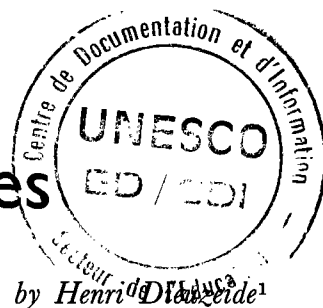


International
Education Year
1970

New techniques in education

The International Education Year has made apparent the need for a twofold effort: towards approaching the reform of educational systems in a spirit of innovation, and improving the efficiency of those systems. For both purposes, the utilization of new techniques in education provides a contribution of considerable value. It has seemed justified, therefore, to devote the greater part of the present issue of Prospects in Education to various aspects of this problem.

Unesco and new techniques in education



The present crisis in education shows that attempts to meet the demand by linear expansion are financially illusory and pedagogically outdated. In the years to come the human and material resources available to education will have to be redistributed in accordance with new, more productive pedagogical patterns: better utilization of existing installations, improved learning processes enabling the period of study to be reduced, changes in the teacher-pupil ratio, etc. From this springs the question we are dealing with here: does there already exist a set of new communication and organization techniques which would make it possible for the functioning of education to be rationalized and optimized at the level of individual learning, at the level of the group (class) or the institution (school), or even at the national level? In the areas where partial positive results have been recorded (programmed instruction, mass communications), are they suitable for general application? More particularly, are they capable of being systematically applied in the developing countries, and on what conditions? Following another train of thought, we might ask, first, why attempts to apply these results have hitherto been so few and far between, and indeed, whether any strategies actually exist for introducing these new technological developments into existing educational systems, and at what cost. Lastly, it should be asked what this incursion of new techniques will mean for the future of education and the man of tomorrow.

The Unesco programme has been endeavour-

ing for a decade to assist Member States in this vitally important investigation. Besides preparing audio-visual year-books and programmed-instruction directories, studies on the combination of audio-visual media and on the intercultural possibilities of audio-visual communication and refresher courses for experts in the technology of education, experimental projects on the development of programmed instruction have been launched in Central Africa and in Asia. Experiments in the combination of new methods and techniques for teacher training in Algeria and the teaching of mathematics in the United States of America have been organized.

The present trend would appear to be towards the abandonment of a wasteful craft approach to teaching the conviction that the teacher must not be left isolated in his class-room, and towards linking the introduction of communication equipment with a reorganization of school work on more scientific lines.

A number of studies and projects have made it possible to review the situation: the use of dynamic inertia-free networks such as radio and television enables identical innovative models to be disseminated simultaneously over large territories.² The combining of several communication networks for establishments of higher technical education allows the dissemination of

1. Henri Dieuzeide is Director of Unesco's Division of Methods, Materials and Techniques.

2. Report of the Unesco Mission to Niger, Samoa and San Salvador, Paris, Unesco, 1969.

information models for instruction purposes and demonstration by radio and television. Feedback of information through correspondence courses and face-to-face contact through work in small groups with an instructor have also been encouraged, especially in the case of the experiment of the Polish Tele-Polytechnic.¹ The possibilities of using integrated sets of equipment to give accelerated, intensive, individualized instruction by means of learning laboratories, teaching machines, individual response control systems, closed-circuit television, etc., have been examined.² The development of research on the psychology of learning, of behaviour study laboratories, and, in particular, various forms of programming of the acquisition of knowledge ('operant conditioning' in America, research on learning algorithms in the U.S.S.R.) have led to teaching problems being stated in more accurate terms of objectives, organization of the material to be learned, the nature of the learning activity, and methods of evaluation and control related to these objectives and activities.³

In the course of these studies, it has become clear that some developing countries, whose view is less clouded by educational myths than that of the developed countries, might find it easier to transform their education systems. The interpenetration of school and environment which has been attempted in rural secondary schools in Cuba, using television and programmed education, the total integration of televisual communications into the functioning of primary schools in Niger, the thousands of simplified radiophonic schools in Colombia and the techniques for rural community leadership based on the collective reception of radio and television programmes in India, lead one to think that the developing countries could usefully teach some of the developed countries technical lessons in the regeneration of educational structures and methods.

In the light of this experience, Unesco has made an effort, during International Education Year, to define what the contributions of educational technology should be, by means of a

series of expert meetings—on the training of primary teachers (Paris, December 1969), the application of systems analysis to the integration of educational technology into teaching (Geneva, May 1970), training and employment strategies (Constance, June 1970), organization and administration of audio-visual services (Conference of the International Council of Educational Media, London, July 1970).

The new techniques do in fact offer a vast range of possibilities, but their field of application often seems to be a wasteland scattered with spare parts which no one knows how to put together to form an efficient system. The first result of Unesco's work was to show the necessity of moving gradually from thinking about technology in education (i.e. from being basically concerned with equipment, the preparation of *ad hoc* messages and integration with traditional teacher-centred activities) to thinking and action bearing on a technology of education centred on the active use of mass media and computer science for the individual learning process, under the teacher's supervision. This line of thought seeks to move away from dispersion of effort (or worse still, the patching-up of shaky education systems) to the fullest and most organized possible use of all the resources of the technological era.

On the operational level, International Education Year is an important landmark, in so far as Unesco's technical assistance has enabled some Member States to begin to apply these new bearings in practical ventures. The Ivory Coast, for instance, links the reform of its school curricula with the reshaping of its primary-

1. Television for Higher Technical Education of the Employed, 1969.
2. *Consultation on Computer-assisted Instruction for Developing Countries*, Unesco, Paris, 16-18 March 1970 (doc. EDS/MMT/CAI-TM).
3. *Seminar on Programmed Instruction*, Varna, Bulgaria, 19-29 August 1968 (doc. ED/ENPRO/17); Unesco/ILO Seminar on the Application of Programmed Instruction to Technical and Science Teaching, Turin, 10-24 July 1969.

school teacher-training system and the systematic use of television in order to steer its primary education system towards ruralization and more satisfactory adaptation to the environment. In India, a new approach is emerging, involving a method of visual communication in which the new systems of mass communication, including space communication will be able to be used, as soon as they appear. In Indonesia, a systems approach is being used for the first time on a national scale to analyse the state of school organization and the position which schools radio could hold. In Spain, the possible use of a network of computers for accelerated training of the new kind of secondary-school teacher which the country most urgently needs, is being examined. Finally, the Andean states of Latin America are studying the extent to which space communication would accelerate educational integration in the region.

In all these cases an effort has been made to carry out an over-all analysis of general data

on education before deciding on the introduction of educational techniques, so that they can play their true role and thus help to improve the educational system as a whole.

Unesco's Future Programme plans to accentuate this effort (development of innovation centres, establishment of a network of research centres, bringing together of hardware and software manufacturers, setting up of task forces for questions of education regeneration).

Trying to achieve increased educational efficiency does not mean trying to substitute mechanical methods for human beings, but developing new patterns using both men and technological achievements in order to teach more people better, more rapidly, and more cheaply. The analyses in this issue will show some of the efforts which have already been made and will mention those which remain to be undertaken, in order to develop a technology which will give support to the teacher and enrich the educational relationship.

Advanced educational technologies

by Seth Spaulding¹

It seems fashionable these days to be critical of education. Most of us think we have learned enough during our school and university years to decide how it could be done better. Even those who have not finished their schooling are demanding drastic changes or even complete abolition of certain kinds of educational institutions as we now know them.

Much of this, I suppose, is as it should be. Certainly, educational institutions must, in part, reflect the aspirations of the community, of the parents and of the clientele, the students. And, although education must be credited with helping create the good things of life, it also can be criticized for not changing rapidly enough to cope with many of the critical problems of today and of the future. What is the score to date? Quantitatively, the record is astounding. On the positive side :

1. We have, in most countries, provided more and spent more on formal education in the last twenty-five years than we have in recorded history. Educational enrolment has more than doubled in most countries since 1950.²
2. Within one man's lifetime, since the turn of the century, the educational systems of the world have produced 90 per cent of all of the scientists and technologists who have ever lived.
3. The products of our educational systems are so creative that they are doubling our store of knowledge, we are told, every five to ten years, especially in scientific and technological fields.

4. The human minds prepared by our educational systems in the recent past have published more books and periodicals in the past quarter-century (both numbers of titles and numbers of copies) than have been published in all of history.
5. The graduates of our schools and universities have led us, in virtually every field, at such an accelerated rate that, by all quantitative indicators, more has happened since the turn of the century, and in many cases since the mid-forties, than in all of recorded history. This holds true no matter what index of change is chosen: the number of health-saving procedures available to us, the speed of transportation and ease of communication between individuals and countries, the number and kind of labour-saving devices, explosive power we can generate.

The record is, then, impressive. We are, in essence, providing more education than ever before in history and the products of our systems are apparently more creative than all of our forefathers put together.

But let us take a look at the other side of the coin:

1. For all of the quantitative expansion of education, we still have more and more illiterate
1. Seth Spaulding is Director of Unesco's Department of School and Higher Education.
2. Office of Statistics, Unesco. At the first level, enrolments have increased by 83 per cent, second level by 140 per cent and third level by over 200 per cent (world averages).

adults in the world each year. Estimates are that there will be a world total of some 810 million adult illiterates in 1970, compared to 740 million in 1960 if the present rate of increase in illiteracy continues. In Africa alone, there will be about 4 million more adult illiterates each year during the 1970s if current projections based on what seems reasonable are accurate.

2. Despite tremendous increase in educational expenditure in virtually all countries, in many so-called 'poorer' countries, it is likely that as many as one-third of the school-age children will never see the inside of a school during the seventies. Of those who do enter elementary school, less than one-third will finish the elementary cycle. As many as 50 per cent of the students in upper elementary grades are repeaters. These wastage and repeater rates in many educational systems both make the cost of successful graduates phenomenal and, at the same time, continue to swell the ranks of illiteracy and semi-illiteracy.
3. Although virtually all governments now recognize education as largely an investment rather than a social expenditure (and most international agencies are willing to fund educational projects as such), there comes a point when greatly increased expenditure (as a proportion of the national budget or of the gross national product) is impossible. Many countries are reaching this point and are finding it difficult to meet the quantitative targets suggested at various international conferences on education.
4. Quality-wise, there are grave questions as to whether what we are doing in education is relevant to contemporary and future problems of the community and of the world. 'Education', as the Director-General of Unesco stated in a recent address, 'is the pre-condition for man's true integration into reality and his dominion over history.'¹ Has the content of education kept up with the accelerated change for which education is, in part, responsible? Does education prepare

its captive audience to deal with the pollution problems, population problems, the problems of peace and the problems of technological living that are unique to this century and to the future? Probably not as it must. If succeeding generations do not deal with these problems more effectively than we have in the past generation, it will soon be too late. Yet we continue to prepare students in formal school systems which often look and teach much like they did one, two or even three generations ago.

5. The way we manage and administer our educational enterprises would probably bankrupt any other kind of business. Although education has shared in the creation of the technological age, education itself has not learned how to use the fruits of technology to improve the efficiency and the quality of its own institution. In attempts to 'catch up' quantitatively, education has usually attempted to multiply what has gone on in a pre-technology system of schooling.

In essence, we have provided more and more money to do more and more of what we may be doing poorly. But we have suspicions that we might be able to do it better. Let us look first at how we might create new research and development institutions to make possible curriculum reform, and then at how we might apply educational technologies to make the curriculum more effective and the school more efficient.

Curriculum research and development

It makes great sense to begin with the curriculum when one is interested in educational improvement. After all, the curriculum is the stuff of education. It is what we teach, what the students 'get', what we examine for and what we give certificates and diplomas for when the students complete it.

But what precisely is the curriculum, where

1. Address to Economic and Social Council, 17 July 1969.

does it come from, how can we be sure of its relevance, and what kind of continuous progress is necessary to be sure it is continuously relevant in the future?

In order to answer these questions, the curriculum must be defined in terms of how and what we want the students to know, do, think and feel when they are no longer captives of the school. As we try to so define the objectives of the curriculum, we must keep in mind what kinds of information, skills, thoughts and feelings the children bring with them when they come to school, what kinds of things are happening to them outside of school and where they will likely go and what they will likely do when they finish school.

One of the reasons for current student unrest throughout the world is the fact that curriculum reform has not been continuous and the curriculum has not been entirely relevant, neither to what the student brings to it, nor to what the student expects from it. The student in today's secondary school and university is a very different kind of person from the student of a generation or two ago. The information explosion has affected the younger generation. The secondary-school student has probably learned more out of school than he has in school and the university student often feels much closer to the problems of his nation than does the professor who lectures to him. Yet the curriculum has changed little to reflect the changing nature of the students and of the society in which education exists.

Similarly, we know that in many countries only one out of every ten students entering primary school will finish, yet we have a linear curriculum which assumes that the purpose of primary school is to prepare the student for secondary school. What could be done, instead, that would be useful to children—no matter how few years they attend?

In the same vein, how do we define what should be done in technical education? How is technically biased education related to general education? If technology is changing at such

an accelerated pace, does it make sense to have several kinds and levels of technical schools, or should many technicians be trained on the job in industries and organizations that know what they need?

What about traditional subject-matter areas? Are these structured so as to teach the behaviours we think are necessary for survival in the next generation? What do we teach students to know, do, think and feel about population problems, about the role of the family in the future development of their country, about what each of us can do about pollution problems, transportation congestion, peace and war?

In essence, are we asking the right questions when we build a curriculum? Do we have the right institutions and the right people involved when we make curriculum decisions? The students beating on and rocking the foundations of our institutions may be right.

The new curriculum approaches

Academicians in the physical sciences, as indeed those in all academic disciplines, have become in recent years interested and involved in the curriculum problems of the elementary and especially the secondary schools. The new curriculum approaches in biology, physics and mathematics were the forerunners of new curriculum approaches in other subject areas, including foreign languages, history and social studies.

The strength of most of these new curriculum approaches is that they attempt to define the processes at work in each discipline and attempt to develop ways of teaching these processes. The assumption is that students will then think like scientists, historians, or what have you, and they will thus be able to keep up with the accelerated rate of change. We have little experience, as yet, in watching what happens to students who have come through these new curricular programmes to know if, indeed, they have learned to think like academicians and if, in fact, this does them any good. Certainly we have

no answer to the question as to whether a student should think like a biologist or physicist as opposed to a philosopher, a demographer, a historian, a psychologist, or an anthropologist.

Presumably, one of the basic needs in most countries is for more *entrepreneurs*, more organizers and doers and ground-shakers; better administrators of government, more achievement-oriented businessmen. How many scientists do you know who are any of these things? Perhaps people are better if they know something of the processes of science, but what are the other things they need to know, do, think and feel in order to become agents of development in their countries, and how can the schools teach these things (or how can we create the environment so that students can learn them)?

Institutionalizing the curriculum development process

One of the basic needs in most countries is a substantial investment in new kinds of action-oriented curriculum research and development institutions to continuously seek answers to these kinds of questions. These institutions must first deal with the establishment of broad curriculum goals. Inputs into this goal-setting process must come from the community (what do parents and the public want in the way of education for their children?), the government (what are the political and economic goals of the future within the context of which the children will live when they leave school?), and from the various institutions which must interact with the educational system (what are the needs of industry, agriculture, government, etc. for certain kinds of manpower, what other institutions offer educational services, etc.?).

Once the broad goals are clear, the technology of curriculum building can begin. Inputs here must be provided by subject-matter specialists (what is the nature of the content in each area and what are the thinking processes involved?), pedagogues and psychologists (what are the best ways of 'mediating' whatever it is you have

decided must be taught?), sociologists, anthropologists and economists (what is going to be the effect on society and on the economy of what you are trying to do in the curriculum?), school administrators (how can you create and manage a school that does all of this well?), teachers (is it feasible to do this in a class-room or some other environment that takes the place of what we know as a class-room?) and teaching-materials specialists (how do you package all of this in the form of materials and display devices that can be used by the students and the teacher, in the teaching-learning environment you have defined, to achieve the goals agreed upon at the beginning of the process?).

This kind of curriculum-building process would begin to make use of the technology available to us. It would represent a scientific approach to the applied art of teaching. It would make possible a systems approach to curriculum planning (or at least a 'systematic' approach), whereby various goals as seen by different sectors of society are considered and a matrix of goals agreed upon. Once these broad goals were set, behavioural goals would be suggested in very concrete terms. Alternate teaching strategies and materials would be tried in schools and universities until these strategies and materials were found to be effective and efficient. Collaborating teacher-training programmes would adapt their programmes to train the kinds of teachers needed to manage the new educational approaches. New kinds of school financing and school facilities would be developed to make possible the new strategies and approaches.

All of this would require specialist talents not usually found in ministries of education in large numbers. It would require a commitment on the part of government to invest moneys where heretofore they were not spent. It would require interdisciplinary collaboration among disciplinarians who must work together in the designing of a total school curriculum that is complementary—where we worry about the total school environment as well as each of the subject-matter areas in the curriculum.

Technological devices in education

A true technology of education includes the entire process of the setting of goals, the continuous renewal of curriculum, the trying out of alternate strategies and materials, the evaluation of the system as a whole and the re-setting of goals as new information on the effect of the system is known. However, educational technology is often identified with the various devices and processes which make possible the recording, storage, manipulation, retrieval, transmission and display of data, information and printed and photographic material with an efficiency and speed unheard of even ten years ago. If these capabilities are considered as part of a broad curriculum for research and development design, they have tremendous potential in education.

Technological devices and materials useful in the instructional process range from those which help the teacher develop and present his material more effectively in a more or less traditional class-room to those which completely alter what goes on in the class-room, including what the teacher is expected or required to do. A number of technological devices can be useful in both instruction itself and in the management of administrative data that is necessary in modern mass education. The computer, for example, can be used to make new kinds of administrative strategies possible (by, for instance, making complicated individual tests of students and the flexible scheduling of classes feasible) and, at the same time, can be used in the instructional process itself in the more efficient manipulation of instructional materials (computer-assisted instruction).

The unsophisticated enthusiast often believes that new educational technologies will quickly and cheaply resolve the current problems of education. These enthusiasts usually underestimate the complexities of education and the immense problems inherent in changing the way we go about education so as to permit the new technologies to contribute effectively. Let us examine, briefly, the past and the likely future of some of the educational technologies.

The audio-visual aid

It seems reasonable to assume that it is good to have devices that help the teacher do better whatever it is he traditionally does. It is in this vein that the so-called audio-visual movement has run its course over the past two generations.

Many of us have visited schools which have been proud of all their audio-visual equipment. We are shown store-rooms full of tape recorders, slide- and filmstrip projectors, 16-mm film projectors, overhead projectors, record-players and the like. Often, much of the equipment is very dusty and much of it may be out of service for the need of minor repairs. If the equipment is heavily used, it is usually by the few teachers who take an interest in it, or because of a selfless teacher who has become the 'audio-visual co-ordinator' and who acts as a missionary among the other teachers.

These 'first-generation' educational technologies have suffered (and continue to suffer) from ineffective utilization because they are usually not conceived of as part of an entirely new strategy of instruction which requires new kinds of administrative support, new kinds of curriculum materials (software) suitable for presentation via the devices (hardware) and new ways of managing the materials so that they are easily available to the teacher. For instance, there may be a 16-mm film library available to the school, but it is usually a complicated process for a teacher to locate an appropriate film in the catalogue, order it for preview, then again for the class-room showing. Add to this the borrowing of the cumbersome projector, the setting up of it in a class-room that is usually not designed for projection, the taking of it all down again, and you have the full picture of the reason why most class-room teachers are not excited about the use of 16-mm films.

If we were really serious about the use of one medium, such as the 16-mm film, in an educational system, the problems such as the above could be resolved through over-all systematic planning of needed services. These would range

from the prior selection, by curriculum-planners, of existing films for use at certain points in the curriculum to the development of new films where existing films do not do the desired job. Administrative problems which impede the use of the films could be resolved through the provision of new services (perhaps a film library in each school), the permanent installation of projectors in each class-room, pre-focused and ready to use.

On the other hand, there may be alternate strategies for improving the teaching process which would be more efficient, more suited to the flexibility we want in the class-room and easier to adapt as the curriculum changes. For instance, why bother with 16-mm at all, now that we have 8-mm, cartridge-loaded projectors available? With these, it is conceivable that each class-room could have, say, in science, a shelf of film cartridges, each showing one of the essential demonstrations of the course. Students and teachers alike could take the cartridge whenever they wish, insert it into a rear-screen projector of the size of a television set, and review a selected demonstration. If the teacher has creative abilities, he could make his own cartridge films as well, but it is likely that a pre-prepared set of film cartridges would be part of a curriculum package developed by a curriculum research and development centre.

The overhead projector has similar potential. This was originally used as a kind of substitute black-board, and very effectively at that. The teacher can look at the students while writing on the transparency with a grease pencil, and whatever he is writing is projected on the screen over his shoulder. But recently curriculum planners have been making available complete sets of prepared transparencies. The transparencies are a packaged teaching methodology and they provide the skeleton for anything from one teaching unit to a complete course. If the teacher uses the transparencies in the right order and as per instructions, even the most pedestrian teacher can make a good class-room presentation. A good teacher, of course, goes far beyond the

basic suggested presentation of the set of transparencies and becomes, with their assistance, an excellent teacher.

In essence, these second- and third-generation teaching devices and materials are making approaches possible that go far beyond the first-generation 'teaching aids'. They increasingly depend on more and more sophisticated packaged software which is provided for the teacher and which can come only from curriculum research and development efforts. They similarly depend more and more on global planning of what goes on in the class-room and a re-budgeting of how moneys will be spent in the instructional process.

Mass-instruction technologies—efficient and/or effective?

Strangely enough, at one end of our educational spectrum, some experts are stressing the need to adapt instruction to individual differences while, at the other end, some are advocating systems of mass instruction which involve thousands of students simultaneously watching the same instructional sequence via a television screen. Certainly, the piper of television and radio often hypnotizes the unwary into believing that these mass media can somehow suddenly educate all our children painlessly and cheaply.

We not only have television stations which have a range of 40 or 50 miles but we have satellites which will make it possible to transmit educational programmes to an entire continent or to several continents at the same time. Hot and heavy controversies are under way in many countries as to whether or not the way to resolve their educational problems is through direct-broadcast satellite (a system whereby slightly modified television sets can receive directly from a satellite) or through ground-based satellite systems (stations on the ground which depend on satellites for inter-connexion).

Evidence, as yet, is extremely meagre as to how effective television can be in contributing to the quality or efficiency of what goes on in our schools. Couched in its most fundamental form, the question is simply: what can and should

be done simultaneously on small television screens in each class-room of a country that would raise the quality or improve the efficiency of instruction to such an extent that it could not be done better, more cheaply or more conveniently some other way?

The ability to bring a wealth of outside experiences into the class-room at the flick of a switch excites the imagination. But the definition of what this should be, its planning, production, broadcast and use in schools must be part of the over-all curriculum research and development process already described. In many cases, it might be more appropriate to provide libraries of 8-mm cartridge films than to produce an instructional television course. In other cases, a set of transparencies to help the teacher, plus sets of workbooks for students, may be more effective than a television course. Certainly, the concept of substituting television 'lessons' for broad ranges of activities in the school is to be discouraged.

The elements of successful broadcast instruction

Of course, one might decide that at certain stages in the development of an educational system it may be useful to present a core of sequential instruction via television or radio because of the lack of highly trained and experienced teachers. If other alternate strategies of improving what goes on in the class-room have been carefully examined and discarded as being less appropriate, television is certainly worth a try. In such circumstances, the technical problems of getting the material broadcast are important. But, as demonstrated in Samoa, Colombia, Niger, San Salvador and elsewhere, transmission problems are much less important than: (a) the planning of what needs to be broadcast; (b) specifications of how it will be used in the class-room; (c) development of the materials which will be needed by teachers and students along with the broadcast; (d) development of feedback and evaluation devices to find out what is happening in the class-rooms;

(e) establishment of a system for interaction with the teachers so that they know what to do and feel a part of the system; and (f) constant revision of the entire strategy as the teachers, students and the context of the educational system change.

It is unlikely that such a system would save money in the sense that many more students can be enrolled at less *per capita* cost. The cost of education per enrolled student would probably rise, but the cost of the successful student might drop. Additional quality bought for the additional investment might be worth it in achieving less drop-outs, less wastage and better efficiency.

As with any other educational strategy, there must be a full financial and conceptual commitment if such a system is attempted. An instructional television scheme operated on a shoe-string is doomed to failure.

Out-of-school uses of television or radio require the same sort of planning. Although experience has shown the drawing power of television, its effectiveness as an educational medium depends largely on the infrastructure at the receiving end to encourage continuous, sequential viewing and interaction on the part of the audience. Thus, the occasional programme on agriculture probably has little identifiable immediate effect but 'farm forums', which are organized around reception centres, may be more effective. Similarly, attempts to teach literacy via radio and television have been discouraging, except when broadcasting is used within a system to encourage adults to meet in groups to watch the programmes as a part of a literacy class which includes more than television viewing or radio listening.

Broadcasting has been used successfully, also, as a supplement to correspondence courses. Again, the broadcast programme is rarely sufficient in itself to provide the core of instruction, in large part because of its inherent limitations (it cannot, for instance, be re-read and studied at leisure). But, in conjunction with sets of self-study materials and a system for sending assignments to a central location for assessment and help, broadcasting can offer a significant contribution. The cost of the broadcasts in such

a system may be the least of the investment necessary. The preparation of the self-study materials and the supervision of the correspondence activities will probably be much more costly and will require much more administrative infrastructure than the broadcast portion.

Broadcasting within broader educational strategies

Current attempts to promote broadcasting, and especially satellite broadcasting, because of its possible benefit to education, are often misleading. Broadcast-satellite systems are probably a good investment for many countries because of the advantages they would provide in telecommunications in general, but to imply that any educational problems would, in themselves, be resolved by satellite broadcasting is simply naïve.

On the other hand, the technology of broadcasting has much to offer within the complex structure of formal and informal education. Educators must learn how to use the medium, however, and learn how to integrate broadcasting into an over-all educational strategy. This will often mean changing the way we do things in a traditional class-room, if a broadcasting-oriented system is decided upon. It will also mean that broadcasters will have to collaborate with learning psychologists and educators in developing new styles of instructional broadcasts. There is much too much carry-over from show-business in most educational television. Good instruction is not a 'show'. Nor is it the 'talking face' of a teacher.

Other than broadcast uses of television and video-tape, equipment may, in the long run, be more significant in instruction. For instance, closed-circuit television systems within a school would provide much more flexibility in displaying instructional sequences when the teachers in that school want them, rather than when they are broadcast by some central authority.

Similarly, portable video-tape equipment is increasingly used in the training of teachers.

Student teachers, for the first time in history, can record their teaching performance on video-tape and then see themselves teaching. If this is done within an analytical scheme which helps them judge their performance, it can be very effective.

Programmed instruction

At the other end of the spectrum from broadcast instruction we have those interested in programmed instruction. In a sense, these are the educational technologists who are interested in doing micro-analyses of the teaching-learning process so as to be able to construct a series of self-instructional materials which will, most of the time, teach what you want to teach. Behaviours to be taught are clearly defined, teaching steps are developed and tried out until they seem to work with most students, and with each step there is some sort of active involvement on the part of the student, often a response to a question or the filling in of a blank space. The instructional material informs the student if his response is correct or not, thus presumably providing reinforcement. The two basic approaches have been the 'linear', in which it is assumed that all students should move in a linear fashion through all frames (each at his own speed), and the 'branching', which assumes that a student who can move fast will be branched to fast material and one who learns more slowly will be branched to remedial material.

The early applications of programmed instruction were limited both in conception and in format. Psychologists who were new to the teaching-learning field would break the simplest concept into dozens of steps in an instructional programme which would then be very cumbersome and time-consuming to use. The same concept could often be taught much more simply by a well-written, pre-tested and revised paragraph requiring a few seconds to read.

Similarly, extravagant claims were made to the effect that anything which can be defined can be taught by paper-and-pencil-type pro-

grammed instruction materials. Anything which can be taught by a well-written book can be taught by a well-written programme, but there is much that cannot be taught through reading alone, whether the words are strung together in a programmed-instruction format or a traditional book format.

Early technical arguments as to whether linear programming or branching programming is best have given way to broader considerations as to where programmed materials fit in the total curriculum process, and attempts to conceive and try out broader new strategies of instruction that go beyond paper-and-pencil programmes. It is not likely that entire courses of study in paper-and-pencil programmed-instruction form will ever become very popular. They are simply too bulky for easy use, too costly to produce and distribute. It is more likely that programmed-instruction units will be increasingly used as parts of more sophisticated curriculum packages, perhaps as integral parts of new kinds of textbooks or perhaps as units cross-referenced with the textbook so that students can pick the programmed-instruction unit off the shelf if they have trouble with the more succinct presentation in the text.

Individualized instruction

In the long run, programmed instruction's most notable contribution to educational practice will probably have been the popularization of the notion that you can and should try out and revise instructional material to be sure of precisely what it does to typical students before you distribute it widely. On the other hand, many early programmed-instruction enthusiasts have become interested in the more complex problems of something called 'individualized instruction'. As most often used, this refers to attempts to establish behavioural goals within the curriculum of a school and to establish procedures whereby the progress of each student is continually charted and whereby what he does and what he studies day to day and even

hour to hour is determined by his individual progress toward these goals. Only a few examples exist of the experimental application of such an approach (one of these is the Individually Prescribed Instruction Project at the Baldwin-Whitehall School System near Pittsburgh, Pennsylvania, undertaken in collaboration with the Learning Research and Development Center of the University of Pittsburgh). It is not difficult to chart a model of how such a system might operate, but it would be fiendishly complicated to administer on any mass scale, unless great use is made of computer technology and newer methods of data and information storage, manipulation, retrieval and display.

In order to make possible fully individualized instruction, there must be constant, day-to-day, even hour-to-hour assessment of how well each student in the entire school is doing, so that he can be appropriately guided (or guide himself) to the next appropriate learning experience. This assessment must be built into the learning materials he is using. This would be possible on a mass scale only if such materials were computer-based and if the computer were automatically informed in some way of everything every child did. In this way, both teacher and student could have a full record of the learning accomplished at any point in time.

Many of the learning sequences would be stored in a computer-managed programme and brought forth on a display console as demanded by the teacher or the student, or as the computer analysis of the student's cumulative history so suggested. In the ultimate, most of the learning activities available in the school could be scheduled by the computer programme. For example, when five or six students out of the entire school find themselves studying a similar controversial point in history, the computer programme would direct these five or six students (and no others) to enter into a round-table discussion of the matter. At the same time, the computer would select a room that is free, might suggest the questions to be discussed (displayed on a display console resembling a television

screen), and would direct the students to return to inform the computer of the results of the discussion so that this could be entered (again automatically) into each student's cumulative record. It might also, of course, automatically notify a teacher it knows to be free that hour that the discussion is to take place, and the teacher would inform the computer that he would attend or that he wanted this to be a discussion not disturbed by a teacher.

So far, attempts to individualize instruction are much more limited, but inspired by the long-term view that something like the above may be possible. Such an approach in the ultimate would require the systematic analysis of all available learning experiences in a school curriculum and decisions as to how youngsters should be guided through these experiences, according to the interests and abilities they demonstrate day by day and week by week. It would require the development of a fantastic amount of new curriculum material and student assessment procedures in such a form that they can be managed by a computer-based system. It would require very sophisticated computer programming, even to the extent of providing fourth-generation computers with the ability to create new instructional sequences as the need arises.

Our present notions of children in a lock-step curriculum, grouped in class-rooms managed by one teacher, would have to be radically modified with such a new approach. Our present notions of what a teacher must know and do to be a good teacher would require drastic alteration.

Curriculum research and development and the technology of education in developing areas

It is often suggested that developing countries cannot afford to invest in curriculum research and development centres and in educational technologies. I would take the contrary position: they cannot afford not to. Although wealthy

countries can, to a degree, sustain inefficient educational systems because they can better afford it, the poorer countries cannot tolerate such waste.

The need is clear for new kinds of product-oriented curriculum research and development institutions at the heart of educational systems in developing countries. New approaches to education cannot emerge spontaneously in this age of technology. There must be a structuring whereby those with the various inter-disciplinary skills and interests and resources can work together, with the necessary financial support and authority to change the way education is conducted. As we have come to accept educational planning as an institutional entity in most countries, we must come to accept research and development institutions which are constantly developing, trying out, revising and improving the curriculum, methods, materials, strategies and technologies of education.

There must be more than a patch-work approach to curriculum innovation and reform in each country. The introduction of remarkable new curriculum materials in one science area, for instance, will do little good if the rest of the curriculum is archaic, if the rest of the programme uses inadequate methods, and if the school environment and teaching resources as a whole are impoverished.

Initial and continuing investment in systematic approaches to education which involve educational technologies is generally high. Most such technologies, however, permit the unlimited distribution of the fruits of this investment to the point where *per capita* student cost is very low. The production cost of a good textbook or of a good instructional television series or of a complete set of single-concept 8-mm cartridge films for an entire course, or a set of programmed-instruction materials, for instance, is substantial, as is the cost of gearing up the school system to effectively use these materials. But with thousands of students using the textbook or viewing the television series or using the cartridge films or programmed-instruction materials, the percen-

tage of the national educational budget would likely be very low.

Even computers can be used more extensively in education in developing countries. There are few countries where computers are not already being used by several government ministries and by various businesses such as banks. Very often these computers could be used by the educational authorities, at the very least, to improve the administration of education. The better handling of student-flow data, student records, teacher and employee records and the like could be done on time given by or rented from those who now have computers. Many ministries of education, of course, already have their own computers and, in these cases, experiments could proceed with computer-assisted instruction with on-line terminals in schools. Similarly, most universities now have computers, many of these under-used, which could be helpful in university administration and in new instructional approaches.

The first step by any country wishing to establish an appropriate agency for educational development and change might be to do a survey

of all the patch-work pieces that already exist. Many countries already have pilot curriculum research and development centres in science or other curriculum areas. Many have some sort of educational or instructional broadcasting. Many have some interesting, innovative work going on in teacher-education institutions. Many have film-production centres and audio-visual service agencies. Many have educational publishers and teaching materials companies which would collaborate fully in packaging and in helping distribute the fruits of innovative new approaches, if they are invited to collaborate.

A new kind of educational research and development institution which articulates all of the above would have to have a doctrine and mission which would take it beyond the sum of its parts. To learn how to create and manage such institutions is one of the major jobs ahead in all countries. For the major task of the future is to learn how to institutionalize for appropriate innovation and change in education.

The time is right and the technology is with us. In another decade it may be too late.

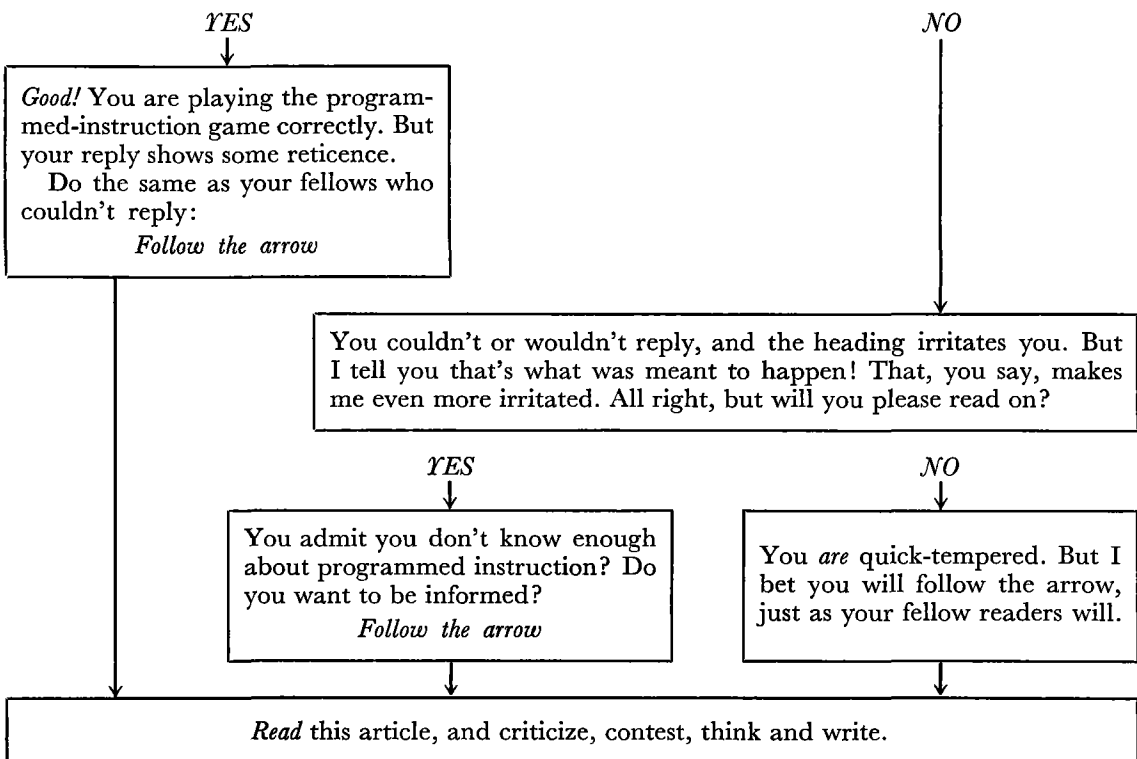
Programmed instruction

by Jerry Pocztar

Programmed instruction is:

1. Good, but too dear for us.
2. Cheap, but
(fill in)
3. No good to us.

Does (3) mean you wish to reply in more detail?



Various experiments in so-called 'programmed' instruction are at present under way in the developing countries in Africa and elsewhere. Not all have as yet produced conclusive results. But opinions both for and against them have been expressed, and on the basis of these opinions irreversible judgements have been passed on the various techniques which go to make up programmed instruction. It is interesting that this method is being subjected to the very criticisms which it was designed to meet. It was heralded as the education of the future, obeying the laws of science and using the methods of industry. The accusation made against it is that the use of such means will affect the quality of the students. What sort of an adult will such educational methods produce? Some say 'a happy, standardized robot'; others, 'a man who has mastered techniques, and who will consequently be fitted to play a constructive part in the community'.

Such discussion is very far removed from the way in which experiments are actually developing. People speak of programmed instruction 'in general', as if it were possible to talk about its defects and its qualities without taking into account those concerned with it. One might go further, and argue in equally general terms, but far more dogmatically. For example, a regional inspector who was taking up his appointment in an African country, on reading a programmed lesson, declared without a moment's hesitation: 'Programmed instruction does not suit the developing countries.' His remark was the essence of a number of objections based on very little study of the subject, no knowledge of programming techniques, and no means of judging how they fitted into the context.

The remarks quoted above and the inspector's reaction do in fact bring up two serious problems. In the former case, the subject of concern was how programmed instruction might affect the education which a child receives; in the latter, what expense it involves, and whether it is an economic proposition. We can combine these two concerns in one question: does programmed

instruction really improve the qualitative and quantitative efficiency of an educational system, without being such a burden on the national budget that it impedes the development drive?

I should like to answer this question by referring to experiments now in progress, and I hope this will provide material for thought and for discussion. As we shall see, when we know more about the subject the question will have to be re-worded and qualified. I should therefore like to set the discussion on the right lines from the outset, by referring briefly to certain facts and defining certain terms; many a false problem disappears once we know what is meant by the specialists' jargon.

Programmed instruction was invented by an American psychologist, B. F. Skinner, who through laboratory research discovered certain laws of animal behaviour. He thought that these could be used applied to teaching—and to teaching human beings. Programmed instruction, then, can be thought of as the application to teaching of discoveries made in the course of experimental laboratory research.

How is the pupil given a programmed lesson?

Never directly by the teacher: the teacher's role as 'communicator' of the lesson is taken over by a device which we shall call a 'medium'. This may be some sort of workbook, similar in external appearance to a textbook. It may also be a machine which the pupil operates each time he takes the next step in his lesson. Some machines require no operating, and stimulate the pupil—or challenge him—when he shows how he reacts to what is being taught. Machines of the latter type seem to take the initiative and arouse the pupil's interest. The most striking experimental results are achieved with computers. But books, workbooks and 'teaching machines' of greater or lesser complexity, the outstanding example of which is the computer, are all 'media'. To the extent that their function is to replace the teacher in his role of communicator of the didactic message (the content of the lesson), we may say that they are 'automata'. So then we have automata that can use words, automata

that can teach. How do they do their job? Before explaining this, let us look at an example adapted from one used by Skinner in his book *The Technology of Teaching* (translated into French under the title *La Révolution Scientifique de l'Enseignement*). The problem, simplified here, is to teach the spelling of the word 'aerodynamic'.

automaton is a book) or by word of mouth (if he is recording his voice) or by some other means.

When the pupil has replied, the automaton asks him to go on to the next item, where he finds: the correct answer (the question was so well framed that he sees he has not made a mistake).

AERODYNAMIC means: shaped so as to offer little resistance to air.
Modern automobiles have an *aerodynamic* form. Copy the word here:

1

Part of this word can be found in *dynamism*.
In both cases, it comes from a Greek word which means *force*.

2 A E R O M I C

Part of the word can be found in *aeroplane*. It means *air*.

3 D Y N A M I C

The two empty spaces represent the same letter.

4 E R O D Y N M I C

Modern automobiles have an . . . form.

5

The numbers at the left indicate the stage: the pupil is always at one stage only; the function of the automaton is in fact to move him on to the next stage only when he has completed the previous one. This can be done in a book if the successive stages are set out on separate pages.

The teaching machine achieves the same result automatically.¹

Each stage is called an 'item', and comprises several components:

a minimal piece of information, followed by a question about it, so phrased as to call for an answer which makes the student deal with the information in such a way that the answer is correct;

the pupil gives his reply, either in writing (if the

Pleased and encouraged, he goes on, and comes across:

another piece of elementary information, followed by

a question which he answers correctly, and, encouraged and pleased, he continues till he reaches the end of the lesson.

1. This example is enough to give any reader an idea of 'machines'. If we were going to deal only with the question of the cost of such machinery, this one example would be enough. We must make this imaginative effort if we are to realize the scale of the problems we are facing. It is worth making the effort. Think about it a moment, and talk it over with your friends.

Thus all pupils go through the same stages, from item to item; this type of programmed lesson is called 'linear' or 'Skinnerian'. Since all pupils can use the machine individually, they go ahead quickly, and things are so arranged that all get to the end of the lesson, since they have moved along rapidly, encouraged and pleased, from one correct answer to the next.

This is where objections are raised. Let us leave them aside until we have listed the advantages. Here we have a system of teaching through success, made possible by the use of anonymous teachers who can go over the points again and again without irritation or weariness, as only machines can do. They also have the patience to put up with the fact that Jeremy takes three quarters of an hour over a lesson which his friend Peter, in the same class, learns in twenty minutes.¹ Individual pace, very carefully planned progress, active response and immediate checking, independence in learning—these are the basic principles of programmed instruction.

There are other ways of setting out a programmed lesson: the best-known is the proposal put forward by N. Crowder, an American scholar. This, too, consists of items, but they are of a different type. The 'information' component is larger and more concentrated. It is followed by a question which the pupil answers by choosing from several possible replies: hence the name 'multiple-choice programmes'. If the answer is the right one, the pupil moves on to another item, in which he is first congratulated, and then once more taken over the argument which led to the right answer. Next another piece of information is introduced, another question is put and so forth. Any pupil making a mistake is moved on to an item which indicates where he went wrong. What happens after that depends on the nature or the seriousness of the mistake. If it seems to be due to a lack of information, more 'information' is provided, and then the pupil is sent back to tackle the same question. If the fault is more serious, an attempt is made to bring home to the pupil the causes of his fault by showing him what was wrong with his

reasoning. After being given a sort of refresher course, he may be sent back to the question he answered badly, or allowed to continue, or perhaps given items in which the exercises are easier.

Crowder's programme, then, allows for the possibility of error, and tries to bring the error out into the open in order subsequently to treat it and eradicate it. Moreover, the object is to bring all the pupils successfully through to the end of the lesson, although the path followed may differ from pupil to pupil. This is why it is also called a 'branching' programme. But, obviously, for any one pupil progress is linear from the beginning of the lesson to the end.

This brings out an important feature of programmed instruction. Wrong answers are provided for because it is assumed that pupils will follow a reasoning such as will lead them to those wrong answers. Thus the item can be thought of as a real test by which a hypothesis relating to the pupil's mental processes can be verified. The learning process is arranged according to the way in which successive hypotheses are confirmed. The essential feature of programming is that it provides for absolutely all eventualities, and always makes the lesson suit the pupil's ability. From the point of view of the teacher working out such a lesson, programmed instruction is the whole set of techniques which he uses to achieve this result.

We shall not describe these techniques, but merely consider, in the light of experiments now in progress, what fresh contribution they bring to our concept of teaching. Let us first look at some of the results achieved by 500 pupils in first-year classes of colleges of general education

1. It has been proved experimentally that in any class some children take twice as long as others to learn the same lesson. It has also been found that the 'slowest' are not necessarily the dullest, nor the 'fastest' always the best. This fact, easily ascertained by the use of programmed instruction, also calls for an explanation.

in Congo (Brazzaville).¹ These pupils studied almost half the material taught in their mathematics course by means of programmed sequences. At the end of the year, almost 80 per cent of them were judged ready to move up to the second form. We tried to determine what part the teaching of mathematics had played in these over-all results.² The following were the over-all conclusions.

Of those who went on to the second form, rather more than 80 per cent had an above-average mark in mathematics; the difference was almost 1.5 marks. These pupils' mathematics results helped to secure their promotion to the next higher class, in that they improved their over-all standard. The rest (rather less than 20 per cent) had a higher over-all average than in mathematics. The latter subject was of no advantage to them, but it should be noted that the difference was only 0.75 marks.

Of the pupils who failed, 75 per cent were not handicapped by mathematics, since their results in that subject were almost 1 mark better than in all their other subjects. In the case of the remaining 25 per cent (i.e. about 5 per cent of the total number of pupils under consideration), their over-all average, which was below the pass mark, was still further brought down by their average in mathematics. The difference was about 1 mark. It is to be noted that only a few of these pupils failed because of their results in mathematics.

Such findings, even if so briefly stated, appear to speak for themselves. From the purely quantitative point of view, most pupils obviously benefit from the new type of teaching.³ The benefit is also a qualitative one, since those who gain by such teaching gain more than is lost by those to whom it is of no benefit. The data we have quoted would suffice to show the effectiveness of programmed instruction and justify our expectations that it will progress just as much in the future. We need only provide programmed sequences for all classes and the same results will be obtained by all pupils.

But this would be rushing things, and reading

more into the statistics than they contain; figures cannot speak, and it is dangerous to try to force them to talk. Are we in fact so sure that the gain observed is to be attributed solely to programmed instruction? Many factors may have been at work in producing the good results noted: the personalities and methods of the teachers who took part in the experiment; the fact that what was being taught was modern mathematics; the backgrounds of the pupils, who all came from towns; the marking systems in the various subjects; and so on. Comparisons were made which showed that some of these factors had little effect on the results—factors such as the marking systems used in different subjects or by different teachers, or the different weightings which subjects might be given when the over-all average was worked out. Conversely, all the factors which may affect the learning of a subject remain operative: the content of the programme; the distribution of material over successive stages of the syllabus; the method used by the teacher; testing methods; the way information provided by tests is used to adapt subsequent lessons; and the way in which pupils participate. Any one of these factors would be sufficient to explain the encouraging results mentioned a moment ago. If it could be shown that this was so, it

1. We refer here to an operation launched in 1967 by Unesco and four States in Central Africa—Congo (Brazzaville), Chad, the Central African Republic and Gabon. After two training courses, teams wrote and tested sequences in four subjects. The results we mention relate to the first full-scale experiment, which is to be followed by a general application of programmed instruction from 1971 onwards.
2. This was done by comparing the marks in the registers—the annual average in mathematics with the over-all yearly average. The mark required for admission to the second form was 8.93 out of 20. The conclusions we give here are, of course, approximate and relative, but the data on which they are based were collected in a uniform manner.
3. An examination of the results obtained in the previous year by the same teachers in the same colleges of general education seems to confirm this.

would be justifiable to take note of these figures and subsume them in one 'fact'—that programmed instruction played no part in the success noted.

But here again is a risk that we may have twisted the figures and distorted the nature of programmed instruction. In the long run, the use of programmed-instruction techniques certainly has the effect of improving the way pupils take in the lesson. But programming also consists of arranging the circumstances which are a prerequisite if this is to be achieved. And in fact the result of arranging these circumstances is to bring the factors mentioned above into action in a coherent fashion. The educational content of the lesson, the order in which it is taught and the method by which its content is transmitted and used—all these points are by no means unrelated to programmed instruction, as one might be tempted to think; on the contrary, they are an inherent part of programmed instruction, which modifies their nature and their structure. Thus all the circumstances and factors involved in the act of teaching require to be made clear, step by step, before the decision is taken as to how they are to be embodied in the lesson.

Let us see if we can show this by reference to our example.

Before a programmed lesson is prepared it must be decided exactly what the pupils will be expected to know after studying it. The lesson is a path which they must tread alone; we shall be waiting for them at the end of their journey to see whether they have learnt what we wished them to learn. The pupils must make the journey; not until they arrive shall we be able to see how they have travelled. For this reason we must first of all describe all the stages through which they must go, and the best order in which those stages should be taken. This seems very simple, indeed trivial. A single attempt at programming soon convinces teachers that this is not so. They very quickly realize that the concepts which they think the most clear are clear only to them; the encounter with another mentality, the need actually to describe the steps and concepts with-

out assuming that the pupil knows them, puts the soundness of their own knowledge to the test. What is the subject of a verb? What is an epithet? And what, in mathematics, is the difference between an operator and a relation? Can it be said that 'the point is the intersection of the straight-line set D_1 and the set D_2 '?

When anything is questioned, the teachers' most natural reaction is to say: 'As far as children still in primary school are concerned, an epithet is such and such...; the rest is beyond them'—and thus the problem of defining 'the rest' is put off until later. The attempt to describe the nature of an epithet is abandoned, and in its place we are offered the image of an epithet which a child can form. When this happens, the pupil is getting between the teacher and the knowledge he is there to impart. Can we not see the schoolboy that the teacher once was coming back on to the scene? Leaving this question unanswered, we shall simply state that, if the content of the lesson is called in question by the programming, this is mainly because the teacher has to state clearly the information he intends to transmit (with no pupil between himself and that knowledge). Stating something 'clearly' means expounding the concepts concerned in such terms as allow a real check to be made. To take an example: I have understood the associativity of addition if I can find the value of x when $a + b + c = x$ and also in the following cases: $a + b + x = d$; $a + x + c = d$; $x + b + c = d$.

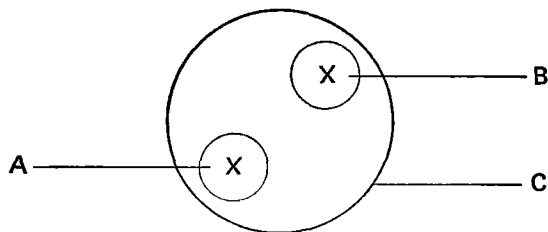
Teachers are very much aware of the step between the challenging of their knowledge and its updating—a step which programmed instruction makes them take. While the first fine rapture is by no means careless, time spent in disquiet is not wasted. Even teachers who do not use programmed instruction acknowledge the beneficial effects it has on them: 'Something has changed in the way I prepare my lessons and my pupils are really benefiting from it as much as I am', one of them said.

But once they begin to have doubts about the content of their courses, teachers almost always

go on to question not only themselves but also those syllabuses (in the official sense of the term) which call for reflection and arouse criticism. Is it really necessary to teach first-year Congolese children French grammar? And if so, should it be normative, functional, structural or what? Here, you will say, we are getting into the realm of disputes between schools of learning, grammar being a very special case. You are wrong: the problem of a choice between doctrines arises in every single subject. This necessarily leads to the conclusion that the doctrine must be chosen before a syllabus is drawn up. In the end you even come round to the view that the syllabus should be tried out experimentally before it is adopted. Should the first-year work be 'structural' or 'functional'? The question cannot be properly answered until investigations have been made and tests conducted.

What we say about the content of the course also applies to methods, systems and so on. For the use of programming techniques brings about a real change in the teacher's attitude towards his work. The first sign of this is the development of a critical outlook. But this change is by no means purely negative; it brings with it a new desire for experimentation.

This will be apparent if we look at the new types of teacher-pupil relationship which programmed instruction entails. It has been recommended that the pupil should temporarily be disregarded when the statement of concepts is begun, but in the second stage it is equally essential to concentrate all our attention on the pupil. For we need to know what prior knowledge we can assume at the beginning of the lesson and use to lead the pupil step by step to the end. What does he know about language or grammar which can serve as a basis for his study of epithets? In addition, we must ask ourselves not only what prior knowledge he has, but also what rate of progress, what proofs, analogies, examples and so on are best suited to him and will therefore be of most help to him in his task. For example, should one start by representing three sets as in the diagram given below?



The mathematician would contend that if C is empty, the diagram implies that C includes A and B, which are not empty. To which the educationalist and the psychologist would reply that as a beginning, this representation, however imperfect, is a better way of conveying certain concepts than are the 'standard' diagrams.

Here again, care must be taken to foresee, i.e. constantly imagine, the pupil's reactions. But what is required is not a dreamy sort of imagination which relies on a more or less stereotyped image of the pupil, but rather a knowledge of his actual reactions, and these have to be patiently studied and discussed by the members of the team. We must in all honesty admit that experience of programming brings home the need for such knowledge to the programmer very forcibly, even if he does not face up to it. And this makes him aware of the need to carry out research, inquiries and studies in the project under consideration, and of the need for the educational-research institution to work together with the programmed-instruction teams. But many tentative approaches were made before the prospect of such co-operation became a reality. Is this surprising? Does it make you indignant? Do you suspect back-stair intrigues? Who cares! The main point is the need to get as close to the pupil as possible. It is not enough for the programmer to say this: he must prove it in his lessons.

What does the pupil do in class? One Congolese child said: 'This is good fun! The book is speaking to me!' Another said: 'The exercise book told me off because I was wrong, and that made the teacher laugh.' And one young teacher

in a college of general education in Congo (Brazzaville) said that his classes were studying quietly and more attentively than he thought possible: 'First of all they cheated, by looking up the answers. But they got their answers wrong in the test. So they have stopped cheating. When they have finished the lesson and taken the test, we go over together the points which some have failed to grasp. Those who have understood very often want to correct the others.' The teacher is no longer there to give the lesson; he joins the others in helping those who get into difficulties; and he drives the best pupils hard. This teacher, for example, was struck by the fact that the pupils themselves make up exercises during the sessions when the courses are being used. When he talks of it, he is enthusiastic; and so he is happy about his work. Why not? On the evening when he gave a broadcast about programmed instruction, his pupils all sat around a transistor to listen to him, and they had brought with them friends from the other classes.

As might be imagined, the school itself is eventually affected: you cannot introduce a type of teaching which is adapted to every pupil without producing some sort of effect. The pace of the 'class' is different, as the teacher is no longer conducting the orchestra. It is always striking to see the different speeds at which different pupils learn: the fastest may take half the time the slowest takes. What are we to think of the 'average pace' which everyone thinks he can find—a pace that meets the needs of both, fastest and slowest, in a lesson being given to fifty pupils?

Then there is the programmed-instruction experiment in which three first-year classes in a college of general education are taking part. The pupils speak about it, then the teachers, then the parents and then others. And the teacher we mentioned above, whom we met at the beginning of July, told how third- and fourth-year pupils and even adults who wanted to take a refresher course have come to him to ask for programmes to 'study during the holidays'. It

would be wrong to think that all this is evidence of a flood of enthusiasm. Nevertheless, the frequency with which one meets such evidence gives one some idea of the context in which the results referred to above were achieved.

This context shows the need for close co-operation between those who teach the same subject. But, what is more, the teachers engaged in the project are to some extent all-rounders: the mathematics teacher also teaches physics and chemistry or sciences. With the new programmed instruction, such versatility in the practice of teaching produces another kind of versatility. One teacher told me that in a mathematics lesson his pupils could manipulate the Diéniès equipment, but that they almost all failed at ordering problems. The reason was quite simple: the pupils did not understand the meaning of the word '*trier*' (to sort) which appeared in the exercise. The teacher said to me: 'Pupils should not be taught the meaning of this word in mathematics lessons. It should perhaps be explained in science classes, or in French.' Here, then, we have a teacher concerned with vocabulary which he has to use in teaching one subject, vocabulary which should have been taught in another subject and by another teacher. This is only a matter of vocabulary; a pupil obviously needs a knowledge of grammatical rules if he is to understand the wording of a geometry problem—and possibly *vice versa*. Once this idea is accepted, we are not far from the view that grammar is related to mathematics and that the natural sciences have much in common with geography, history and language study. Such interdisciplinarity, which is commonplace as far as theory is concerned, has still to be achieved in practice; the question is, 'How?' The organization of the task of programming a lesson is an example, if not a model, of how it could be done. But in this case what has to be programmed is the work of the teachers at a school. In the Congo the question has arisen whether a certain discipline on the part of teachers would not enable the courses to be better adapted to the pupils' needs. The question is worth pondering,

and will interest those engaged in teacher training.

We have touched on some of the conditions which the use of programmed instruction requires and the changes it entails. Such conditions and changes can be fully appreciated only in the light of the requirements of the planner. He may listen politely to a detailed statement of the educational advantages and concede the qualitative value of the new techniques, but he will then say: 'Here are the country's educational needs. Here are the weak points. Can you deal with them? How? And what will it cost?' Educationalists are unfamiliar with such concerns. They are easily irritated by them, and sometimes do not like the idea that the aims of education are not their exclusive responsibility. We have come up against these problems—and we have left teachers and planners to seek solutions. After three years of groping in the dark, of misunderstandings and talking at cross purposes, discussions have been started. We are past the stage of playing variations on the 'arts subjects and technology' theme. The problems we are tackling now are entirely practical ones.

Let us take an example.

Five hundred first-year pupils have been given programmed instruction in mathematics. How can this be provided for the 8,000 pupils in the Congo and then, if necessary, for pupils in other countries near the Congo? Then, if we provide courses in technology as well as mathematics, from the first to the fourth years and probably for primary classes as well, tens of millions of programmed lessons will have to be prepared. When we tried to express the project in terms of the weight of printed paper it would involve, the figures very soon rose into scores of tons. So the planner, the educationalist and the director of education enlisted the assistance of physicists, chemists and industrialists. A medium had to be found which had the advantages of paper (cheapness, ease of handling and so on) without weighing as much.

The problem was set in exactly these terms.

It has been three-quarters solved. The solutions already open to us are satisfactory since we can contemplate lesson sets which are usable at least fifty times and will withstand any climatic conditions and rough handling. But we are seeking something better still: a means of writing on plastic 'paper' in such a way that the letters can be erased or will disappear. The firm that egged us on, talking of profitability and good management, has not yet made any serious attempt to study the problem. But we can estimate here and now that the programmed lesson studied by one pupil would cost only two to three French centimes!

The revised fourth-form 'physics' syllabus gives pride of place to technology. But the teachers are not all ready for it. So what will happen? With the best will in the world failures cannot be avoided, and the pupils will receive mixed instruction. Why not let one of the best teachers handle virtually the whole of the programmed instruction? It would take six to eight hours of his weekly time-table, but one would know exactly how the pupils had got on and could rest assured that no irrevocable mistakes had been made.

This and similar problems were discussed. They are not all so clear or so simple. But in formulating them one gets into the habit of tackling them in groups, in which all those responsible for education are involved: the minister, the director of educational research, the planner, the director of school broadcasting, the teachers, the psychologist, the advisers, etc.

And when they are seated round the same table it implies that the problems have already been well defined. Thereafter their solution will depend on technical skill and common sense; there ought to be no difficulty that cannot ultimately be overcome.

Jerry Pocztar, professor at the École Normale Supérieure de St. Cloud, has published several works on programmed instruction and has made a special study of the use of this technique in the developing countries.

Microteaching: an innovative laboratory procedure

by Arye Perlberg

There seems to be a growing realization among educators the world over that the problem of improving instruction at all levels of education is common to all countries and that one of the most important pre-conditions for better instruction is the improvement of teacher-education programmes.

In a recent report, *Innovations in Education and the Preconditions for Better Schooling*, the Committee for Economic Development in the United States has stated that the 'most pervasive problem in American schooling is the need for improving instructional techniques and processes. In any national effort to improve our schools the decision-makers at all levels of education, and the public as well, must give immediate attention to the principles and methods of teaching and learning. Such improvement is the precondition for achieving better education for all—for those from poor families as well as those from affluent families, for the culturally deprived as well as the advantaged'.¹

Microteaching, a recently developed procedure in teacher education offers a new model for improving teaching. To understand the value of microteaching a brief review of some aspects of the traditional teacher-education system is required.

Traditional teacher-education programme

The traditional professional teacher education programme consists of two main elements:

theoretical courses covering the philosophical, historical and psychological foundations of education and teaching methods on one hand and supervised practice teaching on the other. It is generally assumed that such a programme provides prospective teachers with the basic elements essential for good teaching. The theoretical courses—to which greatest attention is given at present in teacher education—are mainly verbal, abstract, and sometimes even vague. In many cases student teachers do not see the exact relationship between the content of these courses and actual teaching in the class-room.

With regard to supervised student teaching, it is assumed that during that period the student will practise intensively and will develop proficiency in instructional procedures and class-room

1. The studies cited in this paper were conducted while the author spent his sabbatical year as a visiting associate professor at the University of Illinois, Urbana, Illinois. The author wishes to acknowledge the Department of Vocational and Technical Education of the College of Education, the Department of General Engineering of the College of Engineering, and the Illinois Board of Vocational Education and Rehabilitation, for providing the opportunity and the funds to conduct these studies. He would also like to acknowledge the work of his colleagues, Professor R. Tinkham, D. C. O'Bryant and R. Nelson who collaborated with him. The author is at present engaged in similar studies at the University of Tel Aviv and at the Technion and final results of these studies will be published in the near future.

management. In reality, however, supervision of student teachers tends to be very limited and superficial. In general, co-operating teachers are not prepared professionally for their role as supervisors and are given very limited time and advice on how to guide their student teachers. The professional supervisors, whether from the universities or the educational system, are even more limited in the attention they can give to the individual teacher. When performing their task, they are handicapped by not being able to provide the teacher with objective feedback about his performance, essential both for motivating and redirecting the teacher's instructional behaviour. In addition, the regular class-room setting neither encourages nor allows the student (or, for that matter, even the qualified teacher) the opportunity to test alternative methods and styles of teaching essential for developing effective teaching strategies.

The problems, however, are even more complicated. The improvement of teacher education is not only a matter of additional supervision, better feedback or adequate facilities for practice; there is also the need for better understanding of the complexities of the teaching process. Unfortunately, our knowledge about cause and effect in this process is, as yet, very limited. Half a century's research on learning has had no great impact on instruction in schools, and while there has been less research on teaching, it too has produced little of value for the class-room teacher. There is, at yet, no comprehensive theory of teaching, nor are there generally accepted criteria for evaluating teacher-effectiveness. The commonly held belief that teaching is an art, together with the unwarranted assumption that learning theories provide us also with instructional theories, has probably greatly hampered the development of a research-based theory of teaching and the creation of an instructional technology.

Microteaching

It was in response to this situation that a group of educational researchers and teacher-educators at Stanford University developed, in 1963, a new procedure called 'microteaching', designed to overcome many of the short-comings of traditional teacher-education programmes and increase our understanding of the teacher-learning process.

Microteaching is a training procedure aimed at simplifying the complexities of the regular teaching process. In a microteaching procedure the trainee is engaged in a scaled-down teaching situation. It is scaled down in terms of class size, since the trainee is teaching a small group of four to six pupils who volunteer to participate in the laboratory activities (or may be paid for their participation). The lesson is scaled down in length of class-time and is reduced to five or ten minutes. It is also scaled down in terms of teaching tasks. These tasks may include: the practising and mastering of a specific teaching skill such as lecturing, questioning or leading a discussion; mastering of specific teaching strategies; flexibility; instructional decision-making; alternative uses of specific curricula instructional materials and class-room management.

The short lesson is recorded on an audio- or video-tape recorder, and the trainee gets to hear and see himself immediately after the lesson. The pupils who attend the lesson are asked to fill in rating questionnaires evaluating specific aspects of the lesson. The trainee's own analysis of the lesson based on the authentic feedback from the tape together with the pupils' reaction and a supervisor's analysis and suggestions, assists the trainee in restructuring the lesson, which he then immediately reteaches to a new group of pupils. Further assessment by the 'learners' and the supervisor lead to further improvements when he teaches again, either immediately after or several days later. This microteaching sequence is practised usually in a microteaching laboratory in a teacher-training institution, or an in-service training programme in regular schools.

The micro-element

The micro-element, which systematically attempts to simplify the complexities of the teaching process is the cardinal feature of microteaching. Underlying this is the basic supposition that before one attempts to understand, learn and perform effectively the complicated task of teaching, one should first master the components of that task. By focusing the training on a specific task, and by reducing the complexities of the teaching situation by diminishing the number of students, the duration of the lesson and subject-matter to be covered, it is possible to concentrate the training process and assure greater effectiveness.

The micro concept is cardinal also for the improvement of research in teaching and the development of a theory of instruction. While summing up half a century of teaching, Gage arrives at a conclusion that macro or global paradigms in research on teaching have 'a respectably long history but a regrettably inglorious one'. In many instances these were 'fruitless paradigms' and 'sterile approaches'. As an alternative Gage suggested taking 'the same path that more mature sciences had already followed: if variables at one level of phenomena do not exhibit lawfulness, break them down. Chemistry, physics and biology had, in a sense, made progress through making finer and finer analyses of the phenomena and events they dealt with. Perhaps research on teaching would reach firm ground if it followed the same route'.

Technical skills of teaching and teaching strategies

A repertoire of teaching skills such as lecturing, questioning, or leading a discussion and mastery of teaching strategies is the second important feature of microteaching. The concept of teaching skills is not new, and many textbooks on teaching methods refer to specific skills or teaching strategies. But never before has there been such a systematic approach to analysing class-room

interaction for the purpose of research and training. For example, teaching skills can be classified under the five general headings of response, questioning, increasing student participation, creating student involvement, and presentation, with three or four skills further delineated within each category. Detailed manuals and series of model films explaining and illustrating these skills have been prepared for training purposes.

Research and development in microteaching has been focused mainly on the analysis and description of what could be identified as the 'basic' or 'primary' or 'low-order' technical skills of teaching. While available classifications are by no means conclusive, there is a growing interest in the development of 'high-order skills' which require proficiency and mastery in the use of the basic skills but which are, in themselves, more complicated; they are often described as 'strategies' or 'styles of teaching'. Practice sessions in these skills will probably require longer periods of time and even larger groups.

Some critics of microteaching claim that while teaching a micro-class the teacher does not encounter the regular management problems common in larger classes. But even class-room management problems can be taught in the micro-class by simulating specific behavioural problems.

The feedback element

The feedback element is the third important feature of microteaching. At present, 'feedback' in the supervision of student teachers is ordinarily based on a supervisor's recall and selective note-taking. His over-all impressions provide the basis for subsequent analysis of the student teacher's performance. But subjective factors enter into his assessment (as they do into the student's ability to recall details of the lesson) and in the absence of objective criteria the student may covertly or overtly oppose the supervisor's evaluations and suggestions.

The student teacher, whose inexperience is

likely to make for tension and nervousness, is often highly selective in remembering details. Nor is the student supervisor exempt from selective recall. Emotional states, attitudes, personal attitudes, perceptual distortions, attention limitations, sensitivity to class-room interaction and memory lapses influence his general impressions and consequently the accuracy of his records.

Yet accurate feedback of behaviour is critical to the improvement of teaching. It reduces disagreement, facilitates analysis and comparison of the student teacher's behaviour with accepted objective criteria, helps to reinforce desired patterns, and creates dissatisfaction with undesirable ones.

Several sources of feedback could be employed in the microteaching laboratory. The most simple source is the oral feedback of the laboratory supervisor. Experience has shown that the relatively non-threatening atmosphere in the laboratory creates better communication between the supervisor and the trainee, even if his feedback is subjective. The micro-elements of the laboratory help the supervisor in focusing and concentrating his observations, thus ensuring greater accuracy of feedback.

Another source of feedback consists of questionnaires filled in by the pupils learning in the micro-lesson. These questionnaires—geared to specific skills with well-defined questions—provide the most important, although subjective, feedback from the teacher's 'clients'. When teachers are used to the pupils' feedback and accept it with some ease, it is possible even to conduct short discussions with the pupils in which the teacher and his supervisor try to elaborate on the feedback provided by these questionnaires.

Audio-tape recordings are an important source of accurate feedback. Recent technological developments have resulted in small, portable tape recorders, operated by batteries and relatively low-priced. This calls for expanding their general use in schools and particularly in microteaching laboratories. They are, however, limited to verbal interaction in the class and thus do not provide the 'whole picture'. A supervisor's

comment, based solely on an audio-tape might be considered by the teacher as one-sided. In addition, the peculiarity which causes many people not to recognize their own voice on tape, disturbs sometimes its acceptance as a source of feedback.

The most accurate and powerful source of feedback is the video-tape recording. Newly developed portable video-tape recorders consist of a small camera and a small television monitor. Class-room activities can thus be recorded with minimum disturbance to teacher and students. It provides instant and accurate feedback of class-room interaction (verbal and non-verbal) in the teacher's natural habitat and thus provides a basis for reliable analysis.

There remains the problem of motivating teachers to engage in self-analysis and modifying their teaching behaviour. In general, their attitude to feedback of their teaching performance may be ambivalent. While realizing that this analysis is essential for any improvement, they dislike this self-confrontation, because they are anxious about its results. In the past, unacceptable feedback of their class-room behaviour could have been rationalized by claiming it to be inaccurate, subjective or even distorted. There was often failure to recall observed class-room episodes. Such lapses were sometimes undoubtedly defence mechanisms, often resulting in resistance to behaviour changes. The portable video-tape recorder has, however, made it possible to present the teacher with reality, in all its nakedness. A teacher must be ready to confront himself, and have the courage to accept what he sees. If properly managed, the initial shock of this traumatic self-confrontation increases readiness to accept criticism. The fascination inherent in facing one's own image—the magic of the mirror or the 'visual echo'—also may induce the teacher to look at himself and thus see himself as others see him.

The discussion until now has focused on the modification of undesirable teaching behaviour. It is important, however, to recognize also desired and favourable teaching behaviours. These, with both the neophyte and experienced teacher, need

positive reinforcement if they are to become anchored in their regular behavioural repertoire. Here, too, the accurate, instant visual feedback of video-tape recordings plays an important role.

The effectiveness of video-tape recordings and playback techniques has been confirmed in a number of studies of teacher training and in related areas such as counsellor training and counselling, psychotherapy and human relations.

Safe practice-grounds

Providing a safe practice-ground is another important feature of microteaching. As a rule, the first teaching experience student teachers have is in the methodology, but usually only a few students have the opportunity of playing the teacher's role. Moreover, teaching fellow students (peers) provides an unreal class-room atmosphere. It is also much too safe, for the behaviour of one's peers, both during the lesson and its subsequent analysis is influenced by the fact that each knows that he will eventually be in the same position. Teaching subject-matter already known to one's peers also greatly reduces the reality of the teaching situation. Even when the subject-matter is suited to the level of the class, the problem of 'peer consideration' remains. This type of teaching also requires a lot of time from participants and is therefore used primarily for demonstrations in methodology.

It is generally assumed that the main teaching experience will be gained during the student-teaching period (practice teaching) in an experimental or regular school. The experimental school, although attached to a university, is also in most cases a regular school where pupils are required to study an approved curriculum, and those in charge are careful to ensure that experimentation does not 'harm'. This is even truer in regular schools. The student teacher thus has no place for 'try-outs', without the fear of failure. Unfortunately, confidence and proficiency have to be acquired by trial and error in the regular class-room, at too high a cost to the student.

How then can we provide a safe practice-ground for student teachers? A microteaching laboratory seems to be one effective answer, for it appears to possess all the inherent features of the real class-room. The student teaches the relevant subject-matter to genuine pupils (at whatever level is desired). At first, many exhibit the typical tensions of neophyte teachers, but because teaching is a laboratory exercise, tension is rapidly reduced, and it becomes possible to focus training on the acquisition of teaching skills and instructional techniques related to pupils with different abilities, aptitudes, characteristics and needs. An opportunity is also provided to master curriculum material.

The teaching 'models'

Acquiring new behaviour patterns by observation and imitation is recognized as one of the major learning processes. The use of formal or informal demonstrations of particular behaviour patterns in the traditional teacher-education programme is based on the underlying assumption that during this period, the student observes a 'model' of a good teacher and acquires proper teaching behaviour by imitation. Whether the 'models' students observe really excel in teaching and class-room management is debatable. However, even in the case of the trainee who is fortunate enough to work with an excellent teacher, mere observation of his teaching is not sufficient for studying and evaluating the characteristics and techniques of his 'model'. On the other hand, a record on tape or film, provides the student teacher with the opportunity for a through study and analysis of those qualities which merit adoption.

The tapes or films of teaching 'models' are an important facet to the learning process in the microteaching laboratory, and provide the trainee with many opportunities to study desired patterns of teaching behaviour. There are, of course, many styles of good teaching and trainees will develop their own individual styles using these models as a guide.

The research laboratory

Research in teaching has been greatly hampered by the complexities of class-room interaction, and the limitations imposed by the regular school setting on attempts to control and evaluate the multitude of variables involved. The microteaching laboratory, on the other hand, simplifies the act of teaching and provides opportunities for controlled research to a degree never possible before. According to Allen and Ryan, the following areas of research seem to make the most effective use of the microteaching settings: (a) in-house studies designed to optimize the procedures and sequences in the microteaching situation; (b) research in modelling and supervising techniques; (c) task analysis of the teaching act and the investigation of the relationships between teaching behaviours and student performances; (d) aptitude treatment interaction studies, to try to provide optimal training procedures for teachers with different abilities, interests and backgrounds. This list is not exhaustive, and the innovative educational researcher could find additional subjects to be tested in the microteaching laboratory.

Some current and potential uses of microteaching

In a recent survey in the United States on the use of microteaching in teacher-education programmes, it was found that 141 of the 442 NCATE-accredited colleges and universities were using microteaching in their secondary-education programmes, and about fifty reported the beginning of its use in in-service training programmes. Here it will only be possible to describe briefly a few of its applications.

Microteaching in pre-service teacher education

Several alternatives have been adopted by colleges and universities in introducing microteaching procedures into the teacher-education

curriculum. Some universities have adopted the original Stanford microteaching laboratory model, in which students are required to practise for a certain number of hours or acquire proficiency in certain teaching skills. Variables such as the content of teaching skills, length of micro-lesson, size of classes, the teach-critique-reteach cycle ('critique' is the term in common use for the criticism offered by the supervisor), patterns of supervision, and the use of models are still the subject of extensive experimentation and research in the search for optimal procedures, although many of those tested have already yielded significant results.

Even more prevalent than the adoption of microteaching laboratories has been the trend to incorporate microteaching procedures into methodology. The nature of teaching skills and class-room interaction is illustrated with tapes of 'model teachers'. Sample tapes of a student teaching or participating in class are brought before the group for analysis. The resulting 'improved' versions of the lessons are again taped and brought for discussion. Microteaching procedures provide the methodology with new dimensions of audio-visual reality and experimentation.

Microteaching procedures could greatly enhance the effectiveness of the student-teaching period. A study conducted at the University of Illinois tested the effectiveness of various procedures described here to augment the microteaching experience of student teachers. The university supervisor, on visits to student teachers in different schools, taped the classes which he attended on a portable video-tape recorder. His discussion with the student and the co-operating teacher were based on feedback provided by this tape. In accordance with microteaching techniques the tape analysis and recommendations for change arising from it were focused on a limited number of problems. The portable video-tape recorder and its accessories were left at the school for several days and used by the student teacher and his co-operating teacher to tape and analyse each other. Here again emphasis was placed on the improvement of specific teaching skills.

The shortage of qualified university personnel and the distance of schools from the university limited the college supervisor to three visits, a quota known to be inadequate for the supervisory process. It was therefore arranged for the student teacher to mail three of his taped lessons to the university, where they were analysed by his professor and discussed with him and his co-operating teacher via a telephone conference, during which the professor was observing the video-tape.

Most student teachers and experienced teachers are aware that teacher education is a never-ending process and that pre-service training is only its first phase. However, not enough is done in pre-service education to motivate student teachers to engage regularly in self-improvement activities, and far less has been done to equip them with skills and techniques of self-appraisal which result in improved class-room interaction. The extension of self-confrontation and systematic appraisal from the microteaching laboratory to the school class-room would lower the psychological barriers which deter many teachers from engaging in such activities, and would increase the likelihood that the student teacher continues in self-improvement activities in his future career.

Microteaching and in-service education

In view of the inadequacy of many of the pre-service programmes, in-service education is the only chance of improving the quality of education. Teachers require the opportunity to observe the way in which they function, and appropriate advice on how to evaluate and improve their present behaviour.

In spite of their potential importance, in-service education programmes have little effect on teacher-pupil class-room interaction. Accumulating a few more university credits or attending lectures organized by the school does not ensure a change in class-room teaching. Microteaching techniques, however, seem to offer a promise of effecting a real change. The same basic procedures including taping, analysis and subsequent behaviour modification are used both

in pre- and in-service education. It is furthermore important to realize that it is not easy to induce experienced teachers to engage in such activities voluntarily. Since they have the potential of creating dissatisfaction with existing behaviour they may prove to be too threatening. Student teachers in pre-service education can be required, as part of their training, to take part in microteaching and video-tape recording. However, if experienced teachers are expected to engage in these activities, they need to be confident that this training technique is not devised to monitor their activities for administrative purposes.

Microteaching in higher education

Academic teaching ironically enough requires no formal pre-service training. There is, however, a growing realization of the need for some kind of pre-service and in-service programmes for preparing new faculties and increasing the teaching effectiveness of the existing faculty. Viewed realistically, there is little today to motivate a professor to improve his teaching. The university does not reward it, and there is the threat of being tagged a 'teacher' as opposed to being a research worker. Projects have been carried out using microteaching techniques and portable video-tape recorders in improving instruction at the university and community college level. Work was done with individual faculty members, or groups of faculty members, utilizing the basic microteaching procedures described above. The conclusions from these and similar projects suggest that these media and techniques have been instrumental in modifying university teaching behaviour. It should be noted that the participants were often encouraged to proceed because they experienced for themselves the authenticity of the feedback, the practicality of the microteaching procedure, and especially its effectiveness in modifying behaviour. Participants also showed greater awareness of teaching problems and increased motivation to engage in other activities designed to improve university teaching.

Microteaching in other settings

Ivey has applied microteaching procedures to counsellor training. He tested the effectiveness of this micro-counselling in training for three skills of great importance in any counselling situation: 'attending behaviour, Rogerian reflection of feeling, and summarization of feeling'. He found the method sufficiently effective to suggest that many more counselling skills could be developed, and even suggests that 'the microteaching and microcounselling framework may be the means by which the developing skills of living may be taught'.

Microteaching procedures have been used in two workshops designed to train Peace Corps personnel. In both, these procedures seemed to facilitate better training results and the attitudes of trainees were favourable.

Basic microteaching procedures have been used in medical education. Third-year medical students interviewed patients in a simulated doctor's reception-room. The 'patients' were trained to perform various roles. Interviews were taped and brought to the class for analysis and, after incorporating suggestions, were then tried again by the same student. Model tapes of doctor-patient relationships were developed.

Microteaching in developing countries

Being a recent innovation, there are not as yet published reports about experimentations with microteaching techniques in developing countries. Several 'trials' have been made, however, by Dwight Allen, David Evance and some of their colleagues in some countries in Africa and South America. From oral impressions, communicated to the author, it would seem that these attempts were successful and that teacher educators in those countries believe that microteaching techniques could greatly improve pre-service and in-service teacher education.

Some observers, involved in international education have been sceptical about such prospects especially in view of the high cost of technical

equipment and the problems involved in its operation and maintenance.

While the importance of instant and accurate feedback through video-tape recorders has been stressed throughout this article, it should be stated emphatically that microteaching can be practical even without television equipment. Several other techniques to obtain oral feedback have been described and in the absence of sophisticated technical equipment the emphasis should be given to the micro- and laboratory elements.

The importance of bridging and balancing theory and practice in professional teacher education programmes has been advocated throughout this article. This is true for developed countries and more so for developing countries. In many instances, teacher educators who were trained in universities in developed countries attempt to 'import' and impart to their own countries theories and practices which are totally strange to their people and cultures. The advisability of training educators from developing countries in traditional teacher-education programmes is highly questionable. On the other hand, the reality and practicability inherent in microteaching techniques could have a greater impact on the quality of education in developing countries. Being an accelerated training technique, it could speed the process of improving education in these countries. It should be borne in mind, however, that the microteaching model described above is just a general framework of an idea to be adjusted and developed according to the needs of each case in different countries.

While the present absence of technological devices should not deter the introduction of microteaching, it could be assumed that the rapid technological development will greatly reduce the cost, and simplify the operation and maintenance of technical devices to obtain feedback. Small, portable, battery-operated, 'cassette' audio- and video-tape recorders will probably be within the reach of many educators the world over, including developing countries. The basic problem at present is to train teams

who will be able to introduce these innovations into their school systems.

The above are but a few examples of fields in which microteaching and video-tape recorders have been used; they are, in fact, capable of being used wherever the need to shape behaviour is felt. For example, they could have application in modern industry and commerce, in the training of manual skills, certain executive skills, salesmanship, etc. To be sure the armed forces could greatly benefit from their use.

Microteaching as an innovation

While microteaching has been described as an innovation in teacher education, in fact certain of its aspects have long been in use in various training situations. Moreover, it is based on long-standing educational theory. For example, the 'laboratory' concept as a training procedure preceding actual field practice is an accepted part of many branches of learning (e.g. science laboratories). It was accepted also in teacher training, where certain schools were designated as laboratories for testing new curricula and instructional materials and as practice-grounds for new teachers. The microteaching innovation lies in the establishment of specific educational laboratories, rather than in the designation of regular schools as laboratories, with the many limitations they impose on experiment.

The micro concept which is based on long-established learning theory today underlies programmed learning and computer-assisted instructions. In both cases, it is assumed that learning is more effective if a complex skill is divided into its components and learned step by step before it is undertaken as a whole. Other concepts of learning theory such as feedback, reinforcement, or extinction were also adopted in the microteaching procedure. Observational learning through a 'model' is another example of well-established educational theory and practice. The developers of microteaching should be credited, however, with incorporating all these well-

known principles into a systematic training system.

As is the case with many innovations, microteaching too has both its strong and sometimes over-zealous supporters and its critics. In a recent presentation at a microteaching conference at the University of Massachusetts, Earl Seidman raised several pertinent questions about microteaching and its future. Like several other critics he is greatly disturbed by the fact that microteaching is strongly influenced by behaviouristic psychology: 'microteaching trains teachers to perform in ways those who are running the program think is good. . . . Are we involved in a program which trains rather than educates?' Seidman is alarmed that such great emphasis is being put on training in teaching skills which 'presuppose the idea that the teachers' role is to control the students and to direct the class. . . . If we treat our interns mechanistically, how will they treat their students?'

Within the limits of this discussion it is not our intention to elaborate on the problem of the place of behaviouristic psychology in education and teacher education. It should therefore be stressed that microteaching is only intended to be one aspect of a teacher-education programme. It does not intend to substitute the theoretical foundation in the teacher-training programme. It corrects unevenness between the over-emphasis on theory and the neglect of effective practice. Practice in a microteaching laboratory begins with the basic teaching skills, but should not stop there; it should provide the teacher with opportunities to learn and practise 'clusters' of basic skills, high-order skills and instructional decision-making. Only those who have mastered the basic skills can freely engage in exercises of high-order skills and instructional decision-making.

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Training teachers by correspondence

by Ben Miloud Hassen

There is no need to recount the troubles which beset education in most of the developing countries. Indeed, it might almost be thought that this is the normal state of affairs. Officials in the newly independent countries are fired with enthusiasm for the task of meeting the legitimate aspirations of their fellow citizens, who for so long have not had the advantage of a democratic education, provided on a national scale. In most of these countries, enormous sacrifices have been made; but the results achieved are far from satisfactory, and almost everywhere those responsible are disturbed about the same phenomena: the ineffectiveness of schooling and the huge wastage (taking the form either of drop-outs or of very high repeating rates which in turn result in a very high cost of schooling and a small return on investment).

I do not wish to analyse the causes of such troubles in this article; the subject has already been treated in numerous articles and studies.

Nevertheless, there seem to me to be two important points which call for special attention.

First, it is noticeable that in some countries which are anxious to provide a primary education for all children of school age, and to make education compulsory, at least at the elementary level, the ever-increasing demand due to the large numbers of potential pupils forces the authorities, however reluctantly, to appoint larger and larger numbers of teachers who are definitely under-qualified, not only in that they lack vocational and teacher training, but also because they have reached only a very low level

of general education. It is common knowledge that nowadays young people who hold only a primary-school certificate are sometimes appointed to a teaching post. This shows either an erroneous conception of planning or failure to grasp elementary statistics; and the result is that such young recruits, whose numbers are increasing every year, are incapable of doing any worth-while teaching; and the practical training courses—mostly for short periods—which are organized to help them do nothing to remedy the situation. The result can only be that the educational standards of their pupils and educational standards in general will continue to fall. And it is not surprising that such falling standards have a bad effect on standards in the first stage of secondary education, the quality of the pupil teachers appointed, and so on at every link in the chain, until the vicious circle is complete.

Again, the fact that more and more under-qualified young teachers are joining teaching staffs, particularly those of primary schools, tends to discredit and down-grade the job itself. How many primary teachers, over the last ten years, have resigned their posts to seek employment in other parts of the civil service, or even in the private sector, where they are welcomed with open arms and receive better salaries? Worse, those who have done the course at a teacher-training college, where they have been trained for primary education, and are under contract to the government, break their contract on the pretext that they wish to continue their higher education; but the fact is that, since they have

their *baccalauréat*, they can be sure of finding a better position.

Thus primary education is losing a large proportion of those trained for it, and is being flooded with untrained staff.

That, then, is the general situation, although there are other factors that aggravate the trouble, such as the great variety of backgrounds from which recruits come, the disadvantages of recruiting abroad, with its budgetary implications, and difficulties related to the actual work of teaching—the content of syllabuses, methods and bilingualism for instance.

Realization of the problem

Officials in all the developing countries were quick to realize the scale and complexity of the problem, and attempts were very soon made to find ways of training teachers. The measures taken included weekly teachers' meetings, monthly or fortnightly further training courses, teaching seminars or courses for teachers occupying a week of the school holidays, cultural study courses held in the summer, information and training courses or courses preparing people for professional examinations during the long holidays, correspondence courses, etc. Considerable attention and much hard work are being devoted to these activities, and substantial credits have been earmarked for them. Is it all in vain? By no means; but it does seem that for the most part the results are not very good—in fact, not even satisfactory—and that 'the game is not worth the candle'.

A great deal of reflection, discussion and experimentation is going on in all these countries. The problems they face are not easy to solve. Some people blame the syllabuses or the organization of the courses. Sometimes young teachers are criticized for their attitude and for their lack of interest in the work offered them. Material incentives are tried, such as grants for training courses or the award of certificates at the end of such courses.

The experimental aspect

The experiment now being carried out in Algeria is one of many attempts to improve standards among young teachers. It is not quite finished, and it is too early as yet to take stock of the situation and assess the results, but we feel we should give some account of it, since it is perhaps a beginning, though we claim no more for it than that. Its main features are as follows.

Functional value

First we determined the professional level of the young teachers whose standards we were trying to raise. They were uncertificated teachers, but they had attended courses for a sufficiently long time (three years) to sit an internal professional examination leading to the Certificate of General and Professional Education (*certificat de culture générale et professionnelle*). If they pass this exam they are entitled to an established post at the appropriate level, that of *moniteur* (assistant-teacher).

Next we considered the marks obtained by the candidates who had failed several times, and we gave four groups of twenty-five assistant-teachers of this standard an initial test to determine their level and find which were their weakest subjects. We found that Arab-speaking assistant-teachers at the above-mentioned standard were weakest in mathematics and the method of teaching.

Consequently, when we suggested that they should take courses designed to improve their knowledge of various subjects, we were assured from the beginning of their co-operation and enthusiasm—the spontaneous motivation without which nothing can be done.

Flexibility and adaptability

The courses were worked out in accordance with official syllabuses, and the rate of progress was determined by the central group planning the project. They have not been finally adopted, however, but are being evaluated by a reviewing

committee made up of local education officers (inspectors, educational advisers, specialized teachers), who express their opinions and suggest alterations and corrections; the central group sees to it that these are taken into account. This makes it less likely that the courses will be over-ambitious, or above the heads of those taking them. In any case, they are reviewed again at the end of the experiment, after an analysis has been made of the study records which every participant is asked to fill in for each course he takes.

Freedom and self-determination

One important feature of the scheme is that from the outset we try to make participants aware that they must do a good deal of the work themselves, that they must take part of the responsibility for their own training. We therefore do not object to each one's working at the pace which suits him best; some mark time for a period, and then put on speed and catch up. All we do is to advise students and warn them of the dangers of going too slowly or too quickly, so that they settle down to a normal pace, for a certain pace is regarded as normal in our scheme, as in any scheme in which work is logically organized.

The principle of freedom is still more apparent in another feature of the course: attendance at the special consultation sessions on cultural subjects and on the method of teaching which we hold every week.

Assistant-teachers are not obliged to attend these sessions at a particular time: they know that they are held from 9 a.m. to midday every Thursday (the second weekly holiday) and they can come when they like and go when they have finished.

Methods

Starting from the basic principles set out above, we opted for programmed correspondence courses, which are the most suitable for individual work.

Mathematics lesson sets

The sets of mathematics lessons so far worked out include fifteen for algebra and ten for geometry.

Each set of algebra or geometry lessons comprises a series of questions and an exercise. The student can correct his own work by comparing his answers with the key at the end of the set of lessons. The only work corrected is the exercise, which is marked by the teacher during the consultation sessions described above. The exercises are planned so as to enable each student's progress to be recorded and his diligence assessed. In addition, for the purposes of the final assessment of the scheme, each student is asked, as he does each set of lessons, to fill in a form in which he notes his results and says what he thinks of the exercises he was asked to do, indicating which he found too easy or too difficult. These data and others are assembled, recorded and collated at the end of the experiment. It should thus be possible to improve the lesson sets, select better exercises and see that difficulties are more evenly distributed when the next sets of lessons are issued.

Programmed lessons on teaching methods

About fifteen sets of these have been worked out. Each deals with a topic related to general or specialized teaching methods, and four or five questions are asked. In addition, each set of lessons includes either a set passage to be studied or an exercise on teaching methods, accompanied by an outline and instructions.

The purpose of thus alternating textual studies and exercises on teaching methods is to train young teachers in the practice of analysis and synthesis, which are both essential if they are to learn how to expound a subject.

At the consultation sessions, the student is received by the educational adviser, hands him the programmed lesson on which he has worked, and asks him for clarification of any points which are not clear. The educational adviser

checks his work and, in his presence, corrects the written answers which he has given; only exercises on teaching methods are collected and corrected at the centre. After this they are given back to the students, with comments, a report on their work, and sometimes a fair copy. A carefully worded individual comment is made on every piece of work; this is never indulgent, but always suitably encouraging. We have been careful to preserve the individual nature of these consultation sessions. At first the young teachers were rather reserved, but they rapidly gained confidence and eventually began to speak freely, explaining their problems and consulting us frankly, while acknowledging their failures and weaknesses.

Various practical activities are undertaken in addition to this theoretical work.

When we decided upon the time-table for the consultation sessions, we took care that every second consultation session should fall on the fortnightly half-day's study of teaching methods organized by the primary-school inspector for the area.

On such occasions we start our day by attending a demonstration lesson, together with our groups. It is usually given by a good teacher, and when it is over we discuss it. We noticed that after a few such sessions our groups were freer in their discussions, and could easily pick out both the good qualities of the lesson and any important faults to be found in it.

We also use such demonstration lessons to show how closely related theory and practice are and to point out anything of general interest to our group. In future, we intend to use broadcast programmes also, as a practical way of assisting students. We have drawn up a programme of educational broadcasts to accompany the programmed lessons on teaching methods.

Each broadcast lasts about forty minutes, and starts by depicting a situation in which education is involved: part of a lesson, or a conversation between teachers of different classes or between parents.

Next, this situation is analysed, and recordings

are made of round-table discussions which educationalists at various levels (inspectors, educational advisers, primary-school teachers and assistant-teachers) are invited to attend. We now use tape recordings instead of broadcasts. This means that our experimental groups have to gather around the tape recorder to listen. On the other hand, tape recordings have a certain advantage over radio broadcasts, in that the latter are soon over, and cannot be repeated. Groups can listen to the tape paragraph by paragraph and play it back at will; and we can encourage the young teachers to discuss important points before playing it over to them in full.

Such playback sessions are very lively, and arouse the interest of the young teachers.

The project includes yet another type of practical work: monthly television broadcasts.

In each broadcast a demonstration lesson is given by a good teacher, and this is followed by a round-table discussion between one or two inspectors, several experienced teachers, and the assistant-teachers.

Such discussions are interspersed with televised sequences, which relieve the monotony of too much talking, stimulate interest and focus attention on important details which may have been passed over.

Consultation sessions

We have twice referred to these sessions. What are they? The consultation session plays an important part in our training scheme. There is nothing original about correspondence courses in themselves, there are many of them. However, although something can undoubtedly be achieved by the usual type of correspondence course, it is also true that very many students lose heart and drop out after a few weeks' work. The introduction of consultation sessions (one for every fifty students) is specifically designed to make such excessively impersonal work more human, by establishing contacts between the student and the instructor who corrects his work (one math-

ematics teacher and one adviser on teaching methods attend each session).

Moreover, the person who corrects the student's work is available to him for consultation, and everything except work on teaching methods is corrected and checked during this session. This also means that less time is taken in correcting work, and exercises are returned more quickly, which is a considerable advantage.

Finally, at the consultation sessions students stock up with as many new sets of programmed lessons to study as they require, depending on their working pace.

Assessment and criticism

While it is impossible at this stage of the experiment to pronounce on the results achieved, there are some grounds for optimism about the future. First of all, by periodically examining the students' record sheets and the marks they obtain in mathematics and in teaching methods, we are kept regularly informed as to how most of them are progressing. Secondly, when we inspect their class-room teaching, we can often detect a distinct change in their approach to their work. We drew up and distributed a questionnaire on attitudes, which we took three months to prepare. The young teachers' replies are very much to the point. We quote some of the replies to the first question, which was: 'What do you think of the programmed lesson sets?' 'They are very useful, because in them I find what I cannot read up in other books, and it is programmed.' 'They are excellent, because they are exactly at my level and I understand them perfectly.' 'These programmed lesson sets have given me back the will to work, despite myself.' 'I like these programmed lesson sets because the lessons are detailed, clearly set out and carefully explained; they cover the questions on the special teaching methods syllabus and on algebra, but I found the programmed lesson sets on geometry more valuable.'

'I like these programmed lessons, because when I use them I can work by myself and reach the required standard, and understand what I am doing.'

Another question—'Would you like to study other subjects by the same method?'—produced replies in the affirmative and almost all to the same effect. All the assistant-teachers thought it would be a good thing if other subjects were treated in the same way—history, geography, science and literature, for instance.

A study of these replies will give us food for thought as to the future of the scheme, and we will take them into account in planning for its extension and expansion.

In short, the last word has not been said, and cannot be said before the experiment is finished. We must wait until our assistant-teachers have sat the final test, the results of which will be collated with those of the initial test. We shall have to compare the results obtained by the experimental groups and the control groups both in the individual tests and in the examination for the Certificate of General and Professional Education.

Finally, we shall have to analyse the record sheets systematically and make corrections for insertion in the lesson sets.

Expansion

However, we are already thinking of the future of our project. When the present experimental stage is over we shall have worked out a set of effective but flexible methods and designed and produced the materials required for our purpose. How can the system be extended? There is a choice of several schemes.

The lessons which have already been prepared could be improved, corrected and enriched, and could then be distributed throughout a whole *wilaya*¹ or several *wilayate*, so that they could be

1. A *wilaya* corresponds to a French administrative *département*.

used by all Arab-speaking assistant-teachers of comparable standard. For this purpose, more copies will have to be produced when the lesson sets are re-issued, and the necessary number of consultation sessions will have to be arranged. On the other hand, those who conduct the consultation sessions will themselves have to attend a refresher course.

Another way of extending the scheme horizontally would be to strengthen the programming team in the central planning group and prepare programmed lessons for other subjects such as history, geography or science; in the initial experimental stage the scheme could be extended to only one *wilaya*.

Finally, the scheme might be extended vertically. The assistant-teachers whom we enrolled this year were at levels III and IV. It would be possible to go down a step to assistant-teachers at levels I and II, or move upwards to take in primary-school teachers holding a certificate of secondary education such as the *brevet d'enseignement général*, but not fulfilling the conditions required for appointment as qualified primary teachers.

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New resources for learning¹

by Norman MacKenzie, Michael Eraut and Hywel C. Jones

It is a reflection on the rate of innovation in education that the phrase 'new resources for learning' is normally considered to include resources such as film (first used regularly in education in about 1910) and slides (first used in education in about 1890). Nevertheless it is true that for most college and university teachers the use of any resource other than chalk, talk and book is regarded as something special if not as a novelty. The purpose of this chapter is not to suggest which resources should be used but merely to outline which resources can be used. . . .

There is no obviously convenient or generally accepted system for classifying learning resources, so we shall use one which is based primarily upon information sources. Our first three sections will be on television, the language laboratory and other audio-visual resources. We include teaching machines in a section on feedback devices and reprographic equipment in a section on accessing devices. These are followed by a section on new resources for the 1970s, which describes some of the new equipment now being developed and its possible implications for higher education, and a section on the computer as a learning resource. Programmed learning is left to a later section because the previous sections are potentially relevant to it. Programmes are different in kind from the other resources described in this chapter in that they are neither hardware nor confined to one particular medium. Indeed, most of the resources listed are capable of being incorporated into a programme, since we define

programming as a process for developing resources which is independent of the medium of communication.

Television

The glamour of television as an entertainment medium has at least brought it to everybody's notice, and it has probably received more attention in education during the last decade than any of the other new media. Its potential for education lies in three main directions: (a) it can show things that would otherwise be difficult to see because they are of an inconvenient size, too far away or too complex; (b) it can transcend the limits of space and time either by open-broadcast, closed-circuit or recorded transmission; (c) it can be used for evaluation of performance; for instance, an athlete, an actor or a teacher can be recorded as he performs and his

1. This article is an abridged version of a chapter from *Teaching and Learning: An Introduction to New Methods and Resources in Higher Education*. This work, recently published by Unesco and the International Association of Universities in English and French, is the latest in the Development of Higher Education series. The book was written by Norman MacKenzie, Director of the Centre for Educational Technology; Dr. Michael Eraut, Fellow of the Centre; and Hywel C. Jones, Research and Development Officer—all of the University of Sussex. The book can be supplied by any of the national distributors listed in the final pages of this review.

performance can then be viewed in a replay by himself and others.

But few of these discussions give much account of the cheap portable video-tape recorders (VTRs) which have recently come on the market. A simple camera, recorder and receiver can now be purchased for about \$1,500 and operated off a battery power supply by virtually anyone. These camera-recorder chains are well suited to the evaluation of performance and can also be used for demonstration or for recording if quality is not critical and the intended audience is small (thirty or less). We believe that cheap VTRs will find increasing use, that their price will fall and that their pattern of use will soon resemble that of the ordinary sound tape recorder. Indeed it may eventually become more popular.

In marked contrast to this cheap equipment is a closed-circuit television installation, complete with studio and distribution system. These installations cost much more (up to \$300,000 for a large system) and while small systems (about \$10,000) can be found at the departmental level in American, European and some other institutions, they will more usually be set up at the institutional level. They are a commitment which should never be undertaken lightly or hastily because their costs are nearly always greater than has been originally foreseen. It is easy to underestimate the need for professional and technical staff, for graphic and photographic support, for studio space and for expensive distribution networks; especially when a high rate of work is necessary in order to secure economies of scale. Of course, a beginning can be made with new equipment and techniques without a commitment to such long-term and large-scale implications—and a beginning is usually made in this fashion. If innovators had to wait until their institutions were ready to commit big sums of money, it would be hard to make any start at all. But it is essential to note that many media projects have been started without adequate consideration of what may eventually be involved.

Language laboratories

Discussion of the use of language laboratories is inevitably coloured by the fact that the laboratory is a fixed installation. This poses practical problems, but they ought not, in the first instance, to obscure the basic principles involved. What is normally termed a 'language laboratory' might best be regarded initially as a series of facilities lending themselves to use in certain circumstances for the fulfilment of limited tasks. It is usually (though not inevitably) true that for reasons of convenience these facilities are housed in one place, as opposed to being portable or mobile, and this introduces factors not directly related to the degree of efficiency of the 'laboratory' to fulfil the tasks allotted to it. The financial implications of housing the facilities in a fixed spot are considerable and must not be ignored once a decision has been made on pedagogical grounds concerning the need for, and the availability of, the facilities.

It is therefore logical to proceed from an analysis of the language-teaching problems to a consideration of the number, type and arrangement of the facilities required to deal with them. But the facilities are only means of exploiting material, and it is frequently the need for adequate supplies of specialist materials that is overlooked and underbudgeted when language laboratories are discussed. Unless such materials are accessible, or provision is made for their manufacture and multiplication (i.e. that the requisite facilities are available), even the provision of a laboratory will be of very limited use.

A second premature conclusion sometimes imposed by the fixed nature of a conventional laboratory, and the cost involved in installation, is an exaggerated estimate of the use and function of the laboratory in an over-all teaching programme. Over-use and inappropriate use lead inevitably to discouragement and disillusion, and this is an all-too-familiar pattern. At its crudest, the laboratory is appropriate in the teaching of a certain amount of certain registers of language to certain people for certain purposes

in certain circumstances; unless all these conditions are fulfilled, there will be a decrease in efficiency and consequent psychological reaction.

A laboratory—whether fixed or otherwise—must be fed and serviced. Its consumption of raw tapes, spools, boxes, labels, etc., will vary according to use, but will always be considerable (perhaps an annual outlay of about one-fifth of the original cost). The maintenance of the complicated electronic components is a highly skilled job, requiring an appropriately skilled staff. Certain less-skilled servicing tasks are also essential to smooth running. And finally the problem of random access to materials must be solved by a carefully defined and administered system of classification, storage and retrieval, requiring certain library skills. All these must be

costed in advance, before decisions about installations are taken.

The language laboratory has proved its worth within the parameters indicated above. But it is not a panacea for the production of instant linguists, it will not replace the teacher; essentially it provides certain quantities, types and combinations of facilities for learning.

Other audio-visual resources

Further information about other audio-visual resources can be obtained from general audio-visual references. For the sake of completeness the common types of resources are listed in Table 1.

TABLE 1

Presentation equipment	Materials	Production equipment
<i>Sound</i>		
Record players	Records	
Tape recorders	Tapes	Tape recorders
Radio		
<i>Still pictures</i>		
Slide projectors	Slides	Cameras
Filmstrip projectors	Filmstrips	Photographic equipment
Overhead projectors	Transparencies	Graphic equipment
Epidiascopes	Photographs	Heat copiers, etc.
Micro-projectors	Wall charts	
<i>Still pictures with sound</i>		
Record/Filmstrip systems		
Slide/Tape systems		
<i>Motion pictures with or without sound</i>		
Loop projectors		
(8-mm and super 8-mm)	Film loops	Cine-cameras
Cine-projectors	Silent film	
(8-mm and 16-mm)	Sound film	

Many institutions have established central agencies to provide audio-visual services and the advantages of centralization include economies of scale and the ability to attract professional staff of the appropriate quality. While we do not dispute that some audio-visual services can be best provided by a central agency, we feel that it is important to note certain disadvantages which can only be overcome by careful planning. The professionals who run such agencies are bound to measure their success by the total value of their equipment and by the extent to which their facilities are used. Indeed it is difficult to imagine how other success criteria could replace those of size of budget and intensive use without altering the whole administrative structure of the institution. But valuable assets and high turnover do not necessarily imply profit: there is no obvious relationship between the quantity of audio-visual materials produced and improvements in the quality of learning. It is the planned use of audio-visual resources which is most likely to improve quality, and most of the planning and preparation time will have to come from the faculty concerned rather than the audio-visual specialists. But how does one reconcile the provision of a service to all who demand it (and most central agencies go out canvassing rather than just sit and wait) with the observation that the use of audio-visual resources without adequate faculty planning usually increases the cost of teaching without increasing its effectiveness?

Another important development is the increasing emphasis on the use of audio-visual resources for independent study. This has led to the concept of the learning resource centre. While in our view this should be a natural extension of the library—or at least closely associated with it—it has often developed quite independently. Usually a learning resource centre has learning booths (or 'carrels') in which individual students can use slides, filmstrips, film loops, tape recorders and books. The more ambitious examples even include viewing facilities for television. They must seem forbiddingly expensive to visitors from

developing countries, yet much can be achieved at a relatively cheap level. Very similar learning situations can be set up with cheap battery-operated slide viewers and small battery tape recorders. And it would not surprise us if someone was to demonstrate that a proper exploitation of this cheap portable equipment gave better value for money in developed countries as well.

Feedback devices

The purpose of feedback devices is to supply knowledge of results when a student or a group of students are questioned on what they have learned. When the question is also presented by the device it is called a 'teaching machine'; but when the question is posed by a teacher it is usually referred to as a 'feedback class-room'. The feedback class-room gives knowledge of results to the teacher as well as to each of his students.

Teaching machines are normally divided into three categories, adjunctive, linear and branching. The adjunctive machines developed by Pressey and his co-workers provide knowledge of results to students answering multiple-choice test questions. Methods of giving feedback include lighting a bulb, allowing a punch in the correct answer space to penetrate more clearly, and having chemically treated paper change colour. The term adjunctive is used because these machines are adjuncts to the main teaching-learning process. They only contain tests and they are used to test and revise material which the student has already encountered elsewhere. Linear and branching machines present original material as well as questions and answers and can therefore assume total responsibility for teaching a topic. The linear machine presents questions step by step in a predetermined sequence, gets the student to answer each question in turn and gives him immediate knowledge of results. The branching machine allows the student alternative routes through the material and uses his mistakes to determine his route, but it can only accept

multiple-choice button-pressing responses. None of these machines has so far been shown to have any learning advantages in higher education over programmed texts; and they impose considerable restrictions on the person writing the material. Many of the other resources discussed in this chapter can, however, be used as teaching machines with considerable advantage. The slide projector and the tape recorder are both useful for presenting material in media other than print, and the computer has all the flexibility which the traditional teaching machines lack. We shall return to this in a later section when we discuss programmed learning.

The feedback class-room is essentially an electronic response system, which permits a teacher to pose questions to a class in which each student is equipped with a press-button device which registers on a scoreboard visible to the teacher. In its simplest form the student switch registers 'Yes' or 'No' and an appropriate light showing the student's response appears on the teacher's indicator. More elaborate versions permit a choice of up to five possible answers, indicate to the student by a green or red bulb whether his response is correct, and then tabulate the individual and group scores, both for individual answers and series of them. In its most sophisticated shape, such a device punches a paper tape which can then be run through data processing equipment to give print-outs and analyses of student response.

Some of the same purposes, however, may be achieved much more cheaply by using pairs of cardboard discs. One disc is divided into five sectors, marked A, B, C, D and E on one side and coloured on the other side; then a second disc of the same size with one sector cut out is pinned to it centrally. If each student is given a pair of discs he can use it to answer a multiple-choice question by putting his chosen sector at the top where the second disc has been cut out. When he holds the discs up his teacher will only see the colour appropriate to this choice, e.g. blue, because the other colours will be masked by the rest of the cut-out disc. This enables the teacher

to judge the approximate distribution of his students' answers by rapidly assessing the colour distribution held up before him. A multi-coloured cube can be used in a similar manner. More accurate measurement and recording of student answers is given by the more sophisticated 'feedback class-room' but it is questionable whether this greater accuracy is significant in view of the extreme variability of the teaching performance.

Accessing devices

At the moment most accessing devices can be divided into two categories: reprographic devices, which enable the student to take away copies of a resource and which require the physical presence of an original; and dial-access devices, which enable the learner to examine a data bank located at some distance but do not give copies to take away. A third type of device, which permits the examination of a distant data bank as well as enabling the student to take away copies of the information he requires is likely to emerge in the not-too-distant future.

The impact of reprographic devices on education is already considerable. The paperback revolution has become institutionalized and now we are in the midst of a photocopying revolution. There are copyright problems involved in this, but we are here concerned with the technique. The price still needs to come down if photocopying is to become economic for general teaching purposes but many of its advantages are already becoming apparent. It is possible for students to work at home with copies of articles or chapters instead of having to buy or borrow whole books and the pressure on library resources can be thereby diminished. It is possible for all the students attending a discussion to have read the same short background paper beforehand; and it is possible to copy a student's paper and circulate it for discussion. All these advantages offer an escape from the use of a single textbook or a few scholarly works as the main sources of information.

The earliest form of dial-access device is the telephone, though it is still rarely used in education. It is particularly useful in remote teaching situations and access to a tutor by telephone can be a valuable supplement to a correspondence course. With suitable amplification a telephone can also be used by a class to question an expert at some distant location. This is particularly valuable when the group has already read an article or listened to a recording made by the expert or one of his colleagues. A sophisticated addition to this 'tele-lecture' or 'tele-discussion' is the 'electro-writer' system, often referred to as 'blackboard-by-wire'. This system makes it possible for a person to write with a stylus on the surface of the electronic equipment, for the image to be transmitted over telephone lines and for his message to be projected on to a screen at the receiving end. Both written materials and simple diagrams can be transmitted as they are produced.

So far we have discussed the use of the telephone for obtaining access to a distant person. It can also be used for access to stored information in a Dial Access Information Retrieval System (DAIRS). The simplest version of such a system allows a student to dial for a sound tape or a record instead of having to fetch it and play it back on his own machine. This is particularly valuable when the student can listen in his home as well as in the library/resource centre; and it tends to be used for listening to lectures or for language study. Its main disadvantage is that the student has little control over pacing, stopping or starting: he cannot choose to listen to excerpts as he can when operating his own machine. For this reason it is best to view the simple DAIRS as reducing the demand for student-operated equipment rather than replacing it. A video-channel can be obtained either by adding decentralized ancillary equipment which the student operates himself or by expanding the distribution system to carry visual information in addition to audio-information. Some of the more expensive systems now in use allow the student to dial a television programme or a film, though the store of visual information to which he has access

is very limited in size. As with sound-only systems, he cannot easily browse or select excerpts from a particular programme.

New resources for the 1970s

Until now cost and complexity have limited the development of visual recordings. Even the cheapest VTRs are still too expensive for one to consider installing them in learning carrels for regular student use and their picture quality is too low for many purposes. Movie projectors are not quite as expensive but films are costly and it is very difficult to select excerpts from them. But the need for a motion-picture equivalent of the long-playing gramophone record or audio-tape recorder is likely to be at least partially met during the next decade by the emergence of a new class of machines, a class which may be broadly described as teleplayers or devices for retrieval television.

The first of these to be announced, in 1968, was the Electronic Video Recording (EVR) player. This device, developed in the laboratories of the Columbia Broadcasting System in the United States, stores pre-recorded programme material on a narrow film contained in a sealed cartridge about the size of an audio-tape reel. Each cartridge contains up to thirty minutes of material on each of two tracks, or, in the version still under development, thirty minutes of colour programme, using the second track in this case for the colour coding. The film cartridges are printed from a master tape, prepared in an electron-beam recorder, which will accept television film originals.

The quality of picture and sound is high—superior to that obtained from broadcast television on most video-tape recorders—and the projected cost of a one-hour cartridge and of the player are both well below current prices for either video-tape or video-tape recorders on which to play it. The manufacturers claim that quite small production runs of cartridges—between 100 and 200—are economically usable and practicable,

and of course all cartridges are compatible with all players.

The three virtues claimed for EVR are (a) that it permits relatively cheap central production of materials for presentation through television; (b) that it permits audio-visual materials to be presented whenever a normal television set is available and that this can be done without some of the difficulties, such as blackout, that are involved in film presentation; and (c) that the 'stop-frame' capacity of EVR has great potential for education. The last of these three claims is particularly significant. While a single frame can be held on modern video-tape recorders, and on some film projectors, there is usually a loss of quality and it is extremely difficult to find a particular frame (individual picture). The EVR player, however, presents a still picture of good quality, and has an attachment that permits the user to advance or retard the film frame by frame. It can therefore be used for presenting one or more single frames (such as a filmstrip) mixed with motion picture and sound. This means that it begins to approach the desirable model of a single, relatively simple, all-purpose audio-visual device. Looking further ahead, it is possible to foresee what has been called 'reference EVR': the development of a search or retrieval system which would enable the user to locate any one of the 180,000 frames which make up the EVR film cartridge. Once this occurs, large numbers of maps, diagrams and photographs could be held in compact form, and made accessible to teachers and students. All necessary illustrations for an anatomy course, for example, might be contained in a single cartridge, and comparable advantages for such information storage capacity can easily be projected for other academic disciplines.

The EVR player and cartridges are still under development, and the first models are expected to be available towards the end of 1970. But other manufacturers are working on competitive devices. In the middle of 1969 the RCA Corporation in the United States demonstrated a prototype of a device called Selectavision, similar

to EVR in that it uses pre-recorded material, but using a different film base and employing laser techniques for reading out the recorded signal; it was stated that Selectavision, promised for the market within two years, would have colour capacity from the outset. Reports are circulating in trade circles that other types of teleplayers are under development in the United States, the United Kingdom, the Federal Republic of Germany, the Netherlands and Japan.

In the long run, manufacturers entering this field must be expecting to sell their players and recordings for domestic use as a means of entertainment, as well as enrichment and self-instruction. That, after all, is where the mass market lies. But it is significant that all of them view education as a potential market. The immediate use of such devices in higher education is likely to be limited, partly because the market for pre-recorded teaching or learning materials is likely to be relatively small, though teleplayers might become convenient alternatives to the use of 16-mm film. Yet where a larger audience exists—say, for Open University or similar programmes, or for series with a wider appeal, like introductory-level courses in science or mathematics—the ability to replay at will could be very attractive. Within ten years it seems certain that devices of this kind will have found a useful and expanding role.

The computer as a learning resource

It is certain that the use of computers in higher education will extend most rapidly and extensively in dealing with problems that are common to education, science, business and public administration; that is, for high-speed computation and data processing. Already the use of the computer in higher education for the purposes of administration and research is becoming a major item in a university budget and before long it may be the single most costly item next to faculty salaries. But the proposition that a computer could also become a potent new vehicle

for teaching and learning is more recent, though it is being taken up with considerable enthusiasm. Serious research programmes are now under way, not only in the United States, but also in Belgium, Canada, France, Japan, the Netherlands and the U.S.S.R., some sponsored by commercial enterprises producing computer and associated software, some underwritten by State agencies. Many research studies, conference reports and other materials are already available on this theme.

The potential applications of the computer to teaching and learning are of two main types: those which are essentially similar to existing applications of computers and which are only delayed by problems of cost; and those which are dependent for their realization on the development of new techniques. Naturally the latter are more contentious but they are not necessarily more important. One application that is only delayed by cost is that of providing computational and data-processing facilities for students. The widespread provision of these facilities could have a marked effect on the curricula of higher education. It would allow a much greater use of problems involving computation, since the student would still be able to concentrate on the main principles without being unduly distracted by routine computational demands; and it would encourage successive approximation approaches to optimal solutions. Related to this is the use of computers for simulations, as for example when data relating to a model environment and the way it reacts to certain changes is stored in a computer and a student or a group of students explores the environment by making decisions and assessing their consequences.

Computer-assisted learning (CAL), in which the computer is used as a highly sophisticated teaching machine which can replace and sometimes surpass many but not all of the functions of a human tutor, is the natural focus for the 'educational futurists'. But its long-run potential tends to blind people to its short-run uncertainty. Even though pilot schemes of this kind are already in operation and some American institutions are

using them to present parts of regular courses, there is little evidence that any of the present uses are either very economic or very effective. Nor do they even begin to use the full potential of the computer. There is no way to by-pass the problem of our ignorance about how people learn and this limits the way we can programme the computer. The use of computers in the tutorial mode will undoubtedly accelerate research into the learning process but it can never replace it. Within five or ten years there may well be a place for CAL in many courses in higher education though only for relatively short sections of those courses. There are signs that these limitations are now being increasingly recognized and most publications in the last year have been much more realistic about the likely rate of development of CAL. We believe that curriculum changes in higher education will be at least as important as new programming techniques in determining the rate of adoption of CAL. The further the curriculum moves from its present preoccupation with the transmission of content, the more difficult it will become to use CAL. The same trend may, however, lead to a rapid increase in the use of the computer by students for computation, data processing and simulation.

The use of the computer for the management of learning represents an intermediate stage between its use for computation and data processing and its use in CAL. Computer-managed learning (CML) derives originally from the use of computers for the analysis of test and examination data. Automatic marking does not necessarily require computer capacity but computers can provide a rapid and much more detailed analysis of a student's achievement and abilities, and they can keep an up-to-date record file of each student's progress, which is helpful both for research and for diagnostic purposes. Normally teachers would use this information as a basis for teaching decisions, but in the independent study situation it would be equally possible for the computer to suggest the next step. It would have to be given a list of alternative assignments and a set of decision rules for linking

its analysis of the student's progress to the appropriate assignment. It would also have the theoretical capacity to evaluate the decision rules and improve them in the light of evidence from subsequent student performance. This capacity for self-improvement may not be realized in practice for some time yet, but CML is still a realistic proposition without it. It provides a framework within which the computer can take certain routine responsibilities from the teacher and give some guidance to the student when he is studying independently. This could lead to a more effective use of teacher time without needing inordinate amounts of computer time or terminal time. Though our lack of knowledge about how to make appropriate assignments is clearly a handicap, the greatest problem in CML is probably the evaluation problem. The set of objectives which we can easily evaluate with computer markable tests is still very limited, especially in arts subjects.

Programmed learning

Programmed learning is potentially one of the most confusing of recent innovations because it is difficult to define. Early definitions divided programmes into linear programmes and branching programmes and listed the salient characteristics of each. Schramm in 1962, for example, wrote as follows (with a footnote to the effect that it only applied to linear programmes): 'To sum up, these are the essential elements of programmed instruction: (a) an ordered sequence of stimulus items, (b) to each of which a student responds in some specified way, (c) his responses being reinforced by immediate knowledge of results, (d) so that he moves by small steps, (e) therefore making few errors and practicing mostly correct responses, (f) from what he knows, by a process of successively closer approximation, toward what he is supposed to learn from the program.' One by one these characteristics have been shown to be inessential and the problem of the distinction between programmes

and other kinds of learning materials has become acute.

This confusion over the definition of programmed learning has arisen from a failure to distinguish the process, i.e. programming, from the products, i.e. programmes. It was not until 1964 that several people independently realized that it was possible to define the process of programming but impossible to describe the nature of its products. By 1967 when the United States National Society for the Study of Education published a yearbook on programmed instruction, there was general agreement among the experts that the process could be defined by the following steps: (a) formulation of objectives; (b) design and testing of appropriate criterion measures to determine when the objectives have been achieved; (c) definition of the target population; (d) analysis of learning tasks; (e) preparation of prototype programme; (f) developmental testing of programme; (g) validation of programme. In developmental testing the purpose is to improve the programme and in validation it is to obtain data to demonstrate the effectiveness of the programme.

This process-based definition of programmed learning has not yet been understood by the public at large who, naturally enough, want to recognize a programme when they see one and to refer to any work published with the label 'programme' as a genuine programme. But the implication of the definition in terms of process is that learning materials can only be defined as programmed if accompanied by evidence that they have been systematically developed, i.e. by statements of objectives, criterion measures, descriptions of the target population and validation data. Many of the early 'programmes' met this definition and are known to be effective, though they were not usually very efficient. Techniques have improved since then and some recent programmes have achieved similar results without taking so long. But the greatest problem has been the large number of 'pseudo-programmes' which have been published. These pseudo-programmes copied the superficial characteristics

of the early programmes in that they contained the first four of Schramm's 'essential elements' but were not carefully developed by the process outlined above. In 1965, Komoski concluded from a survey of 291 programmes that no evidence of testing was available for 40 per cent of them; and the situation appears to be getting worse because in 1967 a survey of 707 programmes by Northeastern University found that 70 per cent had no validation data. Many others are suspect because the tests used to validate them are inadequate samples of the stated objectives. The conclusion can be drawn, though it is rarely heeded, that it is exceedingly dangerous to make general statements about the class of published materials which bear the label 'programme'.

The increasingly divergent activities of programmers have also led to programmes which retain none of the distinguishing characteristics outlined by Schramm. No one in 1962, for example, would have recognized a television presentation as a programme; or a film, or a textbook, or a game, or a set of procedures to be followed by a teacher. As Markle has concluded: 'With the increasing eclecticism in design illustrated above, it is not possible to look at a set of materials and insist that they *are not* programmed. On the other hand, because of the ease with which the superficial characteristics of programmed materials can be mimicked without going through even an approximation to the total process as described here, it is equally impossible to look at a set of materials and say that they *are* programmed. The only observable distinguishing characteristic is a product description, providing the consumer with the complete set of objectives, matching criterion measures, and data, drawn from research with students, which support the claims for the teaching effectiveness of the materials.'

Selecting a programme has become a sophisticated problem and we have no space to discuss all the issues in detail. We are therefore confining our comments to a list of questions which we have found useful in arriving at decisions on whether to adopt a programme.

Questions relating to decisions about adopting a programme

- Do the objectives of the programme coincide with your own?
- Is the population for whom the programme was developed sufficiently similar to your own?
- Are there any assumptions about the learner which are not included in the statement of prerequisites?
- Is the Final Test an adequate measure of achievement on the objectives of the programme?
- Was the general performance of the test population satisfactory?
- Did any students in the test population perform badly?
- Would you expect to have similar students, and would you be able to give them special attention?
- Do you have students who lack the prerequisites for the programme and could you remedy this?
- How can the programme be integrated into the curriculum?
- Could or should the programme be supplemented by discussion sessions?
- Is there a need for tutorial help by students working through the programme and can it be met?
- Have you time to plan further activities for students who finish early or students who are already proficient on the material in the programme?
- Does the programme contain good subject-matter (i.e. is it accurate, are its assumptions and explanations valid)?
- Is the approach of the programme compatible with your approach to teaching?
- How does the programme affect pupil's attitudes, (a) towards the subject, (b) towards programmes?
- Does the programme give weaker pupils confidence?
- Predicting the nature of programmed resources in the next decade is difficult because techniques

are changing so fast. It is probably safe, however, to predict three trends. Firstly, there will be an increasing tendency to use media other than print, especially when devices like EVR become available for use as multi-media teaching machines. Secondly, there will be a tendency to adapt much more to individual differences, both

because usable research findings are now beginning to emerge and because the computer will provide a means of handling it. Thirdly, that Green's comment in 1967 will continue to be true: 'The most stultifying programmes seem to be those most carefully modelled on their predecessors.'

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