tion, and broadcasting technologies to educational and training needs. Early work investigated technical research (telecommunications, artificial intelligence, interactive and multimedia developments, high-tech distance learning). The subsequent Phase II ("Telematics for Flexible and Distance Learning") reveals more concern with pedagogical and cultural perspectives of the use of new technologies, and focuses on three aspects:

(a) development of implementation strategies: identification of common requirements and appropriate uses of information technology (IT) and telecommunications;

(b) development of technologies and systems that are interoperable, effective, and modular; by harnessing and harmonizing existing and emerging technologies and telematic services the objective is to reduce costs, improve the performance of technology for learning, and provide adequate mechanisms for learning;

(c) validation and integration of services: to assess the cost-effectiveness and pedagogical efficiency of telematic systems for flexible and distance learning.

The DELTA program is an "act of faith" in the applicability of advanced learning technology (ALT), based on utilization of information technology (IT), new telecommunications systems, and broadcasting to increase access to quality education and training throughout the European community; but the program is also aware of the need to pay close attention to the cost-benefit equation of these technologies (with their high-tech image and costs) as compared with the more traditional approaches.

6. Conclusion

Education technology plays a part in the work of many international organizations, in a range of forms and with a diversity of aims ranging from highly specialized training in the Western world to basic education for rural populations in LDCs. Arguably, in the 1990s, it is in this latter context that its most important role will lie; but it is salutary to note that the UNDP, one of the most active organizations in this respect, spent only 0.8 percent ($4.8 million) of its total education and training projects spending in the period from 1977 to 1986 on educational technology projects (UNDP 1989 p. 153). This highlights the need for educational technology, in all its applications, to maximize the benefit relative to the cost and to be the most appropriate response to the need being addressed. To quote Claudio de Moura Castro:

The complexity of the technology that is being proposed has to match the real possibilities. Illustrations reproduced in an alcohol mimeograph may be the most advanced technology that a given environment can jus-

tify . . . Ultimately, we have to ask whether we can overcome external constraints. If the electrical current is unstable, computers are not practical, unless they are battery operated . . . Can we get spare parts for the equipment? Who will repair them? . . . Finally, does the new technology make sense from an economic point of view? Is it cost-effective on the scale on which it is going to be used? It makes great sense to experiment abundantly with all varieties of new educational technologies. But unless there is a favorable relationship between the efforts—financial or otherwise—and the results, it becomes much harder to justify scaling up the experiments. (1989 pp. 2-3)

These are the questions to which many international organizations are directing their attention.

See also: Comparative Education and International Education: Organizations and Institutions; International Knowledge Networks

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Educational Technology: Conceptual Frameworks and Historical Development

Educational technology emerged as a field of study and occupational category in the early 1960s. One constituent, audiovisual education, was expanded into a tradition of applying within education the technologies developed outside it for entertainment, information handling, and communication. Another constituent, programmed learning, led to an applied behavioral science concept of learning design. Common ground was established around concepts of learning resource, individualized learning, and the systems approach. These were often combined into a single process of instructional development, though many practitioners were forced to adopt a more piecemeal approach. A problem-solving concept of educational technology became more attractive as the applied science claims declined in credibility. Improved access to learning was achieved through distance education, supported self-study, and new
communication interfaces for the physically disabled. Increasing recognition of the power of mass communications led to concern about their control, while research into mass media provoked more critical approaches to learning resources. The emergence throughout the 1950s of interactionist concepts of educational technology is reviewed, distinguishing between interaction embedded in learning resources and interactive settings for using such resources. Research suggests that educational technology needs to give as much attention to interactive settings as it does to interactive resources. Finally, the implications of the developing information society are discussed for rethinking educational goals and the role of educational technology in facilitating their achievement.

1. Introduction

Educational technology came into existence as an occupational category during the 1960s. Prior to that time people were engaged in jobs and activities which are now regarded as pertaining to educational technology, without being labeled as educational technologists, and this situation still persists in the 1990s. Even in the United Kingdom and the United States only a small proportion of those people whom even a cautious analyst would describe as working in the field of educational technology call themselves educational technologists (Saettler 1990). The field of educational technology is scarcely recognized in Europe outside the United Kingdom (Plomp and Pals 1989), or even in Japan (Sakamoto 1989). While the same kinds of activities are pursued, the research aspects are still mainly linked to the older academic disciplines, and practical skills are developed by on-the-job training rather than higher education courses. Nevertheless, there is strong multinational representation at international conferences on educational technology. Conceptual frameworks are shared, if not always agreed; and the factions, debates, and paradigm conflicts which characterize any significant field of study transcend national boundaries.

This entry will confine itself to conceptual frameworks used or advocated by people describing themselves as educational technologists. Most of these frameworks are often treated as occupationally specific, although this is rarely the case. Many have been imported and adapted, and some are still shared with other occupations. There is also a more philosophical line of thinking which examines the idea of educational technology in the context of knowledge claims in general, the impact of the social and natural sciences, and the nature and historical significance of technology. This proceeds with only token attention to the occupational niches taken up by people calling themselves educational technologists. However, this apparently disinterested pursuit of philosophical argument may also serve important political purposes. Educational technologists can be viewed as an interest group whose conceptual frameworks are intended not only to guide and describe practice but also to gain political or academic credibility. Thus, claims about the effectiveness and utility of educational technology serve an important political purpose in attracting resources and sponsorship, and claims about the theoretical foundations of educational technology play an important part in justifying its academic status, for which criteria related to disciplined and research-based study usually count for more than those related to utility.

2. Early Developments

The history of educational technology is so short that an account of how various occupations and patterns of thinking were brought together to create the field of educational technology is essential for understanding the situation in the 1990s. Indeed, the conceptual frameworks evolved during the 1960s still inform what is taught as educational technology in the 1990s, even though they have undergone considerable modification.

Entrants to educational technology during the 1960s usually arrived by one of two routes—audiovisual education or programmed learning. Each was associated with a number of possible conceptual frameworks, which practitioners adopted according to the nature of their job, their training, and their personal preference. However, while programmed learning could be viewed as theory-driven in its initial stages, audiovisual education found it difficult to formulate any theoretical basis for its practice. In contrast, audiovisual educators could easily link their expertise to the accumulated professional experience of classroom teachers, while programmed learning specialists tended to criticize teachers with a detachment that did little to promote mutual understanding.

Most audiovisual specialists saw themselves solely as practitioners: advisers to teachers, trainers of teachers, and providers of learning resources for use by teachers. Insofar as they had a theoretical base it consisted of two assumptions: (a) that stimulus richness and variety would enhance attention and motivation; and (b) that degree of abstraction was a critical variable in learning. Dale’s “Cone of Experience,” with “direct purposeful experience” at the base and “verbal symbols” at the apex (Dale 1969), was probably the most frequently cited conceptual model. Although there were always provisos about appropriateness, quality, and effectiveness, it was generally believed that the more audiovisual materials used the better: and that students needed to spend a significant amount of time in contact with “the real world” or with lively mediated representations of it—for example, motion pictures.
Neither of these assumptions is theoretically tenable today, but they are not without merit as "rules of thumb."

Communication theorists have shown that there is a limit to the amount of information that can be received and processed at any one time, and that multiple channel communication can be disadvantageous (Travers 1970), but the average classroom remains a long way from media saturation. The conclusion seems to be that, in using audiovisual materials to enhance richness and variety, basic principles of message design such as simplicity, clarity, and logical organization need to be carefully observed.

Similarly, the notion of "authentic reality" inherent in Dale's cone of experiences has been undermined by perception theorists' demonstration that much of what people see and hear is framed by their preexisting cognitive/perceptual schemata. It is not just experience but its interpretation that is crucial. Nevertheless, the problem of abstraction is still recognized by developmental psychologists who stress the role of concrete—operational experience for young children and distinguish between concrete, iconic, and symbolic modes of representation (Bruner 1966). The audiovisual specialists' concern with "real experience" can also be reformulated in terms of the sociology of knowledge, with attention being focused on the tensions and barriers to learning which arise from the gap between school knowledge and knowledge that has currency in the students' lives outside school.

How then did the move toward educational technology begin? One of the key individuals was Dr James Finn, who became president of the Division of Audiovisual Instruction (DAVI), the United States media specialists' professional association, in 1960. His seminal paper *Technology and the Instructional Process* (Finn 1960) examined the possible relations of technology with education, but set this in the context of a general discussion of the role of technology in society. His main argument was that many areas of North American society were being transformed by technology, and that it was inevitable that education would eventually undergo a similar transformation. Moreover, although technological change might be led by changes in instrumentation, it was never limited to that. The transformation would involve organizational and cultural changes so radical that it was impossible to predict them. At that time two major trends were discernable but they led in opposite directions: one was the trend toward mass instructional technology, exemplified by the new prominence of television; the other was a trend toward individualization, of which programmed learning provided a new example. The concept of programming was central to both these trends.

Finn's argument included some hard political advice. Recent highly publicized experiments in instructional television had bypassed the audiovisual specialists, and this could happen again with teaching machines. "How many of us," he asked "will go overboard and sink with the old concepts that will be absorbed or outmoded and tossed to the sharks by the new technology?" The concept of audiovisual education may go "down the drain, or it may not, depending on whether or not it can be redefined acceptably." Referring to teaching machines, he added:

It is my position that the audio-visual field is in the easiest position to help integrate these mechanisms properly into the instructional process. They are not primarily audiovisual; they are primarily technological. The audio-visual field, I think, must now suddenly grow up. The audiovisual specialists, are, of all educational personnel, the closest to technology now; we have, I think, to become specialists in learning technology—and that's how I would redefine audio-visual education. (Finn 1960 pp. 393-94)

Significantly, DAVI published a major sourcebook, *Teaching Machines and Programmed Learning*, edited by Lumsdaine and Glaser, the same year. Apart from a shortened version of Finn's paper, it was written entirely by psychologists. Finn explained the reasons for DAVI sponsorship in a foreword, stating: "the audiovisual professional, as a technologist of the teaching profession, must relate to fields like psychology exactly as the medical doctor relates to his basic sciences." The editors' concluding remarks suggested that psychologists were now ready to play their part:

It seems to us that the numerous contributors whose writings have produced this volume have reflected one dominant idea. This is the concept that the processes of teaching and learning can be made an explicit subject matter for scientific study, on the basis of which a technology of instruction can be developed. (p. 563) . . . As we learn more about learning, teaching can become more and more an explicit technology which can itself be definitively taught. (Lumsdaine and Glaser p. 564)

The basis for consistent improvement in educational methods is a systematic translation of the techniques and findings of the experimental science of human learning into the practical development of an instructional technology. To achieve the full benefits inherent in this concept, instructional materials and practices must be designed with careful attention to the attainment of explicitly stated, behaviorally-defined educational goals. Programmed learning sequences must be developed through procedures that include systematic tryout and progressive revision based on analysis of student behavior. (Lumsdaine and Glaser p. 572)

This introduces two new concepts, which were to be of seminal importance. First, there is the concept of instructional technology as applied learning theory. Second, there is the idea of product development through the systematic testing and revision of learning materials. Though familiar in industry, it
appears that the idea of product development was rediscovered in education almost by accident: "An unexpected advantage of machine instruction has proved to be the feedback to the programme" (Skinner 1968 p. 49). Linking the two concepts gives the idea of scientific research leading to technological development which gradually evolved among psychologists between 1954 and 1964. Indeed, associations between science and technology, research and development, and psychology and education provided an attractive platform for expanding psychological research during the 1960s, without the precise nature of the linkages and dependencies needing to be agreed.

At least three different perspectives on this issue can be discerned in the psychological writings of the period:

(a) Technology is seen as the direct application of the findings of instructional scientific research. Laboratory-derived procedures need only minor modification to fit them for general use in education. The psychologist’s expertise is paramount (Skinner 1955).

(b) Technological research and development is needed to combine findings from learning research with other forms of knowledge. Research and development centers are needed to accomplish the often major modifications that are required to put theory into practice. These should be run by a partnership of psychologists and educators (Hilgard 1964, Glaser 1965).

(c) Science and technology proceed in parallel. Each is capable of contributing to the other, especially if general communication is improved. Education is not just the straightforward application of learning theory, and psychological research has generated no more than “islands of knowledge and understanding within the science of learning” (Melton 1959).

The third perspective uses the term “technology” descriptively, much as social anthropologists would use it; but the first two perspectives use the term prescriptively, with an aspirational futurist connotation. Thus Melton would describe current educational practice as technologically primitive, while Skinner and Hilgard describe it as nontechnological.

On the whole, these psychologists saw educational technology being developed within the educational sector, though very closely linked to training technology in the industrial and military sectors. But Finn et al. (1962) saw it coming mainly from the outside:

Education, as a sector of national life, has, for the most part, been cut off from technological advances enjoyed by industry, business, military establishments, etc. The American educational enterprise exists out of technological balance with great sectors of the society. As such, it can be viewed as a relatively primitive or underdeveloped culture existing between and among highly sophisticated technological cultures. (Finn et al. 1962)

Finn was overtly skeptical about the psychologists’ claims that a science of learning was almost developed (Finn 1968).

Many writers confuse these different meanings of the term “educational technology” or simply choose the one that best suits their argument. For easy reference, they have been depicted in Fig. 1. The descriptive categories (1 and 3) have been expanded to include educators’ common concern with disseminating practices developed in one place and thought to be improvements on tradition. Box 4 includes both the psychological perspectives described above: the “strong” applied science of Skinner and Lumsdaine, and the weaker “technological research and development” perspectives of Hilgard. Box 3 could also have been subdivided between those who extrapolate from existing trends (the prophets) and those who have advocated redesigning the educational system from a new set of “first principles” (the utopians), but this is probably too fine a distinction.

Lumsdaine (1964) made a widely quoted distinction between “educational technology 1,” the application of physical science and engineering technology to the design of instructional devices (corresponding with Box 1 in Fig. 1 above), and “educational technology 2,” the application of the behavioral sciences to create a technology of learning (corresponding with Box 4 in Fig. 1); but somewhat marred the discussion with the implication that a technology was dependent upon rather than interdependent with its “underlying” sciences—an unfortunate misapprehension when technological developments such as paper, ink, and movable type are discussed, which preceded scientific understanding of the phenomena by several centuries. More significant for the future, perhaps, was Lumsdaine’s generic definition of a program:

An instructional program is a vehicle which generates an essentially reproducible sequence of instructional events and accepts responsibility for efficiently accomplishing a specified change from a given range of initial competences or behavioral tendencies to a specified terminal range of competences or behavioral tendencies. (Lumsdaine 1964 p. 385)

This goes beyond the idea of a program as a reproducible presentation to the idea of a program as guaranteed learning, with the programmer accepting responsibility for student learning whenever the conditions meet the original specifications. This concept of a validated learning package neatly combined the scientist’s need for reproducibility with the technologist’s practice of empirical development to meet specified criteria, and provided the cornerstone for several important future developments.
Finn also identified programming as a central concept, but for a different reason. In noting that programming was common to several new technological developments—both in mass communication and in individualized learning—he added: “The heartland is programming. He who controls the programming heartland controls the educational system” (Finn 1960 p. 393) Moreover, the economics of program production demanded thinking about learning resources on a larger scale; for only then could the high production costs of television or the high development costs of programmed learning be justified.

3. The Systems Approach

The term “system” appeared fairly regularly in the early writings on educational technology referred to above, but did not immediately become part of people’s central conceptual frameworks. The Oxford English Dictionary gives it two main types of meaning:

(a) “An organized or connected group of objects; a set or assemblage of things connected, associated, or interdependent, so as to form a complex unity; a whole composed of parts in orderly arrangement according to some scheme or plan”

(b) “A set of principles, etc.; a scheme, method.”

The physical, biological, and social sciences used it only in the first sense, but the influential new field of systems engineering began to use it in the second sense as well. The fields having the most immediate impact on the thinking of educational technologists were those of man-machine systems, management, and systems engineering.

The central concept of thinking about man-machine systems was that it made little sense to
design machines without also thinking about their human operators, or to design human jobs without considering whether some tasks were more appropriately delegated to machines than others. It was the system as a whole which needed to be optimized. These ideas were developed in military and industrial contexts, where the use of machines was taken for granted; and resulted in the coordination of the previously separate fields of personnel selection, training, and equipment design. Its attractiveness to educational technologists was that it addressed one of their most pressing problems, the respective roles of classroom teacher and mediated instruction. This recurrent issue was highlighted by early experiments with closed circuit television and programmed instruction. The consequence, as Heinich (1968) persuasively argued, was the need for media specialists to reconceptualize their role. Decisions about the use of machines and materials needed to be made at the curriculum planning rather than the classroom implementation stage, according to Paradigm 2, rather than Paradigm 1, in Fig. 2.

Hoban added a further strand to the reconceptualization process when he emphasized the need for a management of learning perspective:

When we consider the part machines play in education, we are forced into a consideration of man/machine systems. When we consider man/machine systems, we are forced into a consideration of technology . . . technology is not just machines and men. It is a complex, integrated organization of men and machines, of ideas, of procedures, and of management. (Hoban 1965 p. 242)

The central problem of education is not learning but the management of learning . . . No matter which of the new educational media is introduced, the situation into which it is introduced is transformed by the introduction. Acceptance of management of learning as a central problem of organized and institutional education would, at least, permit the admission of a wider range of alternative procedures, techniques, and methods in teaching—without threatening or substantially altering the critical functions of education, teaching, or learning. (Hoban 1965 p. 244)

By this time systems thinking had become an important aspect of the field of management. The initial influence came not from engineering but from biology, where von Bertalanffy (1950) first formulated his theory of open systems. The theory was taken up and further developed by organization theorists during the 1950s and early 1960s (Griffiths 1964), though their prime concern was not with designing new systems but with analyzing and improving existing systems, and not with man-machine systems but with social systems. In particular, the systems concept drew attention to an organization’s interaction with its environment and to the interplay between and coordination of its various subsystems. For the educational technologist intimately concerned with the problem of change this kind of understanding was crucial, and so was the growing body of research on innovation which followed it, but this particular strand of systems thinking had relatively little influence for some considerable time, because it was overshadowed by the impact of the systems engineers.

Systems engineering (sometimes described as operations research) evolved during the Second World War as a field concerned with the design of large-scale technical systems. Its reputation was based on successes in the military and aerospace sectors but it also found increasing application in sectors of industry. Ramo defined it as follows:

The systems approach is a technique for the application of a scientific approach to complex problems. It concentrates on the analysis and design of the whole, as distinct from the components or the parts. It insists upon looking at a problem in its entirety, taking into account all the facets and all the variables, and relating the social to the technological aspects. (Ramo 1973 p. 15)

He illustrated his argument with a comparison between telephones and automobiles. The telephone system was designed as a system from the outset and provided a closely integrated network of people and equipment that handled a wide range of demands with considerable efficiency. The automobile system was never designed as an integrated system, its subsystems (e.g., roads, repair, manufacture, insurance, parking, etc.) were uncoordinated, and it was extremely inefficient. Media specialists had no difficulty in identifying the “audiovisual system” with the latter, for it suffered from an equally frustrating lack of coordination between such aspects as hardware manufacture, building design, teacher training, and software production and distribution. The message was to “think big,” and throughout the 1960s it seemed that systems engineers were waiting for the opportunity to redesign the United States educational system from the beginning.

Thinking big was also a popular pastime for educators in the late 1960s and the early 1970s, and there were sufficient examples of large-scale applications of educational technology—Oakland Community College, Oklahoma Christian College, Project PLAN, Oakleaf School, the Open University, Televised Primary Education in the Côte d’Ivoire, IMU Mathematics in Sweden, and many others—to capture the imagination of educational technologists and nurture their ambitions. Even then, however, few working educational technologists had the opportunity to work on a large scale. They could apply systems thinking to the analysis of their working contexts in order to optimize project selection and choose appropriate innovation strategies (Diamond 1989), but they were unable, except on paper, to consider solutions which changed significant organizational norms—for example, the organization of schools into standard size classrooms, or the promotion of university staff for research rather than teaching. While
there might have been a “promising” innovation somewhere else in the world they were unlikely to survive in employment unless they got something done within the constraints of their own institutional context.

The principle arena for applying what was known at the time as the “systems approach” was higher education. In addition to the rapid growth within higher education of media production and service units, groups began to appear who sought to apply the programming approach identified by Lumsdaine to the development of courses and modules. The course, it was argued, was a sufficiently autonomous entity to be treated as a distinct instructional system; and a systematic approach to the development of courses should take into account both the potential of audiovisual media and the power of a programming process which analyzed learning objectives, prepared valid instruments of assessment, and refined its prototype design by systematic tryout and revision. A proliferation of models for the development of instructional systems flooded the literature between 1965 and 1975, most of which shared the features of the general model presented in Fig. 3 (taken from Diamond 1989).

Conceptually, many of these models subtly changed the meaning of the word “system” from the first dictionary definition, associated with looking at complex situations holistically, to the second definition, a set of design principles. For some a “systems approach” came to mean a “systematic approach,” while for others the issue of fitness for purpose within a larger institutional or social context remained a dominant concern. Politically, the more task-oriented models (Andrews and Goodson 1980) held a short-term advantage for four main reasons:

(a) They were less likely to challenge some of the prevailing institutional norms, although they did challenge the role and autonomy of individual professors and lecturers.

(b) Although insisting on detailed specification of objectives and preordinate evaluation, these models still allowed considerable flexibility of interpretation.

(c) The tightly coupled objectives—evaluation framework gave sufficient sense of a scientific approach to remain attractive both to psychologists and to politicians concerned with accountability.

(d) The product orientation and often implicit promise of a multimedia approach gained the allegiance of media specialists.

4. Consolidation

The period between 1967 and 1972 can be regarded as a period of consolidation. “Educational technology” became a recognized term and people began to accept it as an occupational definition which covered a range of jobs in all sectors of education. The early conceptual frameworks were tried, developed, and modified according to three main criteria: (a) Did they provide a credible rationale for a newly emerging field? (b) Did they define a distinguishable set of activities as being primarily the concern of educational technologists? (c) Did they create a boundary for the occupation that was politically defensible?

The first official endorsement of a field called educational technology may well have been the establishment in the United Kingdom of the National Council for Educational Technology in 1967. This followed the report of a committee on audiovisual aids in higher scientific education, which only used the term in its concluding section. The United Kingdom Association for Programmed Learning promptly added “Educational Technology” to its title in 1968, while in the United States the Department of Audiovisual Instruction of the National Education Association changed its name to Association for Educational Communications and Technology in 1970. This coincided with the publication of a major report by a Commission on Instructional Technology appointed by Congress, and anticipated the creation of a National Center for Educational Technology within the National Institute of Education at Wash-
A conference was held by UNESCO on "Training Programmes for Educational Technologists", in June 1970, and the International Bureau of Education published an important bibliography of educational technology later that year (Huberman 1970). Though the first periodical, Educational Technology, had been founded in the United States in 1960, it was some time before the second journal, Programmed Learning and Educational Technology, added the term in 1967.

As official recognition grew, the problem of defining educational technology became acute. The National Council for Educational Technology (UK), when it first met in 1967, stated that "Educational technology is the development, application and evaluation of systems, techniques and aids to improve the process of human learning" (NCET 1969). This compromise has stood the test of time because it allowed all the appropriate interest groups to identify with it without appearing too threatening to the others. The United States Commission on Instructional Technology showed a similar concern for reconciling the aspirations of educational technologists with the beliefs and expectations of educators and politicians:

Instructional technology can be defined in two ways. In its more familiar sense, it means the media born of the communications revolution which can be used for instructional purposes alongside the teacher, textbook, and blackboard. In general, the Commission's report follows this usage. In order to reflect present-day reality, the Commission has had to look at the pieces that make up instructional technology: television, films, overhead projectors, computers, and the other items of "hardware" and "software" (to use the convenient jargon that distinguishes machines from programs). In nearly every case, these media have entered education independently and still operate more in isolation than in combination.

The second and less familiar definition of instructional technology is more than the sum of its parts. It is a systematic way of designing, carrying out, and evaluating the total process of learning and teaching in terms of specific objectives based on research in human learning and communication, and employing a combination of human and nonhuman resources to bring about more effective instruction. The widespread acceptance and application of this broad definition belongs to the future. Though only a limited number of institutions have attempted to design instruction using such a systematic, comprehensive approach, there is reason to believe that this approach holds the key to the contribution technology can make to the advancement of education. It became clear, in fact, as we pursued our study, that a major obstacle to instructional technology's fulfillment has been its application by bits and pieces. (Tickton 1970 pp 21-22)

More useful, perhaps, is the much longer definition statement produced by AECT in 1972, which included a rationale for the field of educational technology, a description of what people in the field do, and a discussion of its social and professional context (Ely 1973). The rationale section identified the uniqueness of the field with three major concepts and their synthesis into a total approach. These were "the use of a broad range of resources for learning, the emphasis on individualized and personalized learning, and the use of the systems approach." The development of each of these concepts during the consolidation period is discussed below.

The concept of "resources for learning" was a useful expansion of the earlier term "audiovisual materials," because it incorporated printed resources and could also be interpreted as including environmental resources (school trips and visits) and resource people (visitors). Although some resource production was integrated with curriculum development in the manner envisaged by Heinich's Paradigm 2 (see Fig. 3), most of it remained only loosely coordinated with the curriculum. Hence the teacher retained a major role in the selection of learning resources, and considerable attention was given to resource management, distribution, and utilization. Indeed, the teacher was often referred to as a manager of learning resources (Taylor 1970), an idea suggesting that every teacher was an educational technologist (Fig. 1 Box 3) and that teacher education, therefore, was the highest priority (Witt 1968). Resource production was assumed to be a shared responsibility. Some would be produced by commercial firms, some would be produced by locally based educational technologists, and some would be produced by the teachers themselves, preferably with technical and advisory support from educational technologists.

The associated term "resource center" also came into common currency, combining a number of functions now considered essential for the teacher's role as a manager of resources. Thus a teachers' resource center was a place where teachers could select from a collection of existing resources, make multiple copies of a resource, produce their own resources, or even commission others to produce resources for them. Similar facilities could also be envisioned for pupils, for whom the term "learning center" or "pupils' resource center" was sometimes used.

The resources concept raises the issue of the respective roles of educational technologist and librarian; and in most countries there is now a long history of interprofessional discussion and mutual accommodation. It has become increasingly common for simple audiovisual materials to be stored in libraries and for pupils to have access to them there, while production facilities are usually found in educational technology units. Arrangements for storing complex software such as film or videotape and for managing the audiovisual equipment used in classrooms are much more varied, with reprographic equipment often being lodged with the administration.
Attention to individualized learning was not a new concept, but the idea was given a considerable boost by the advent of programmed learning. Earlier initiatives such as the Dalton and Winnetka plans were revived and redeveloped under the influence of behavioral psychologists to incorporate tightly specified student assignments, programmed learning sequences, and criterion-referenced tests (Weisergerber 1971). Most of these systems individualized only the pace at which students could learn, but some, such as the IMU in Sweden or Project PLAN in the United States, introduced assignments of different levels of difficulty, the latter backed by a computer-based record-keeping and advisory system. Later, terms such as “mastery learning,” “modular instruction,” “audiotorial systems,” and “personalized systems of instruction (PSI)” came to be associated with this line of development; these are discussed elsewhere in this Encyclopedia. On the whole, mastery learning and PSI came to be associated with specific objectives and repetition of units by students who failed to get high scores on criterion-referenced tests, while modular instruction and audiotorial systems allowed a looser interpretation of the systems approach and put more emphasis on the use of nonprint media. Some systems incorporated short tutorials and even some group teaching into what remained basically individualized systems (see Individualized Instruction).

The third key concept in this first AECT definition statement was the systems approach, whose origins were discussed above. Its main areas of application were in course development in higher education and in training development in industry and the armed services. In North America both were subsumed under the generic title of “instructional development;” but in European higher education the term “educational development” became more popular because “instruction” carried negative connotations of learner passivity.

At school level, a different problem arose. The systems approach to instructional development closely resembles the Tyler/Bloom model of curriculum development; and when Bloom began to advocate mastery learning even the element of individualization ceased to be unique to people claiming expertise in educational technology. Recognizing this lack of product differentiation, Rowntree (1974) adopted the title Educational Technology in Curriculum Development for his popular book on the subject. Thus, apart from a few nationally funded projects which carried an educational or instructional technology label, the term “educational technology” usually referred to the design, production, and utilization of learning resources which incorporated audiovisual and/or electronic media.

It is also worth noting that the term “resources” in the AECT definition (Fig. 4) is used in a broad sense that includes both people (human resources) and settings (the resources of the organization and its environment). This usage is similar to that of economists and planners, but wider than the educators’ meaning which generally refers only to materials and equipment. Thus educational technologists could negotiate local meanings in their own work settings, according to what they felt was feasible and appropriate.

5. Development and Criticism of the Early Frameworks

A social historian could cite the early development of educational technology as a prime example of the centralist approach to reforming society which persisted throughout the 1960s and early 1970s. In the United States, the post-Sputnik period was characterized not only by the space race but by substantial federal spending on education. The 1958 National Defense Education Act (NDEA) was responsible for a wave of spending which launched educational technology into the schools, and basic research received generous funding from the federal government throughout the 1960s. While other nations spent on a much smaller scale, their mood was not substantially different. Moreover, UNESCO funded substantial projects in educational television in less-developed countries, where the scarcity of trained teachers was seen as offering even greater potential for gaining benefits from the use of technology. In the United Kingdom the idea of a technology-based Open University featured prominently in the successful election campaign of Harold Wilson in 1964.

The initiatives of the 1960s, however, were not based only on expanding the use of technology. They were also characterized by a social engineering approach which claimed to be based on the emergent social sciences. At no time, before or since, have the social sciences been held in such high regard. They saw themselves as extending the physical sciences into the realm of human behavior, presented a strongly positivist image, and claimed to be culturally neutral and value free. It is surely no coincidence that Lumsdaine’s (1964) distinction between a technology-based Educational Technology 1 and a behavioral science-based Educational Technology 2 reflected so precisely the technological futurism and social engineering ideologies which prevailed in Western society at that time.

The term “engineering” itself carries a relevant range of meanings. First, branches of engineering are distinguished by the nature of their product—aeronautical, civil, electrical, mechanical, production, systems, transport, and so on—and there is a debate about how much these branches have in common. Within educational technology, the broadcasters and moving picture producers have remained separate, but the urge to present a united front has
The articulation of a problem-solving concept of educational technology can be viewed as an attempt to introduce greater flexibility and creativity into the design processes in which many educational technologists were engaged. Whereas in the mid-1960s people thought that learning resource production and course development could benefit by being made more systematic and incorporating formative evaluation, by 1980 the situation had changed and the danger appeared to come from those who thought all the relevant expertise would be encapsulated in simplistic instructional development manuals. The problem-solving concept also helped to distance educational technologists from their behavioral science origins at precisely the time when the behavioral sciences were coming under increasing criticism.

Until the mid-1970s, research into the use of media in teaching was dominated by media comparison studies which yielded little information of practical or theoretical use (Clark 1983). Hence there was a need to examine the links between media and learning at a more micro level with greater attention to identifying critical media attributes and the ways in which they affect a learner's cognition (Salomon 1979). This second phase of more cognitively oriented media research was reviewed by Clark and Salomon, who concluded as follows:

Generally, it appears that media do not affect learning in and of themselves. Rather, some particular qualities of media may affect particular cognitions that are relevant for the learning of the knowledge or skill required by students with specific aptitude levels when learning some tasks. These cognitive effects are not necessarily unique to one or another medium or attribute of a medium. The same cognitive effect may often be obtained by other means, which suggests a measure of "functional equivalence". This implies that there may be "families" of functionally equivalent but nominally different instructional presentation forms. (Clark and Salomon 1986)

The modesty of this analysis may not yet be typical of the social sciences, but it is an excellent example...
of the retreat from the sweeping generalizations to which their predecessors aspired. It also suggests that the knowledge base for the media selection aspects of instructional design is both complex and of limited scope. Other criticisms of the audiovisual or technology-driven archetype can be found in Sects. 6 and 7 below.

Criticism of the engineering archetype has been more vociferous, because of its more overtly positivist stance (it was only the research side of the audiovisual archetype which began in such a positivist way). The major focus of debate has been the use of behavioral objectives. They have been criticized (a) for imposing an atomistic interpretation of the learning process and (b) for creating impoverished representations of the relevant knowledge domains. Both arguments have been more strongly supported in Europe than North America: reductionism had already permeated North American practice through the widespread adoption of multiple-choice and short-answer tests, so using behavioral objectives had less effect on existing learning goals. By the mid-1970s, many instructional developers had ceased to define objectives at the behavioral level and were somewhat irritated by critics who failed to distinguish between general and specific objectives (see Erut 1989b for a review of this whole debate). Some even began to use alternative modes of knowledge representation alongside more general statements of goals (Rowntree 1981). In doing so, however, they had effectively abandoned the applied science approach of those like Gagné and Briggs (1974) who continued to advocate design principles based on inferring learning categories from behavioral objectives, then shaping instructional plans to fit those categories. While theoretically sound within its own terms of reference, this approach has gradually lost credibility through lack of evidence that its products have had any demonstrable advantage.

The problem-solving concept of educational technology has not been much criticized but neither has it been greatly clarified. What, for example, is the role envisaged for an educational technologist working in this way? Two answers are possible: one is the role of a process consultant (Hewston 1989); another is that of a specialist member of a problem-solving team which also includes other specialists. In practice, many people attempt to combine the two although there are inherent dangers in such a dual role. Educational technology has been, often justifiably, accused of being a solution in search of a problem. What then is the nature of the educational technologist's expertise? Consultancy requires many interpersonal skills and an ability to conduct analyses of problems and situations and to search for knowledge of possible relevance to developing an appropriate response. Knowledge of educational technology practice and methodology has to be shared with others in a manner which does not jeopardize their ownership of the problem. Beyond this level of competence, however, much of the expertise is tacit. The expert educational technologists in this problem-solving tradition are pragmatic, well-informed people, who know their theory but rely even more on accumulated professional experience. Schon (1983) calls such people "reflective practitioners," and contrasts them with professionals in the "technical rationality" tradition who claim that their expertise is based upon applied science.

Criticism of the conceptual frameworks of educational technology has also developed at a deeper level, reflecting the growing debate within the social sciences between the positivist and interpretive paradigms. Erut summarizes the position in the following terms:

The positivist paradigm has played an important part in the field of educational technology. It is strongly research-based and incorporates two major research traditions. The experimental tradition is rooted in behavioural psychology and is associated with small-scale experiments under controlled conditions. The correlational tradition forms the basis of much educational research and is associated with large field samples and the use of statistical techniques to ascertain the relative significance of various personal and situational factors. In both traditions the purpose of theory is to explain, generalize and predict. Hence the positivist paradigm is associated with strong knowledge claims.

The interpretative paradigm starts from a different view of theory. Theories are not part of some natural truth waiting to be discovered, they are invented by people in order to interpret and make sense of their world. Empirical evidence affects whether people find a theory adequate for this purpose, but so also do other considerations. The purpose of a theory is not to provide a causal explanation of a situation or sequence of events but rather to add to one's understanding of it. Moreover, it is expected that people's understandings of any given social situation will differ according to their role, their interest, and their knowledge; so it is important for one's own understanding to know how other people perceive the situation. Hence there is a strong emphasis on qualitative methods and case study research, though not to the exclusion of quantitative data. Knowledge claims in this paradigm tend to be rather weaker than those in the positivist paradigm because they are believed to be more situationally and culturally specific.

Within the field of educational technology, both paradigms can be found in abundance. However their distribution is not at all even. Positivist approaches are stronger in instructional design, interpretative approaches in utilization. Positivist approaches are more readily found where there is political power and in large-scale developments, interpretative approaches where there is little power and the enterprise is small-scale and local. Positivist approaches are stronger in North America, interpretative approaches in Europe. Positivist approaches believe in expertise, interpretativists in wisdom (Erut 1989a p. 4).

Hawkridge (1993) also gives considerable atten-
tion to criticism derived from a third social science paradigm, based on critical theory. This has become quite prominent among philosophers and sociologists of education, and is increasingly used in research into mass communications. Hitherto it has received limited attention in educational technology, but that may well change during the 1990s.

A contrasting perspective is provided by Heinich (1984). He argues that educational technologists have been too pragmatic, are tackling the wrong problems, and have grown used to thinking too small. They have been oversocialized into the prevailing norms of their host cultures in schools and higher education, and thus have lost sight of the potential of technology to transform those institutions. There is surely some truth in this criticism: much may have to be challenged if progress is to be made. To effect change from the outside, however, requires either power or an alliance with powerful people who have other agendas for change; and to effect change from the inside requires a normative-re-educative approach through staff development, which Heinich regards as a diversion. The primary effort, he argues, should be devoted to “the development of more powerful technologies of instruction along with the development of organizational structures that facilitate their use,” because the basic premise of instructional technology is that all instructional contingencies can be managed through space and time (i.e. they can be incorporated into the interface between student and material and/or device). Our inability to do so in any given situation is viewed as a temporary deficiency in our knowledge base.” It is precisely this premise that most educational technologists have long since abandoned, and attempts to revive it under the label of information technology have been treated with a degree of skepticism.

6. Mass Communications, Access, and Control

A major feature of educational technology since the 1950s has been the regular stimulus of technological innovation. Each new medium to arrive on the scene has raised hopes for an impact on education similar to that achieved in the entertainment, communication, and information-handling aspects of society; and these hopes have been encouraged by industries anticipating sales of new media to schools. However, the investment in software development and training has rarely been sufficient to realize the potential of the new medium, and the evidence for imposing a new burden on hard-pressed education budgets has not been convincing. Resources have gradually accumulated in richer countries and districts lucky enough to be the recipients of pilot projects, but coherent long-term policies have been lacking.

The more successful media have developed their own specialist communities of producers, publishers, designers, and so on, whose criteria for success have had little connection with education. Broadcasters, for example, derive their criteria from (a) aesthetic criticism of peers and critics and (b) their ability to attract and hold an audience (not to teach a captive audience). Designers of computer software also derive their success criteria from their peers, but are mainly judged by their ability to sell their programs to a business-dominated market. There are some specialist education producers in both broadcasting and computing but they are a small group, sandwiched between the norm-determining commercial or public service community and a conservative and penurious educational system. Some are qualified teachers and value the opinions of other teachers as well as anxiously watching their sales and popularity. Thus the needs of education have a small impact on software development but virtually none on hardware development.

Of equal importance is the burgeoning academic field of communication or media studies, which combines the artistic approach of the critic (as in literature and painting) with an essentially social scientific study of the role and impact of mass communication in modern society. Although communication models were frequently cited by media specialists during the formative period of educational technology, they were discussed only in the most general terms. However, the development of research in related fields suggests that communication theory concepts could have more direct application in the 1990s. Since communication theory models have as many variants as systems models, a composite model is presented in Fig. 5 to show the main features of this approach.

Traditional educational technology research focused primarily on the interaction between message characteristics and subsequent receiver action, and was thus dependent on the constructs available for describing them. Neither simple media distinctions nor the simple “types of learning” classifications of the behavioral psychologists have provided adequate descriptions of messages, and this is now recognized as a much more complex problem to which linguistics, visual communication, semiotics, cognitive psychology, and the relevant content...
specializations also have to contribute. The characterization of receiver action also poses problems when it has to be elicited by some kind of achievement test which fails to recognize emotions, motivation toward the subject matter of the message, or transfer to "real" action in subsequent situations. Receiver actions have to be understood as part of their ongoing interaction within their environment in which some messages and some actions are given greater priority than others, so receiver behavior cannot be interpreted in terms of the communication system alone.

Even in culturally familiar settings the sender often lacks appreciation of the receiver's environment and encodes the message in some inappropriate way or misinterprets the feedback he or she received, and this problem is magnified as the cultural gap between senders' and receivers' environments widens. The often unconscious influence of the senders' attitudes and beliefs is being increasingly researched, as also is the influence of the politics of the senders' environment on message selection. This raises the issue of who controls the communication system and whose interests it serves, a major concern when systems have a monopoly or are largely controlled by a single interest group.

One positive aspect of mass communication technology has been its contribution to the problem of access. Sometimes this is interpreted in terms only of access to products, so debate is focused around the extent to which products such as broadcast programs and learning resources can be made more widely available by extending communication and distribution networks and/or reducing the cost. Both raise financial issues familiar to those in public broadcasting, adult education, and library services. Access to products, however, does not guarantee access to learning. There have been a few dramatic examples of unaccompanied products making a difference, such as the Sesame Street series, which helped to increase access to learning opportunities for the vitaly important preschool population, but even these have not taken on the sole responsibility for taking a cohort of learners to specified learning goals. Most individuals in most situations require learning packages rather than single resources, and human support systems as well. How then has educational technology helped to improve access to learning?

The best-known contribution of educational technology to access has probably been the development of distance education systems. The Open University in the United Kingdom made a dramatic impact in this field, through its ambitious planning, high-quality products, political backing, and association with high-status institutions such as the BBC. It also used product development methods derived from educational technology, as well as a multimedia approach, and it made proper provision for a human support system for its students. The consequent opening up of educational opportunities for adults is well-documented.

Less dramatic but not insignificant has been the growth of supported self-study within educational institutions. Though sometimes used to deliver the normal curriculum in the manner of the individualized learning systems reported above, its contribution to access has been to make it possible to run smaller classes than would otherwise be considered viable, to overcome a shortage of specialist teachers, by using them as visiting consultants rather than class teachers, and to enhance the feasibility of drop-in learning systems, which learners can attend flexibly at their own convenience. Often it is possible to construct learning packages around existing resources of a conventional kind, rather than design complete new systems which takes longer and costs much more.

The third major contribution has been the development of technological support for people with physical disabilities. Some members of this group have been emancipated by new technology to a quite remarkable extent, though many others have yet to benefit because of the cost. The arrival of personal computers and the development of a range of purpose-designed interfaces has provided communication with wider society of a quality that had been previously considered impossible (Hawkridge and Vincent 1992).

The limits on the access developments reported so far are largely financial, but finance is not the only form of control. One has only to ask what products and messages are available for people to access, to recognize that control has other dimensions. Not only is there control over the selection of programs for production and dissemination but there is also control over how these programs are conceived and framed. While bias is not always intended, a degree of cultural and ideological framing is unavoidable. Both mass communication systems and school systems present similar problems, and their messages have been known to reflect the views of their controllers on such critical issues as gender, class, and ethnicity, even when overt political agendas have been carefully balanced.

One partial remedy for the problem of minimal influence on these systems is access to alternative channels of communication. The possibilities opened up by desktop publishing, cheap video equipment, and cable networks make this much more feasible than even in the 1980s. Hence an important role for educational technologists could be to provide sufficient education, training, and facilities for local and minority groups to be able to produce and distribute their own learning resources. Not only should one consider access to programs and access to learning, but also access to the means of production and channels of communications.
7. Interactionist Concepts of Educational Technology

Both technological and theoretical developments have brought interactionist concepts of educational technology into greater prominence during the 1980s and early 1990s, but while interactivity is applauded as desirable, there are divergent perspectives about what it means. Hence it is useful to make certain distinctions. First, interactivity may be either situated within a learning resource or viewed as a characteristic of the setting in which the resource is used. Second, although interactivity usually refers to the learning process, the concept is sometimes extended to encompass learning goals as well. However, even when people share the same definition they may have different perspectives about the level of interaction which actually occurs (depending on doubt on their personal norms and expectations), and about the potential for interactivity inherent in any particular resource or setting. Hence claims for interactivity need careful examination.

Two kinds of interactivity may be built into a resource—that which facilitates the use of the resource as a tool and that which attempts to build a tutoring function into the resource. Thus the computer is regarded as the interactive tool par excellence because it allows people to prepare texts, designs, or programs by the interactive processes of trial and error and successive approximation. It is the ability to see what has been done and change it that makes the computer so valuable as a tool. There is an important distinction to be made, however, between using a computer successfully to complete a task and learning the concepts embedded within that task. This latter goal has been approached either through tutoring or through designing what has come to be called a learning environment.

The concept of a learning environment controlled by a computer probably originated with Moore who designed a computer-controlled "talking typewriter" to teach children to read. He described it as one example of an "autotelic responsive environment." He defined as autotelic any activity in which one engages for its own sake and not for obtaining some external reward, and a responsive environment as one which satisfies the following conditions:

(a) It permits the learner to explore freely.
(b) It informs the learner immediately about the consequences of his or her actions.
(c) It is self-pacing, that is, events happen within the environment at a rate determined by the learner.
(d) It permits the learner to make full use of his or her capacity for discovering relations of various kinds.
(e) Its structure is such that the learner is likely to make a series of interconnected discoveries about the physical, cultural, or social world (Moore 1968).

Papert's work with LOGO-based microworlds embraces a similar rationale, though subsequent research has revealed a major problem with the fifth principle. Like other contexts designed to promote discovery learning, students do not necessarily learn all the concepts built into their design. Thus Hoyles and Noss, in a review of learning in mathematical microworlds, drew attention to "the inescapable and perhaps unpalatable fact that simply by interacting in an environment, children are unlikely to come to appreciate the mathematics which lies behind its pedagogical intent." Their observations suggest that:

pieces of knowledge are appropriated (or not) depending upon pupils' own agendas, how they feel about their participation, teacher intervention, and above all, the setting in which the activities are undertaken. Thus it is misguided to argue that simply by interacting with the computer, children are in general likely to 'acquire' specified mathematical ideas. (Hoyles and Noss 1992 p. 31)

They still regard interactive software as a valuable learning resource, but argue that achievement of the intended learning goals also requires a teacher and benefits from interaction with peers. An interactive setting is needed as well.

Attempts to build a tutoring function into learning resources also have a long history. In the 1960s the term in favor was "adaptive programming." The goal was that of adapting the messages presented by an interactive resource to fit the requirements of the learner at that particular time. In the 1990s it is called "intelligent tutoring" and its purpose is to build a tutoring system around knowledge of the subject, knowledge of the system, and knowledge of how to help the student learn (Sleeman and Brown 1982).

Each of these three subgoals presents major problems, which derive not so much from the technology as from the positivist and reductionist view of knowledge upon which any operational version of intelligent tutoring must ultimately depend. First, there are considerable doubts as to whether the knowledge representation problem is solved (Dreyfus and Dreyfus 1986, Selt 1987). Second, it is now abundantly clear from decades of psychological research that the difficulties of characterizing individual students according to some manageable set of variables, incorporating subtle distinctions of mental abilities, cognitive style, and other personality variables are quite intractable. Third, the possibility of making links between student characteristics and machine decisions that are valid at the individual level is rapidly receding as research into aptitude–treatment interaction struggles to find barely significant correlations at the level of groups. Little has been achieved beyond analyzing student responses to a...
small number of test items and tasks, and arranging the next presentation accordingly. Even then the decision rules are primitive and there is little evidence for more than a marginal improvement in learning.

The above discussion suggests that there has been a tendency for the introduction of interactive learning resources to be accompanied by extravagant claims, and that this has not been helped by the use of metaphors like "environment," "intelligent," and "tutor." This contrasts with the relative neglect by educational technologists of the role of interaction with peers and teachers in settings designed to promote learning. Perhaps this is due to their early preoccupation with behavioral psychology at the expense of cognitive psychology and social psychology.

The processes by which learning goals and achievements are defined, accepted, or negotiated by learners have a profound effect on learning. This led Flechsig (1975) to argue that the interactionist concept of educational technology "is characterized by the principle that learners take over the control over their learning processes, whereas the three other concepts—explicitly or implicitly—locate the control functions within the teacher or the teaching system" (p. 8). Meanwhile Azuma, following Moore's autotelic principle, was making a similar argument:

An important problem we have to recurrently rethink during this coming decade is the proper balance of the two approaches which we have seen in technological development over the two preceding decades. One is the effort to improve the effectiveness of mastering externally defined learning tasks, the other is an orientating towards providing a learning environment wherein learning is intrinsically motivated and self-directed. (Azuma 1977 p. 3)

This attractive argument was to be heard throughout the 1980s, particularly by the followers of Papert (1980), but it neglects the fundamentally social nature of human beings. Irrespective of formal statements of purpose, social interactions with teachers, peers, families, and significant others profoundly affect what is considered valid, meaningful, or useful knowledge, and what to count as good or acceptable progress in learning. Nevertheless, within such a context and working toward their future needs, societies are increasingly looking to their education systems to develop independence and collaboration, and the appropriate use of learning resources can play an important part in pursuing this purpose.

One important perspective on this issue concerns the ownership of learning goals. It is argued that the greater the involvement of learners in the determination of goals, the more they will be committed to pursuing those goals. Since goals also require social approval to be accepted as meaningful, this implies a process of negotiation which allows learners to combine a sense of self-direction and efficacy with the reassurance of social approval. In some settings, for example where there is project work or contract learning, learners will have a major say in goal determination. In others, goals will be negotiable only at the level of detail or the order in which they are tackled within a tightly specified formal curriculum. However, even at this level negotiation can have a significant impact on gaining acceptance of goals and cultivating a sense of ownership, provided that the purpose and importance of the externally determined goals is clearly communicated.

A framework for conducting such negotiations and giving reality to their implementation was introduced by the Technical and Vocational Education Initiative (TVEI) of the United Kingdom Department of Employment during the late 1980s under the heading of "flexible learning." It sought to combine the advantages of resource-based learning with the notion of action planning, a concept derived from management theory (Eraut et al. 1990).

The framework involves learners or groups of learners negotiating learning targets with their teachers then planning their own learning pathways to include an appropriate combination of learning resources and experiences. By including groupwork and experiential learning within its remit it avoids the isolationism which often limits resource-based learning, and is much better suited to goals involving practical and interpersonal skills. In practice, three major constraints tend to operate: tightly specified curricula can so reduce the opportunity for negotiating goals that little sense of ownership is developed, learning pathways may be constrained by lack of sufficient resources, and the difficult tutoring role may be too demanding of some teachers' subject and pedagogic expertise, and possibly also of their available time.

Conceptual constraints arise because learning is not simply a matter of assimilating new information, but also involves the development and modification of conceptual frameworks for structuring and organizing information. Theories of cognitive development suggest that it results from learners struggling to construct their own knowledge base in order to make sense of a world that is constantly being revealed to them through interaction with their social and physical environment. While a person's knowledge base will have many similar features to those of others as a result of continuing social communication, facilitated in most cases by use of a common language, it still remains personalized; and it is important for a person's learning as well as their sense of identity that the personal nature of their knowledge is recognized.

Comparatively recent thinking has brought together previously separate developments in cognitive and social psychology, as research in Geneva by Doise, Mugny, and Perret-Clermont has shown that cognitive development of the kind characterized by Piaget is facilitated by peer interaction (Light and
Blaye 1990). These findings have been interpreted views in terms of sociocognitive conflict: divergent views are more effective in promoting development when held by different people than when left for resolution by purely internal argument as a result of cognitive dissonance. The Russian psychologist Vygotsky, however, whose work is now increasingly recognized as of major importance, put more stress on what has come to be called "guided intervention." In particular he developed the concept of a "zone of proximal development" to describe "the distance between the actual developmental level as determined by individual problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers" (Vygotsky 1978 p. 86).

Teaching is then characterized in terms of helping learners to bring within their individual capability that for which they previously required assistance, and a major role for either a teacher or a more capable peer is that of providing the cognitive "scaffolding" to support this transition. Such scaffolding comes from a deeper understanding of the problems encountered and the possession of conceptual frameworks of which the learner is as yet only dimly aware. All evidence so far is that the process of assisting the learner through the zone of proximal development requires interaction with a teacher and/or capable peers, even when interactive learning resources are used (Hoyle and Noss 1992, Erart and Petch 1994).

While some educational technologists are beginning to give more attention to cognitive psychology, most still seem reluctant to come to terms with its implications, perhaps because they find the underpinning constructionist epistemology deeply unsettling and the more extravagant claims of the artificial intelligence field somewhat suspect. However, they cannot afford to remain content with a view of learning which can account only for the assimilation of new information to existing cognitive frameworks. Nor should they continue to treat interaction with teachers, peers, and significant others as irrelevant to the design and use of interactive learning resources.

8. **Information Technology and the Information Society**

What is often referred to as new information and communications technology (NICT) has dominated educational technology throughout the 1980s and 1990s. With it has come a return to the atmosphere of the 1960s when the dominant issue for laypeople, if not for all educators, was how to use NICT for the improvement of education. People have been carried away by inflated claims, treated pockets of innovation as normal practice, and ignored decades of research on the process of planned change. However, there is one important difference. Finn's (1960) prediction that new technology would bring about organizational and cultural changes which would transform society is no longer regarded as mere futurism; it has become part of the conventional wisdom about information technology. So alongside the other concern with using NICT to promote learning is a newer concern with preparing learners for a future in which new technology will play a dominant role in society.

One indication of the growing significance of the challenge posed to education by this development was the dedication of the 1989 biannual meeting of the Council of Europe's Standing Conference of Ministers of Education to the theme of "Education and the Information Society." The conference noted that:

The gradual development of an information society is giving rise to a number of tensions which need to be resolved in policy and practice. These include:

1. The tension between past and future, i.e. between traditional culture and new habits and attitudes.
2. The tension between preparing pupils as citizens who will contribute to creating the future and qualifying them for future employment according to externally determined predictions of need.
3. The tension between the formal curriculum of the school and the 'informal curriculum' available outside it.
4. The tension between teaching pupils about NICT and making the use of NICT part of school life.
5. The tension between responding to vociferous demands from pupils and parents and ensuring equality of access for all pupils. (Erart 1991 p. 13)

These are deep issues whose complexity indicates that the use of NICT is far from being a simple matter of finding the money and training the teachers.

In an expert paper prepared for the conference, Erart drew attention to seven types of educational aim which had been advocated in connection with using NICT in education and in wider society, as follows:

1. The more effective achievement of existing goals by using new methods such as video presentation or computer-assisted learning.
2. Enabling new goals to be taught within the current curriculum framework of subjects. For example, the vicarious experience brought into the classroom by television, the information-processing potential of computerized databases and the modelling capacity of new interactive software have significantly changed what can be taught in subjects like science and geography.
3. Learning about society and its technology. The onset of the information society must have a major effect on what is taught in the social science and science/technology areas of the curriculum. One major issue is the extent to which this should have a future orientation.
4. Learning to use new information and communication technologies as part of a general programme for developing information-handling and communication skills. This can be taught either as a separate subject, or as part of a cross-curricular approach like study skills. The most ambitious claims in this area relate to the use
of computers in developing metacognitive or thinking skills.
5. Learning knowledge and skills appropriate for some specialist occupation. This would be a form of pre-vocational or vocational education. Computer science, technical graphics and office skills are common examples.
6. Learning to criticize the programmes and products of NICT. The purpose is to develop a more critical approach from a variety of perspectives. Media studies has tended to follow the tradition of art or literary criticism, while consumer education has focused more on technological or economic aspects. The appraisal of computer software could profitably draw on both traditions.
7. Creative use of NICT for purposes defined by the students themselves. The assumption is that students should not be only at the receiving end of other people's communications. They should learn to produce communications of their own, e.g. class newspapers, videos, computer programs, partly to improve their understanding of the various media and genres but also to develop their enterprise and initiative; and to counteract any monopolistic tendencies in public communications facilities. (Eraut 1991 pp. 165-66)

These aims penetrate into almost every section of the school curriculum, so what is eventually needed is a reappraisal of the shape and scope of the whole curriculum and the balance and emphasis within each part of it. In the meantime, hard thinking is needed about priorities and about the realities of implementation.

The process of change will remain gradual. Hawkrigde (1993) argues in his analysis of the challenges to educational technology coming from cognitive science, information technology, and critical theory, that the field of educational technology itself needs modernizing, but it should be done without any utopian aspirations. The history of educational technology provides many examples of limited theories, poor quality products, and naive approaches to implementation. New generations of policymakers and educational technologists ignore the lessons learned from such experience at their peril.

See also: Educational Technology: Scope of the Field; Institutional Design Models

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Educational Technology: Developing Nations


M. Eraut

Educational Technology: Developing Nations

The term “developing nations” is used to denote all nonindustrialized countries. Such countries are to be found primarily in Africa, Asia, and Latin America, but the term also encompasses some states in Eastern Europe and island states of the Pacific and Indian Oceans. Two widely accepted definitions of educational technology are: (a) as a systematic problem-solving approach, and (b) as machines or equipment used in educational settings. Educational technology in the first sense can be valuable in such nations, although cultural factors often intervene. Distance education is an important example of the technology applied (Perraton 1982, Hawkridge 1988). Educational technology in the second sense can also be valuable in developing nations; it includes the use of computers (Hawkridge et al. 1990). Particular aspects relating to the use of broadcasting as educational technology in these countries are analyzed by Bates (1984) and Hawkridge and Robinson (1982), and will not be covered separately in this entry (see Instructional Radio; Instructional TV and Video).

1. Rationales for Educational Technology

In considering the use of educational technology in developing nations, commonly asked questions are: Why should developing nations use educational technology? What are the needs and is the technology relevant? What policies should developing nations adopt?

1.1 Rationales for Distance Education

In distance education teachers and learners are physically separate, with teachers preparing multimedia materials which are sent to the learners as individuals. Learners may or may not receive tutorial support and meet other learners. Typically, distance education systems reach large numbers of learners and benefit from economies of scale. They are sometimes characterized as an industrial form of teaching