New Technologies as Pedagogic Tools in Higher Education *

1. Introduction

In the present context we shall define New Technologies (NT) as all equipment, programs, methods and techniques using digital information and communication technologies, found to be suitable for higher education applications. This being said, we shall consider NT's as *tools used to facilitate learning*, not as the core subject of a given course.

From this perspective, NT's may play different roles in the learning process, namely:

- As media-supported learning materials using written, audio, or video discourses;
- As a tool for processing information under the shape of text, calculations, graphics, audio, video and animation;
- As a platform for interactivity between learning contents and users, at different levels of complexity;
- As a tool for researching and collecting information and data within a Net;
- As a means to improve educational and social communications between teacher and students and between the students themselves;
- As a platform for management and diffusion of news and logistic and administrative information, organized at central level and addressed to students and members of teaching and non-teaching staff.

The ways and extent in which these different streams are exploited and developed have a direct consequence in terms of defining students' degree of autonomy in respect to teachers and to the teaching system. This leads to models of pedagogic organization varying

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between a classical classroom regime, with infrequent use of the existing computer facilities, just for illustration of some particular subject in the curriculum and, at the extreme opposite side, a self-learning regime that does not require the existence of regular classes. Between the two situations lye the dual-mode and the mixed-mode distance teaching regimes, wherein face-to-face sessions and self-learning activities can have different relative weights, while complementing each other.

2. NT's in Learning Materials Conception and Production

It is usual to define the nature of learning materials through the kind of document designed to be used as support for a given type of discourse. We use printed paper to present texts, tables, calculations and drawings, although the corresponding pages can also be presented as computer screens. We call it the *SCRIPTO* discourse, including everything that can be properly put into a two-dimensional fixed format, suitable to be printed on a sheet of paper. According to this definition, paintings, photographs, drawings and diagrams are also included in this category of discourses, related to everything that can be *read,* once or repeatedly, at all times.

Sounds, the oral speech, music and even noises can be broadcast by radio or be fixed as a recording in an audiotape or a CD; we name it the *AUDIO* discourse, including all permanent contents that can be *heard*.

The *VIDEO* discourse corresponds to the organization and perpetuation of moving images, real or synthetic, figurative or abstract. Designed to permit the *visual perception of movement*, video documents include cinema, television and all related forms of communication. For instance, a slide show, sometimes called a *diaporama*, is one kind of video discourse, for even if fixed images are used, their movement is an intrinsic part of the presentation. By convention, the video discourse *includes the sound track* that may be associated with the sequence of images and which presence is frequently necessary to reach the full intellectual understanding and emotional integration of the visual message.

Computers have introduced a new dimension of complexity in this simple classification of different types of discourse, for they can make accessible to the user fixed or moving images, sounds of all kinds, written texts, graphics and figures, alone or in various combinations. For this reason, this is called a computer *multimedia* functionality. Moreover, computer documents may have imbedded the possibility for the user to modify a document

in terms of the corresponding shape, order or contents; to introduce new data; to ask for calculations or graphic representations to be made or plotted; and so on. This means that some amount of *interactivity* may have been provided for, within a given document. We call this the *INFORMO* discourse, including everything that computers are able to provide to a given user. The ability to access information, stored locally or existing somewhere within a communication network that this particular computer is connected to, is another form of interactivity; as it is the capacity to exchange all kinds of messages between computers linked to the same network.

Computers are well suited to produce matrices of learning materials, later to be published as books, video and audio tapes, computer disks or CD's. But also, according to the type of discourse into which the information is formatted, it can also be presented as projections to an audience, to be broadcast in radio or television emissions or to be made accessible to other computer users sharing a given electronic network.

We feel necessary to make just two remarks concerning this use of computer technology to produce learning documents, both related to pedagogic aspects.

The first one concerns the suitability of a given discourse to support a specific didactic content. There is a temptation to use always the most sophisticated existing technology for this purpose, like putting the full text of a book in the Net and asking students to study from it; or including in a given INFORMO document a lengthy video recording of someone's lecture. Both approaches are generally unsuitable for the ultimate learning purpose: it is less tiring (and less boring) to read a book and to hear a not too long audio recording.

As another example, most scientific contents of sciences like Architecture and Geology are suitably illustrated by using fixed pictures, even if animated synthetic pictures might be suitable to understand some dynamic processes in these disciplines. The value of a sound track in this context is almost negligible. Conversely, you certainly need video recordings to study processes that are intrinsically dynamic, like dancing, sports training and surgery.

Studying Literature requires reading actual books, more than anything else; learning Mathematics can be improved by using interactive documents, through which calculations can be analysed and corrected, graphics plotted and equations verified in a fully automatic way.

This means that the choice of the appropriate medium and the corresponding discourse is tightly linked to both the nature of the learning contents and to the cognitive processes involved in the study.

The second remark relates to the efficiency of these materials in what concerns their suitability for learning. They do not just need to be scientifically sound but also pedagogically well organized and structured, in order to make learning easier, more pleasant and more efficient. This means that the conception of media learning materials has to provide them with aesthetic appeal, clarity of discourse and friendliness of use, so as to improve students' motivation.

3. Some Comments on Interactivity

We can define interactivity as the imbedded ability of an INFORMO document to become changed, in some way, by voluntary actions of the corresponding user. The most basic level of interactivity is the possibility of this document being accessed at different points of its content and to be read in full by using different reading paths. It must be said, however, that this is not much different from the diverse ways one may use an encyclopaedia to reach some obscure bit of information that does not deserve an explicit heading.

A more elaborate way of creating an interactive document is to provide it with a *hypertext* (or hypermedia) architecture. This means that the internal organization of the corresponding discourse is neither sequential nor linear, but takes the shape of a multi-point net, providing a large number of different reading itineraries. The catch is, nevertheless, the absolute need to provide users with orientation (or navigational) aids to prevent them from getting "lost" in hyperspace. This means that the architecture must be both *logical* and *useful*, facilitating the full integration of the subject and not making it more difficult to understand than studying a conventional, unilinear text.

Another approach to interactivity has been used, for many years, with the so-called *computer-mediated learning documents*. While being linear in structure, the access to their full contents is determined by the ability of the user to satisfy a fixed set of learning objectives. Taking for instance chapter four, the student is only allowed to proceed to chapter five after having successfully answered a questionnaire (usually organized in a multiple-choice format) on the subjects of that chapter. Wrong answers are fully exploited by giving place to an orientation comment; complete success in overcoming difficult questions in the questionnaire may require further study and double attention to previous chapters' contents.

Contrary to the above-mentioned cases, *full interactivity* requires that users have the possibility of introducing *new data* in a document, so as to obtain new outcomes from this initiative. This is the case of many different kinds of operative software conceived to help in performing quantitative projects and calculations, drawings and graphics, and in writing texts, creating music and producing synthetic fixed or moving pictures.

The possibility of accessing further information from a computer network multiplies this ability manifold. Quantitative and qualitative data, bibliographical references, news and archive information, visual and sound components may be obtained, by paying an access fee or just for free, depending on the copyright coverage of the specific item to be acquired.

Like the comments made about pedagogy requirements in learning materials conception and production, all levels of interactivity should be pre-programmed in order to optimise the efficiency of the learning process.

4. Electronic Communications

The top level in interactivity is the possibility of free exchange of written, oral or visual messages between people linked to the same computer network. The Internet and all kinds of Intranets are tools suitable for this purpose, working either in synchronous or asynchronous mode. This is clearly the most efficient and relatively inexpensive way for social, business, administrative and pedagogic communication between a teaching system and its students, the teaching and the non-teaching staff.

On the one hand, it just makes good sense to create, in all kinds of day-to-day activities, a communication path other than telephone and mail, that does not require the physical presence of entities involved in a given interchange of information. But, on the other hand, these added degrees of freedom allow for an increase of citizens' autonomy in respect to systems they need to interact with. This is true when using an ATM terminal instead of going to a Bank, performing an automated check-in when beginning a flight and purchasing goods through electronic commerce.

This is also true in education: *learning* is clearly an *individual activity* by means of which *relevant information* is understood, related and integrated and so becomes *real knowledge*. Contrariwise, *teaching* is a *social process*, through which teachers make structured information accessible to students, while providing them with methods and techniques suitable for making easier their building of knowledge and acquisition of skills.

As in other social interactions, it is advisable in modern education to increase somewhat the degree of autonomy of students in respect to teachers and the teaching system.

5. Autonomy in the Learning Process

In one extreme of possible solutions, we can find the ultra-conservative model of the classical classroom, wherein the focus is placed on teachers as the ultimate sources of information and knowledge. Rather than an educational dialogue, we frequently observe a situation of monologue, the teacher speaking and students hearing and taking notes. At the opposite side of solutions, we can find different situations in which self-learning plays a major role, with the absence of regular face-to-face sessions. Instead of teachers, the main source of information rely on the ready availability of high-quality learning materials and of some face-to-face or communication-mediated tutorial support, used if and when students feel the need for it. This is currently called the *distance learning* or *distance education model*, as opposed to the *conventional* or *classroom-based model.*

Even if conceptually opposed in terms of little against large autonomy of students in the learning process, we can find that the two paradigms of learning have been steadily converging for a number of years. Actually, not all subjects and courses are suitable to be acquired in the self-learning, isolated individual mode: experimental sciences, medicine and psychology need either a laboratory environment or a strong social interaction for the corresponding knowledge and skills to be duly integrated. So, even pure distance education systems need sometimes to provide students with some amount of face-to-face sessions.

On the other hand, introducing computers and the Internet in conventional schools actually creates alternative sources of information and knowledge available to students. In this context, the role of teachers becomes more and more that of a mediator and manager of information resources, allowing students to exercise their individual qualities of initiative and creativity.

The clear trend is to come to a delicate balance between classroom sessions and self-learning activities, so that in the future the differences between distance education and conventional learning will become almost absent.

This is becoming even more obvious in observing the recent adoption, by conventional universities, of distance learning methodologies. In some cases, while keeping their usual on-campus students, taught in the conventional way, they open new programs to off-campus

students, allowing them to enrol in distance learning courses. This is called the *dual-mode* type of operation. As an alternative solution, all students will follow some courses in the classroom mode and others in the distance learning one, this being called the *mixed-mode operation.*

6. Current Developments in Distance Education

In the past, distance teaching universities (also commonly called *open universities*) used a combination of printed material, radio and television broadcasts, tapes and CD-ROMs as vehicles for carrying scientific and pedagogic information to all their students. In what respects student support mechanisms, the most usual solution was to create a network of regional study centers where student could meet tutors and overcome their difficulties.

For distance-teaching systems, electronic communication become an Eldorado of useful possibilities, to circulate learning materials and didactic information, to distribute relevant administrative news and data and to improve communication between teachers and students and between students themselves. Thus was overcome the former typical isolation of the distance-learning student, by creating a social interaction that was, until then, almost impossible to assure.

In what concerns educational communication, the possibility of using e-mail and computer-conferencing for tutorial purposes has a clear added-value as compared with the possibilities formerly offered by infrequent face-to-face sessions or by corresponding just through terrestrial mail and telephone.

However, some caution must be used when dealing with electronic tutoring, due to the risk of overburdening the tutorial staff with too many communication duties. Some kind of limitation mechanisms need to be introduced, for economies of scale may be put into jeopardy by letting tutorial duties become too heavy for the existing number of tutors.

For conventional universities, the recent progress in the use of NT's opened their way to come into the distance education field. So have seen the light the so-called "virtual universities" "e-universities" and "online universities", just different ways of saying that these systems (many of them raised within existing conventional universities) have become involved in distance education.

There is a need, however, for some precautions to be taken. The rationale for creating a single-mode distance education system is, on the one hand, to provide learning opportunities for people unable to follow regular classes for geographical, professional or family reasons. On the other hand, to take advantage of economies of scale, given the suitability of distance education methods to cope with very large numbers of students.

Consequently, two orders of precautions must be taken. The first one relates to the efficiency of the learning process, that must be granted despite the distance existing between students and the teaching system. The pedagogic and didactic quality of learning materials, the usefulness of student support mechanisms, the accessibility of tutors and the provision of appropriate formative assessment opportunities are usual solutions to these problems. It must be said that conventional teaching systems may not be totally aware of this kind of pedagogic requirements.

The second order of precautions relates to organization, logistic and also to the structure of costs, widely different in conventional and in distance teaching systems. Organization and logistic in the latter must be based on a highly centralized level of decision and planning, with a somewhat reduced autonomy of the teaching staff, except in what respects the authoring of scientific contents. The structure of costs should take into account the high fixed cost of conceiving and producing learning materials, while costs proportional to the number of students are much lower than in conventional teaching. This is why distance education systems are said to be capital-intensive, rather than manpower-intensive as conventional systems are.

So, teachers working in distance education must be as qualified in pedagogy as in the scientific content of their disciplines; principals and managers in these systems must be as aware of policy, finance and accounting as in educational planning.

7. Networking

One of the obvious advantages of distance learning systems is their capacity for collaboration with similar structures, wherever they may exist. This may yield the result, not only of the creation of synergies but also the possibility of sharing costs in the development of new courses and learning materials and of extending their respective sphere of influence in the recruitment of new students. This is why many partnerships of this kind exist, both within and across national borders and even between continents, with a high degree of satisfaction of all partners involved.

As a few examples, there is a very successful association between the distance education stream of the University of Maryland and the dual-mode University Carl von Ossietsky, in Germany, with degrees granted together by the two institutions. In Europe, the European Association of Distance Teaching Universities and the consortium Europace 2000, each one aggregating several dozens of higher education systems, teach a large number of degree and non-degree programmes, from environmental sciences, to engineering, to European law and European culture. The same trend can be seen in the United States and Canada, pairing with South American and Australian institutions, while Asian institutions have many partnerships with European countries.

At a global level, the International Council for Open and Distance Education is the umbrella organization for more than one thousand systems in 149 countries, an NGO recognized by UNESCO and with frequent collaborations with this United Nations organism. The biannual Congress of ICDE, the next one to be held in Hong Kong in 2003, is the world forum for having an intimate contact with the newest developments in the distance education field.

8. Final Remarks

It is obvious that the preceding considerations have a most general nature, applying to most fields in education. This is why they may fit in the specific field of the present congress, dedicated to physical education Actually, in higher education programs dealing with this stream of human knowledge, it is obviously essential the use of fixed and animated images, both real and synthetic, to improve the understanding of the human body physical structures and elements, their motions and their functions, both in physiologic and pathologic terms. Moreover, even if a good part of the teaching subjects in this context needs to be supported in actual physical exercise, sustained and specialized training and sports, many others require a theoretical foundation, that one suitable to be taught in the self-learning mode.

But the most important consideration relates to the current trends we have been analysing: the convergence of the classroom-based and the self-learning modes; the necessity to increase the degree of autonomy of students, namely in higher education; the need to imbed significant pedagogic expertise in the conception of quality learning materials, suitable for distance learning operation; the advantages of networking with parent institutions.

In this set of conclusions, not much will be directly related to technologies, be they old or brand new. For we know there will be more and more progress in this field... and, whatever shape the new technologies will take, we shall use them just as tools at the service of people, as they should.