# EDUCATIONAL TECHNOLOGY AND THE NEW TECHNOLOGIES *

*Pløn W. VERHAGEN* and *Tjeerd PLOMP*

**University of Twente, The Netherlands**

## Summary [1]

Like everywhere in our culture, new technologies gradually penetrate the field of education. This may be seen as a problem area, which asks for appropriate actions by teachers, curriculum experts, instructional designers and others. As "technology" seems to be the main issue, one may question whether the introduction of new technologies is to be considered as an educational technological problem. To a certain extent, the answer may be yes. In this contribution, the nature of educational technology is dealt with primarily. On this basis, the new technologies are placed in the context of educational problem solving in general.

In the literature, educational technology is defined in several ways. After discussing three major approaches to educational technology, it is put forward that educational technology should preferably be conceived of as the methodology of educational problem solving.

The program of the Department of Education at the University of Twente is described as an example of a curriculum in which this conception of educational technology takes a central position.

## Three Concepts of Educational Technology

At intervals, publication occur about the nature of educational technology, its use for education and its influence on professionals in the field of education. Several conceptions have emerged from its short

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history, which mainly may be categorized into three types of educational technology :

1. Educational technology as the design, the development and the implementation of teaching aids and teaching systems, using newer (often AV-) media. Educational technology is conceived as technology in education. It is a product (Romiszowski, 1981) or hardware (Davies, 1978) concept of Educational Technology.

Although the advocates of this approach received severe criticism, when they did not succeed to prove that new media would solve all educational problems (see for instance Unwins 1985 statement about unwarrented optimism) educational technology in this sense is still alive and well. Today's product — oriented educational technologists help education to respond to the new technologies to realize wider and more flexible educational and training opportunities, both at classroom level and for mass instruction.

The present trend is to put the learner in a central position, giving him control over his learning environment. Artificial intelligence for instance, could not possibly provide such an environment without the creativity of hardware oriented educational technologists.

2. Educational technology as the process of or the technique for the systematic development of instruction. This educational technology is characterized by a stepwise procedure : define objectives, decide on methods, develop materials, test, evaluate and impleament. Programmed instruction is an early example of this approach. In general, the design and bringing into operation of educational software of any kind to support learning is the central issue. Effectiveness and efficiency are important criteria. The starting point to apply this approach in a given situation, is the identified need or desire for some piece of instruction. This approach of educational technology is called the process (Romiszowski) or software (Davies) concept. It is common practice for many instructional designers, although often labelled differently.

3. The third concept is the problem solving concept of educational technology (see for instance AECT, 1977 ; Davies, 1978 ; Romiszowski, 1981). It goes beyond the other two, taking into account the problem to solve and its context. It is a holistic approach, often also called the systems approach of educational technology.

Educational technologists in this case develop a sensitivity for the needs of people and tasks in the problem situation. Hereby, a problem is defined as every situation where the actual situation differs from the desired one. Problems can be classified with respect to educational level (at the macro-level the problems concerning the educational needs of a society, at the meso-level the problems of instituions, and at the micro-level the problems of teaching and learning) and educational subdomain (curriculum, instruction, counseling, administration, evaluation) ; and be treated accordingly. The first two approaches of educational technology are incorporated in the third one, as they can act as valuable means to solve some educational problems. The systems approach leads to a systematic description of the variables (constraints as well as design factors) which influence the problem solving process, thus defining the problem space in which a prototype solution has to be designed, developed and tested in a cyclical process until an acceptable result is accomplished. This process may be symbolized by Figure 1 (adapted from Plomp, 1982). The future implementation is a key factor which is present in every stage, which is in line with recent implementation literature like Fullan (1985). For some problems, prototyping is only possible as a paper excercise. In that case, guided implementation is part of the problem solving process. Examples are large — scale innovations of any kind, for instance with respect to the introduction of information technology in schools.

## Educational Technology, not a Comprehensive Discipline

The problem we would like to discuss is that of the theoretical foundation of educational technology. The attempts to provide a knowledge base for educational technology is one of the causes of the diversity of conceptions, as they are apparent from the literature. A central question is whether educational technology is to be considered as a separate discipline among other educational sciences, like psychology, sociology, etc. When do we want to call ourselves educational technologists instead of for instance instructional designers, courseware developers, curriculum experts, or other ?

The American Association for Educational Communications and Technology tried to provide an answer by developing a definition on the basis of the problem solving conception, which defines educational technology as a theory, a field and a profession (AECT, 1977). In this definition, educational technology is considered to be "a complex, integrated process involving people, procedures, ideas, devices and organization, for analyzing problems, involved in all aspects of human learning". It presents a view on the field of education in which problems may be solved by proper management of development functions like research, design, production, logistics and utilization, using the theory/research function to create a knowledge base. This approach is indeed holistic, and seems to try to incorporate all relevant scientific knowledge into educational technology. The attempt to adopt relevant theories may be clear from the concluding statements which were presented in the AECT text on the definition by Kenneth Silber, quoting Finn :

"Properly constructed, the concept of instructional or educational technology is totally integrative. It provides a common ground for all professionals, no matter in what aspect of the field they are working ; it permits the rational development and integration of new devices, materials, and methods as they come along. The concept is so completely viable that it will not only provide new status for our group, but will, for the first time, threaten the status of others. (Finn, 1965,

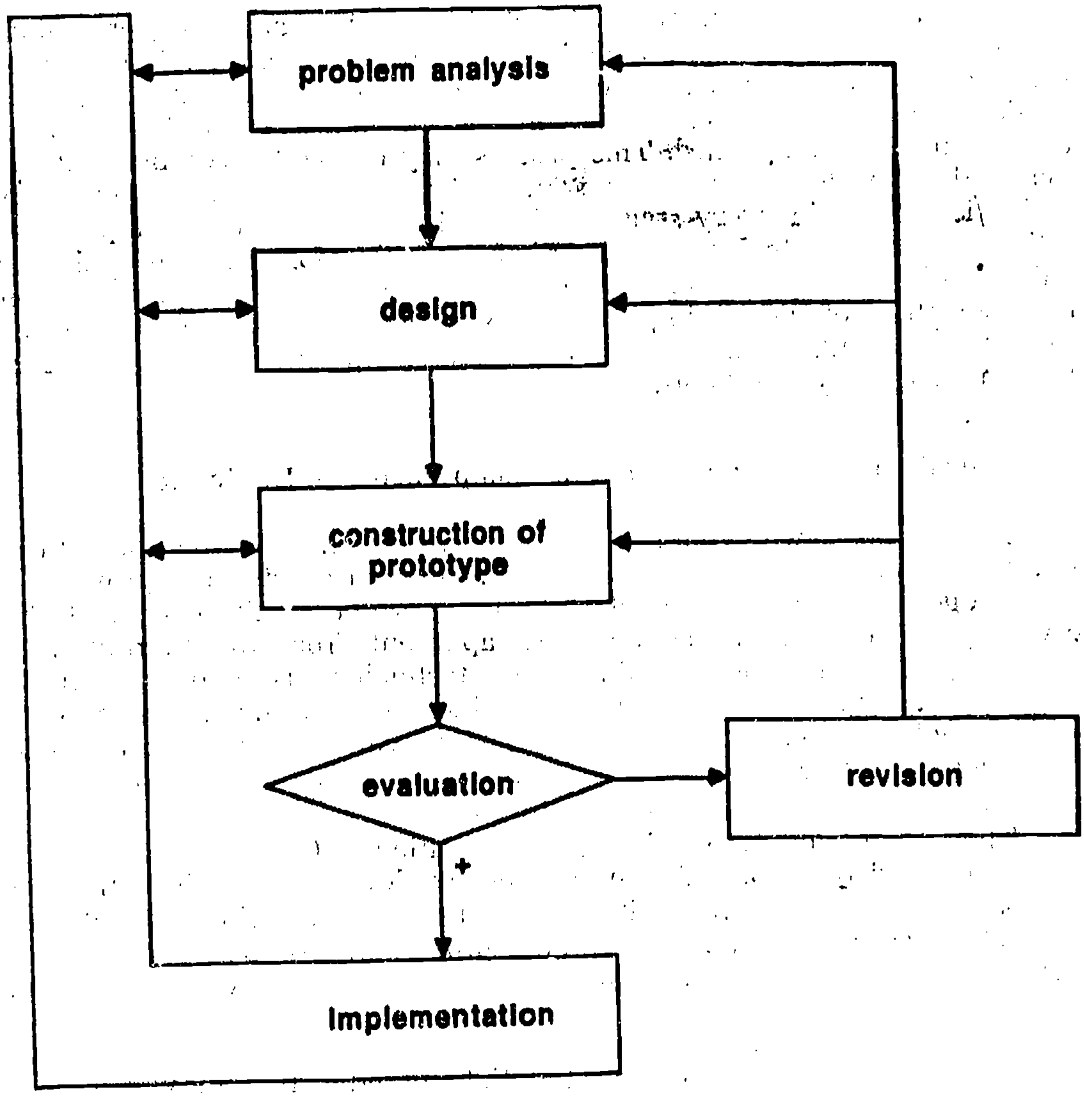


Fig. 1 : General model of educational problem solving

p. 193). The educational future will belong to those who can grasp the significance of [educational and] instructional technology. (Finn, 1964, p. 26)".

Now, ten years later it may be clear that these expectations were put too high. The merits of the AECT definition lie in the stressing of the need for management of the problem solving process ; the recognition of the need for certification and training of aides, technicians and specialists within a coherent set of career options ; and the striving for curricula which are substantially congruent from institution to institution. The integration of all theoretical fields into one educational technology did not occur, however. We contend that this is not even desirable. The educational reality is much more complex in its manifestation than can possibly be grasped in one unifying approach as a comprehensive discipline or theory. Different scientific fields show different representations of education. Theories about learning, sociology, pedagogy, philosophy, economy, management, all show their own perspectives. The same counts for derived design theories. As an example, in Reigeluth's overview of instructional design theories and models, the word educational technology is not mentioned once. The book shows nevertheless a range of applicable systematic approaches to design problems, representing different though often related theoretical schools with all their similiarities and — sometimes — controversies (Reigeluth, 1983). Reigeluth does not treat the subject exhaustively. Other instructional design theories or models exist or are being developed (see e.g. Gustafson, 1981). All together, one sees a manyfold of possibilities for approaching educational problems in what only is one subdomain of education, namely instruction. How to position educational technology with respect to the different subdomains?

## Educational Technology as Methodology

One solution is to speak of technologies in all cases where theory is put into practice by a systematic working method. Several authors use educational technology in this way. For instance: Hackbarth (1985) speaks of instructional systems design as of a technology. Jonassen (1985) describes conceptional roots for instructional design and from thereof derives a new educational technology on the basis of learning strategies.

A consequence of the diversity of views is that the theoretical context of educational technology (or technolgies) is rather unstable. One educational technology leans on cognitive science (Jonassen, 1985), another is based on a constructivist view (Fosnot, 1984), a third approach advocates a philosophic analysis of the role of mediation in learning to be incorporated in educational technology (Jonassen, 1984). These educational technologies tend to change over time, together with the developments in the respective scientific fields (Remember, for instance, the shift from behaviorism to cognitive psychology as the dominant knowledge base for instructional design activities).

The problem is that each specific educational technology confounds in this way the methodology which is implied in "technology" with the theoretical content of some knowledge domain. Heinich (1984) tried to prevent this. He presented a conception of the proper study of instructional technology in which the process of design is elaborated in terms of activities, desired forms of cooperation of technologists and the needs for research to support technological methods. His stand is much in conformity with the AECT definition, but without falling into the trap of wanting a theory to describe the object of the technological activities, in his case instruction, as a part of the technology. This caused a reaction from Clark (1984), who suspected as an effect of his approach

"that instructional technology is itself turning into a craft — The craft of instructional design and development. While this new craft employs techniques (i.e. instructional design models) that are more systematic and organized than those typically used by teachers, in fact much of this design effort could be characterized as lending a "technologizing" sheen to a new craft".

Hlynka and Nelson (1985) are less pessimistic. Like Heinich (1984), they contend that "design" is the key concept of educational technology. Design includes art (i.e. creativity), craft, science and technology, all present at the same time in a synergistic combination. They in fact get round the craft/science dichotomy and come close to our opinion about the nature of educational technology. We wish to see educational technology as a problem solving methodology in which a systems approach, together with eclectic use of scientific and other knowledge, leads to the design and development of solutions. This conception means that educational technology is independant of educational or instructional theories to a large extent. With this conception, we may distinguish the problem solving process as such from its applications. The problem solving process then is symbolized in the generalized model which is presented in Figure 1. Aspects of an educational technology approach can be divided into three categories, as described by Ely & Plomp (1986):

"a) Educational technology as systems.
Using concepts and approaches of systems theory and operations research in the analysis phase, the problem can be handled by defining the problem space as a system with boundaries, within which related subsystems can be defined. Complex problems can be unraveled to reveal well-ordered partial problems with enounugh known properties to make an acceptable solution possible.

b) Educational technology as methods and techniques.
Many techniques, most of which are not specific to educational technology, can be used in the analysis, design and development and evaluation phases. The specificity of these techniques lies in their order within the technological cycle. This cycle can be considered as the methodological basis for the design process. A typical characteristic of educational technology is that techniques for design decisions are considered to be a vital part of the process.

c) Educational technology project organization.
A technological approach makes special demands on the organization of projects. This is partly due to the fact that the problem analysis will result in an overview of knowledge and skills needed for finding a solution. Many problems need expertise from a variety of disciplines. 'Management of expertise' is the key phrase : the classification of a problem with the right expertise at the right time. Continuing attention to the implementation of the solution makes

demands on the project organization. Planning has to be considered as one characteristic of a technological approach. The project organization is directed at achieving an optimal solution within the existing constraints such as budget, personnel and time".

On this general level the eclectic nature of educational technology is reflected in the way resources and man power are allocated in a specific project. They are chosen from a wide range of possibilities, indeed including the craft of, for instance, media personnel and the scientific knowledge of, for instance, curriculum experts.

In a particular problem situation, in most cases particular design methods will be used. On this level, the same principles apply.

Romiszowski's (1981) designing of instructional systems is an example of this for the instruction domain. Again, his approach is eclectic, offering design options as a result of divergent thinking, leading in specific cases to the selection of, for instance, methods and media by converging reasoning.

In conclusion, our conception of educational technology defines educational technology as the methodology of educational problem solving. In this methodology, the systems approach is central. The methodology is relatively independent of the different educational subdomains. Design models in the subdomains usually show great similarity with the general model from Figure 1. In our view, we prefer in these cases not to speak of different technologies, but rather of different forms of integrating problem solving methodology into the design methods of educational subdomains.

## Example: Educational Technology in a University Curriculum

The thoughts on educational technology which were unfolded above, are the basis for the curriculum of the Department of Education at the University of Twente. The Dutch name of the department is "Toegepaste Onderwijskunde" (TO), which means literally: Applied Educational Science.

The curriculum of TO is a four year post secondary program. According to the Dutch educational system, the entrants into the program are graduates of a highly selective preuniversity school. The students in the program attain a degree which is equivalent to a Master's degree. It is the only program in The Netherlands in which educational technology takes a central position. The organizing principle for the curriculum is shown in Figure 2.

The subdomains listed in box 3 are reflected in the organization of the department. The department is composed of the following divisions:

— Curriculum, dealing with problems in curriculum (course, training) design, evaluation and implementation.

— Instruction, dealing with problems in the design and implementation of training situations and instructional methods.

— Educational instrumentation, dealing with the use of media, including computers, in education and with the physical teaching/learning environment.

— Educational administration, dealing with policy, planning and management problems in education.

Besides these four divisions covering educational subdomains, there is a division of educational measurement and data analysis, offering courses on research methods and statistics and dealing with testing problems.

There is no separate division of educational technology. Instead, there exists an interdivision technology group which is responsible for the courses on educational technology. In this way, educational technology is supported by all divisions in the department.

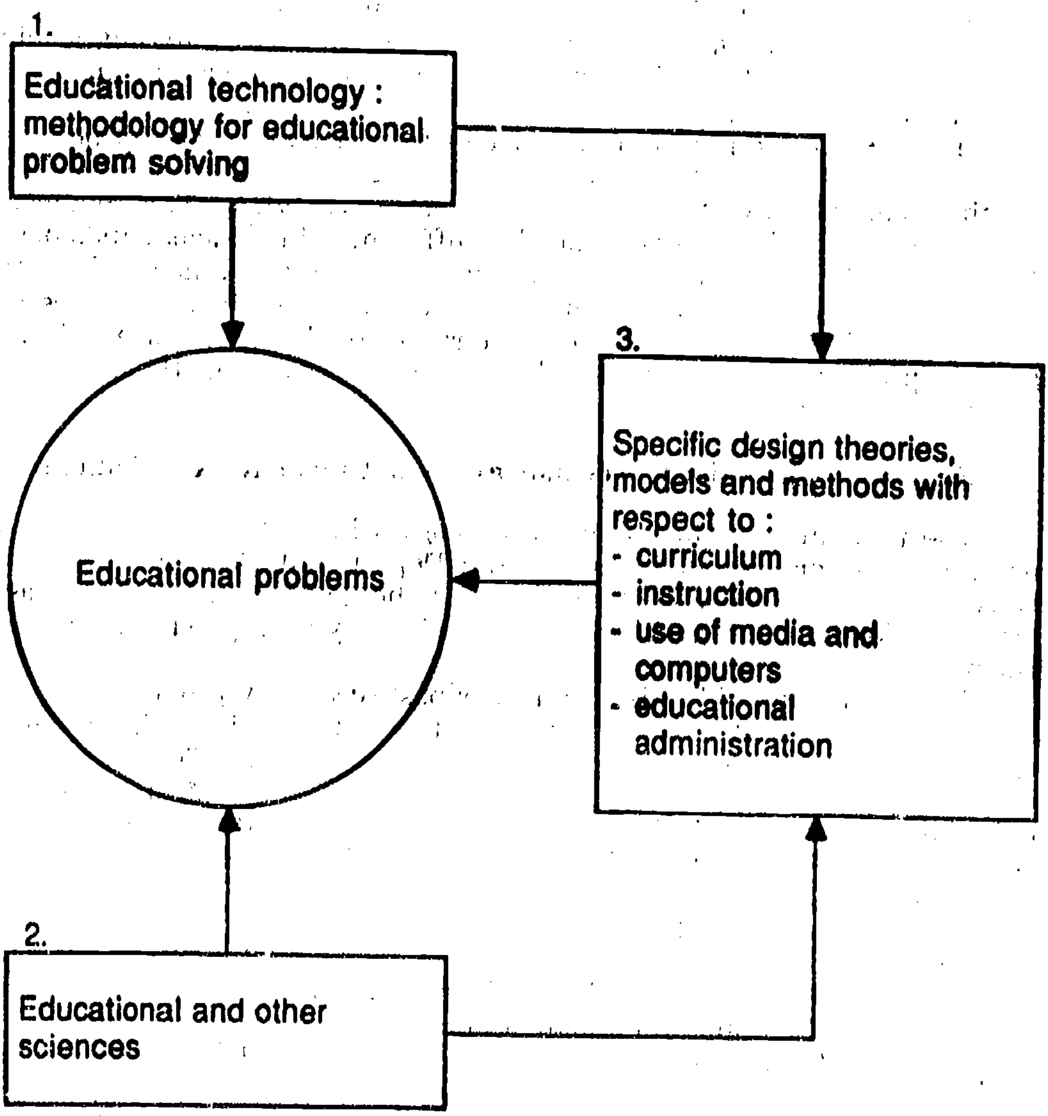


Fig. 2 : Organizing principle of TO Curriculum

In the first $2^1/_2$ years, the curriculum is common for all students. Figure 3 shows the domains on which courses are being offered in this period, and the relative amount of time spent on each.

The common curriculum is followed by a final phase — the last $1^1/_2$ years — in which there are broad options available from which students may draw up their own curriculum. Although the nominal time for the programme is 4 years, the students may spend 6 years on it as a maximum. The program started in 1981. The total enrollment at present is 300. At this moment — spring 1987 — 33 students are graduated. Now, some six years after the start of the programme, we may evaluate the first results of our approach.

Although only 17% of the common curriculum is devoted to courses on educational technology, these courses seem to be decisive on the development of the professional attitude of our graduates. This may partly be due to the central position of educational technology in the curriculum, as symbolized in Figure 2.

Students appear to continue the systematic approach to analyse problems and to develop solutions, after the common curriculum. This is obvious from reports on their work during their final project and from observations of supervisors inside and outside TO.

This attitude appears to be highly appreciated in the educational field, especially in business and industry. 60% of the final projects takes place with companies. Graduates appear to be successful when applying for jobs and again 60% of the jobs taken are being found in business and industry.

## When to Apply Educational Technology

The experiences with the TO-programme lead us to the next characterization of the applicability of the educational technological approach.

Educational technology stresses the multidisciplinarity of the problem solving and design processes. This makes the educational technological approach especially suited for situations in which :

— the problems to be solved are complex in nature (where many interrelated factors are involved),

— a problem is placed on a higher level than that of the individual teacher (where many interests are to be combined),

— several people have to cooperate in order to develop a solution for the given problem.

The educational technological approach does not start a priori from the point of view of the teacher. In the approach, no priority exists for treatment format or delivery system. This by necessity includes relativation of the role of the teacher. This is not to say, that through educational technology the role of the teacher becomes less important. In many cases, the teacher remains in a central position. Further, it is not to be denied, that in some educational situations close to the learners, when an empathic approach of a problem is imperative, the objectiv-

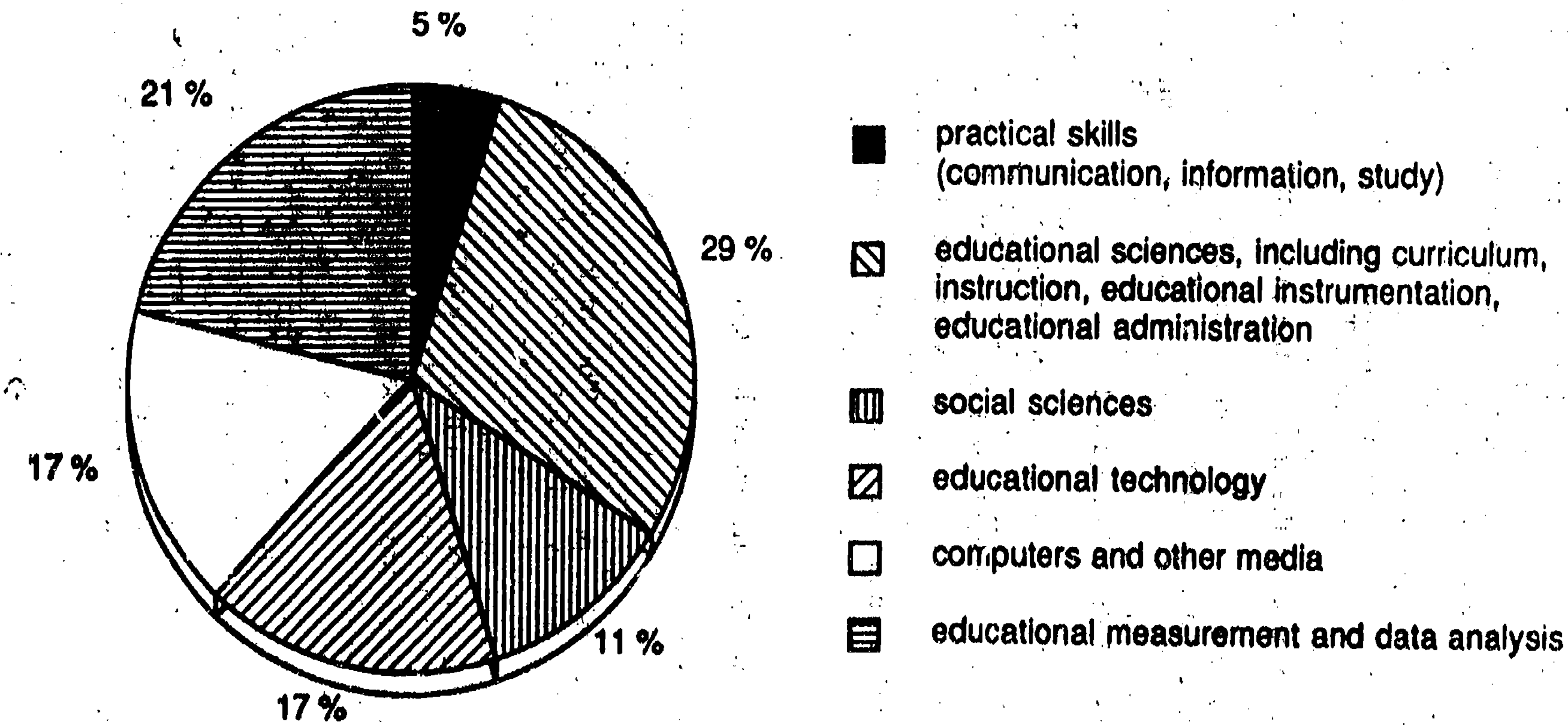


Fig. 3 : Common curriculum of TO (First 2 1/2 years of study)

ating nature of educational technology will most probably not be appropriate.

If we look now at *new* technologies, again one may say that there are no a priori decisions in favour of these technologies either. The new technologies offer new options to create teaching and learning environments. One may approach the new technologies with a positive attitude. But thore is no reason to idolize. Careful analysis and design efforts, as an educational technological enterprise in the above described sense, may pave the way for beneficial innovations. The emphasis on implementation in our conception of educational technology should thereby safeguard an optimal balance between advantage and disadvantages.

In conclusion educational technology, being conceived as the methodology of educational problem solving, offers many perspectives for research and development efforts. Like in research methodology, many methods and techniques are needed to be able to act appropriately in complex situations. They should be derived in sound research and development projects. New technologies take their place in this process. For educational problem solving, they are optional components to accomplish a solution, among many others. Proper use of educational technology puts the new technologies in the right perspective, with problem context and care for implementation as key factors for design decisions.

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