

ICT Driven Individual Learning: New Opportunities and Perspectives

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ABSTRACT

In this paper we shall discuss the various implications for individual learning resulting from the use of Information and Communication Technology (ICT).

Firstly we discuss the new approaches to in-service training needed in the present socio-economic climate and define the conditions for devising such approaches. Then we analyse the operative and cognitive problems that employees face with regard to continuous learning, drawing on our experience with different learner populations: teachers, trainers, company personnel, and employees in public administration. On the basis of this analysis, we will derive some general indications as to the training structure and educational tools that should be created in order to give impulse to continuous learning. In particular, we will examine the role that may be played by a technology-based environment for promoting individual learning via autonomous activities and interaction within the context. We will then discuss how these general indications should be applied in the different environments under examination in order to respond to specific needs. With a view to providing examples of actual applications, we shall illustrate the proposals we have developed and tested.

Keywords

Individual learning, Educational Information Communication Technology, Learning to learn, Computer supported individual learning

Introduction

Increasing competitiveness, technological change and the re-engineering of production and social processes require continuous upgrading of skills and personal growth (European Commission 1995a, 1995b). Let's take schooling as an example. Technological innovation, the adoption of new teaching/learning theories and social change all call on teachers to modify their role, to introduce new contents, tools and methods, and to deal with a heterogeneous student population.

A similar situation is being faced by training organisations. Increased competitiveness and the resulting need to improve and diversify the training they offer means that trainers must have theoretical and practical know-how in new techniques for delivering training. This in turn calls for the application of new methods for presenting contents and organising learning activities.

Another area strongly affected by change is that of private companies, especially small and medium enterprises. Market globalisation and ever fiercer competition call for highly trained, highly efficient staff who are able to make a constructive contribution towards innovation in methodology and contents.

A further example lies in public administration. Public demand for greater efficiency and upgraded services requires personnel with the flexibility to adapt to new roles and the capacity to adopt information technologies to meet that demand.

These situations entail a shift away from the traditional study-work sequence; the formation of one's cultural background is no longer something that can be encapsulated within schooling alone, but must be spread throughout one's whole working life. Sporadic in-service training courses delivered in short spurts in fixed locations without specific tailoring cannot possibly meet individual learning needs. What's more, they impose time restrictions that clash with production requirements and have a low cost/benefit ratio, thus representing only a partial response to training needs.

These factors underline the importance of viewing individual training as the capacity to learn how to learn, and of considering knowledge acquisition as an active and continuous process that results in changes in behaviour

and a different perception of the world around us. It is therefore necessary to provide tools and methodologies that stimulate the development of these capacities, and this is the main thrust of our work. In particular, we have studied the potential that multimedia and network technologies offer for the development of individual learning skills within four different adult populations: teachers, trainers, company employees and public servants.

Individual learning

Individual learning may be defined as the capacity to build knowledge through individual reflection about external stimuli and sources, and through the personal re-elaboration of individual knowledge and experience in the light of interaction with others and with the environment. In modern-day society, this capacity is demanded of practically everyone. What's more, the rapid change brought about by innovation, increased levels of competition and the unsuitability of other forms of training all mean that this ability needs to be much more keenly developed than in the past.

The requisites for individual learning are perception of a need, identification of an object (an objective) that may satisfy that need, and identification of a strategy for reaching that objective. In some cases these requisites are immediate: consider a child who learns to walk and talk in order to achieve freedom of movement and communication; or, more generally, a person who needs to learn how to drive a heavy vehicle or to use a foreign language so that s/he can interact with others. It must be pointed out, however, that in situations like these the motivational factor is extremely high, the relationship between need and objective is immediately apparent, and the path to achievement is direct and clearly defined (Forcheri & Molino, 1999).

Generally speaking, few people have an innate capacity for individual learning. Often, the need is not immediately clear, and the effort involved in fulfilling that need means that less time and energy will be dedicated to gratifying tasks. Moreover, instead of directly pursuing the ultimate objective, it may be necessary to proceed by striving towards indistinct intermediate goals. The strategy for reaching the objective may call for a strong commitment and radical change in normal behaviour.

Table 1 outlines the requisites for individual learning and the conditions we see as necessary for their establishment.

Perception of need

The lack of personal motivation often means that needs are not perceived. In the case of schools and companies, for instance, needs are not seen as personal because they arise out of requirements imposed from an external organisation that the individual only identifies with in a fairly loose manner. This is in stark contrast with the position of the self-employed or corporate management, whose capacity for self-training is a vital element in carrying out their activity.

The environment in which one operates may also be adverse towards innovation and offer no incentive for personal growth. Take public administration for example, which (at least in Italy) has traditionally operated using approaches and means that have become outdated in society at large. Individual endeavours to keep up to date on matters related to one's work are implicitly discouraged by the impossibility of putting into daily practice what has been learned.

In addition, the frantic pace of activity in modern society leaves little time for rethinking what one does in an effort to improve performance. A clear example of this is provided by working women, who not only have professional commitments but are also called upon to manage the household and look after children and elderly family members.

Finally, personal needs do not always match the requirements posed by the context of operation. Take for example a secretary working in a small office that deals solely with local clients. Her work does not call for knowledge of a foreign language or of advanced office automation systems. However, in the current economic climate she runs a constant risk of retrenchment and so needs skills of this kind in order to compete successfully on the job market.

Requisites	Conditions for their achievement
Perception of a need	Motivation External stimuli Synchronisation Time
Identification of an objective for fulfilling it	Self-confidence & confidence in the setting Interaction with others Collection, analysis and organisation of information Enterprise
Implementation of the strategy for reaching the objective	Behavioural attitudes Problem-solving capabilities Psychological attitude

Table 1. Individual learning

Identifying the objective

Identifying the objective, or means, for fulfilling a need is difficult as it calls for initiative in acquiring information and knowledge and then evaluating these both individually and with the help of others. Take for example the need to acquire technological skills in order to compete on the job market. This calls for careful evaluation of the type of skills that may be useful, involving activities like reading newspaper articles about technology, examining job offers and reflecting about personal knowledge. There is a myriad of courses and books available in this area, and making the right choice means finding out about the reliability of the source and the methods employed. This involves getting in touch with experienced people or with others who have faced the same training needs.

Furthermore, in many cases the objective cannot be pursued directly but rather calls for knowledge to be built up through a step by step approach. Take job seeking for example: the need is clear enough but fulfilling it means setting intermediate goals, such as finding out about different forms of work (employment, self-employment, fixed term or permanent positions, etc.), gathering information about each one, knowing how to write a CV and so on.

The final point to consider is that lack of confidence in oneself and in the setting seriously hinders the identification of goals befitting one's skills. A prime example is the use of computers by middle-aged staff members. People in this age group do feel the need to get to grips with new technology, but fear of failure can make them reluctant to learn even the very basics of computing, to the point that they may even refuse to turn the machine on at all.

Applying the strategy for reaching the objective

After setting their goals, independent learners need to develop plans for achieving them. A plan should set out priorities, instructional tactics, resources, deadlines, roles in collaborative learning situations and proposed learning outcomes, including presentation and dissemination of new knowledge and skills, if applicable.

Two factors influence the outlining and development of a plan: problem solving ability and behavioural skills.

Different kinds of mental activities must be brought into action in order to acquire problem solving abilities: observing, imitating, generalising, discovering, making mistakes, correcting, analysing (breaking down), summarising (laying out), modelling (from the concrete to the abstract), comparing, classifying and so on. Take for example a training organisation called upon to develop training paths that meet the standards the market currently demands. This involves a number of steps: study of the organisation's position regarding the factors that influence the quality of training; identification of the key areas to tackle, comparison of the organisation's stance with its competitors'; determining what standard should be pursued in terms of both internal structure and market demand; scheduling of the adjustment programme; and deciding the approach for evaluating results.

Behavioural attitudes include flexibility, adaptability, self-regulation (self-evaluation, awareness, willpower, sense of responsibility and self-reliance) and social regulation (organisation and management) (Brooks, 1997). To take an example, consider a teacher who needs to improve his/her professional performance by adjusting to

shifting social conditions. Italian schools are currently facing new problems related to the increasingly multicultural and multiethnic composition of the student population and to rising dropout levels. Meeting this challenge calls for considerable planning effort, a detailed organisational scheme and a drastic change in behavioural attitudes.

Technology as a tool for encouraging individual learning

These observations underline the fact that any project aiming to foster the development of individual learning must help people to recognise their personal needs, and encourage them to identify and put into practice behavioural strategies and methods that make it possible to identify the means for doing so.

Individual learning may be developed in two ways, through individual activity or collaborative activity. The former comprises study, individual reflection, reworking of ideas and concepts, and the building up of new knowledge on the basis of what is already known. On the other hand, collaborative activity may be pursued either in a formal learning setting, where different teaching models are adopted, or in an informal manner as an integral part of one's work (situated learning).

ICT can play a supportive role in these activities. A well-known example in personal activity is provided by hypermedia systems. When these are paired with the more promising new theories regarding the design of learning environments (Kommers *et al.*, 1996; Vosniadou *et al.*, 1996), they represent a means of knowledge acquisition that, by approaching a certain topic from a variety of directions, makes it possible to choose the most suitable path for studying. In addition, hypermedia systems offer individual learning paths that make the creation of knowledge an active and continuous process.

As far as collaborative learning is concerned, a number of studies have revealed the positive effects on individual learning brought about by the use of synchronous and asynchronous communication tools (Liao, 1995; Schreiber, 1998). The advantage lies in the possibility of accessing the experience of others and of collaborating with others in the creation of a shared product. An example is provided by the use of discussion lists in companies. The aim here is threefold: to create a repository of information and experience that is accessible on an international level (Kiesler, 1992); to permit employees to help one another; and to exchange experience (Rueda, 1992). A further example is provided by the ICONS project, which examined the role of network collaboration in improving individual learning in the field of international politics. In this project, students were linked up in a network in order to engage in political and diplomatic role-plays (Torney-Purta, 1996). The outcome of this study revealed that not only had the technological component driven mutuality and intersubjectivity within the groups, but had also fostered individual cognitive reconstruction of political concepts.

In line with this approach, we have focused our efforts on analysis of the potential that technology offers as a support for individual learning, concentrating on needs perception, identification of goals and choice of strategy. This has yielded a series of different products designed for different user groups. Table 2 shows the technology employed, the population it was tested on and the kind of use that proved most effective.

	Learners' personal activities	Learners' social activities	Population
Perception of need	Diagnostic systems	Diagnostic systems Microworlds Simulation environments	School teachers Company managers
Identifying the objective that will satisfy the need	Multimedia tools Web browsing	E-mail Discussion lists Collaborative Working Support Systems	School teachers School-leavers and the unemployed
Implementation of the strategy for reaching the objective	Multimedia tools Web browsing	Teleconferencing systems E-mail Discussion lists Chats	Company management and staff

Table 2. ICT systems in relation to conditions for individual learning and type of activity

Needs Perception

In the real world, learning needs are often perceived not at the point when they ought to be satisfied but further downstream. Diagnostic systems, microworlds and technology-based simulation systems can all be of enormous help in guiding the user to anticipate his/her needs, offering stimuli for in-depth study of problems and assistance in reflecting about them. Having the opportunity to work on a problem outside of its normal setting is crucial for understanding what individual needs are called for. Indeed, the complexity of the real context and the number of related facts to be taken into account result in urgency becoming the chief consideration rather than medium-term strategies. Let's look at two examples.

Example 1 – Quality standards in training

In order to stay competitive, companies need to keep informed about generally recognised quality standards. However, today this is not true in Italy's training sector, for a number of reasons: lack of legislation, dynamism of the market, the ready availability of public funding, and the dearth of assessment of results. Adjusting to quality standards is a slow process, and so training organisations need to tackle the problem right now.

These are the aims of *Certifying Training*, a system designed to help the managers of training organisations become aware of the need to raise quality in order to compete on the market. This system features a diagnostic module that measures the quality of the training on offer according to a number of parameters: internal structure of the organisation, type of competition and the quality standard gap. It has a library of hypermedia information that provides documents on various procedures, case studies, and orientation material. Measurement of the training organisation's performance against quality standards is done through a set of questions put to the user about the state of his/her organisation, the purpose being to get him/her to think about specific aspects calling for attention and thus about shortfalls to be addressed. The information library represents an initial tool for considering those shortfalls in detail.

Certifying Training is currently being tested in about a dozen training organisations located in regions throughout Italy. It is used both on an individual basis and in the context of collaborative situated learning (Mandl et al., 1996). The user can print out a report describing how the diagnosis was reached, and, by comparing the individual results of staff members from the same organisation, it is possible to outline collectively the steps needed to bring the training offered up to standard.

Example 2 – Teaching/learning processes

Another case where a training need is often perceived belatedly is in gearing courses to the needs of employers, both in terms of improving teaching processes and in strengthening ties with industry (Kommers et al., 1996; Blandow & Dyrenfurth, 1994). This aspect has taken on special importance with the shift in Italy towards greater autonomy for individual schools, together with the drop in overall student numbers. Nevertheless, there is very little awareness of the problem within the education field, a sector that has traditionally operated on an isolated basis in the belief that schooling is an end in itself.

To our way of thinking, two types of technology-based tool are particularly useful for getting the teacher to recognise the need to adjust his/her teaching approach: 1) interactive learning environments; and 2) simulation systems.

Interactive learning environments allow different representations of the same situation and serve a twofold purpose: to improve student learning and to explore firsthand a number of different teaching/learning approaches, testing learning theories and uncovering new problems for investigation (Glaser et al., 1996). In this sense, interactive learning environments can represent the focus for training activities designed to stimulate teachers to update their practice. This is done by confronting them with new issues regarding their role, class dynamics, conceptions about the subject matter being studied, and learning difficulties, so that they are led indirectly to reflect about their individual behaviour in relation to these areas.

A noteworthy example of such environments is provided by courses based on the microworlds concept and its exemplification. These courses have led many teachers to think about learning difficulties and the need to try out new forms of teaching. In line with this approach, we have produced numerous courses for in-service teacher training that focus on teaching/learning issues through the adoption of microworlds (Bottino et al., 1998). One

example examined in these courses is *Enigma*, a system in which arithmetic problems presented in the form of solo-player games can be solved through analogy and difference or through rules of deduction (Forcheri et al., 1997). The system raised interesting discussions about cognitive issues in arithmetic and about possible teaching approaches that combine the operative with the hypothetical-deductive.

Simulation systems are used in the real world for a number of reasons: to avoid danger, save time and money, devise and compare different scenarios, and so on. Such systems provide an opportunity for teachers to reflect about how the knowledge imparted will be put into practice, stimulating them to gear their teaching to real needs. In this light, we have developed a simple simulation that presents a range of scenarios in the field of economics. These scenarios consist of tables of values that present economic situations obtained from a model by changing the values of the parameters. Each model consists of a series of variables, which may be connected by some mathematical law. Upon user request, one or more scenarios relating to the model can be activated. During our training courses we built up a set of activities based on this system (Forcheri et al., 1997). These have proved to be particularly effective in helping teachers to build a link in their class-work between concepts and real-world applications, and in leading them to closer study of how situated learning theories might be applied in their work.

Identifying the objective (means)

In traditional education, the learner is rarely involved in the choice of the objective for satisfying the learning need, and this is one of the main factors behind the failure of many training programmes. ICT changes all this, helping people to perform both individual and social activities designed to control the objective through which the learning need may be satisfied.

In terms of personal activity, what comes to mind here are multimedia systems for self-learning, which make it possible to set the objective in a top-down manner: beginning with a very wide view of an issue, examining various facets separately, and concentrating on those deemed to be of special interest so that one particular aspect is singled out. Self-learning systems can be greatly enhanced when used in tandem with web browsing. If carried out with a clear target in mind, web browsing develops the fundamental skills of learning to find and recognise sources of information, critically analysing and comparing them, and choosing those that are relevant to the problem at hand.

As far as social activities are concerned, the importance of ICT lies in the greater possibilities for communication offered by the network, both in terms of the number of interlocutors available and the different types of communication available. As online discussion develops, it naturally brings about interactive formation of shared objectives. The possibility of studying the experience of others and of comparing it with one's own helps to clarify personal objectives and may result in their reformulation as new elements that were not initially considered are encompassed.

Let's take a look at two examples.

Example 3 – Work Orientation

The dearth of work orientation information provided by schools means that school-leavers in search of their first job often find themselves at a total loss. In today's tight job market, young people are forced to disregard their skills and interests when looking for employment, thus increasing their frustration and further limiting their chances of success.

It is with these ideas in mind that we have developed *Looking for Work*, a self-learning tool designed to guide young job seekers. Job hunting is an activity that requires personal initiative and capabilities like setting objectives, deciding strategies, looking for useful information, and so on – qualities typical of individual learning. The tool helps the user to identify the kind of job that suits his/her personality best by describing various forms of employment, related legislation, the aptitudes required, and so on. It also encourages users to draw on the experience of others in order to clarify personal objectives. This is done by granting access to external information sources like employment agencies, employers' organisations and unions, databases, etc. Experimental uses of the tool have produced very promising results: when asking for further help from those in the work orientation sector, users are submitting plans on how to move and are aware of their personal needs. In

the light of its success, the tool can now be consulted in numerous public institutions in Italy (Forcheri et al., 1997).

An example of the system interface is shown in Figure 1. The example shows the initial indications the system gives the user in order to help highlight his needs (a preliminary experience aimed at job creation, a job with limited time demand, further training, a job that help build experience, any job at all, an interesting job). Further indications regarding a specific need can be obtained by selecting the corresponding expression (underlined).

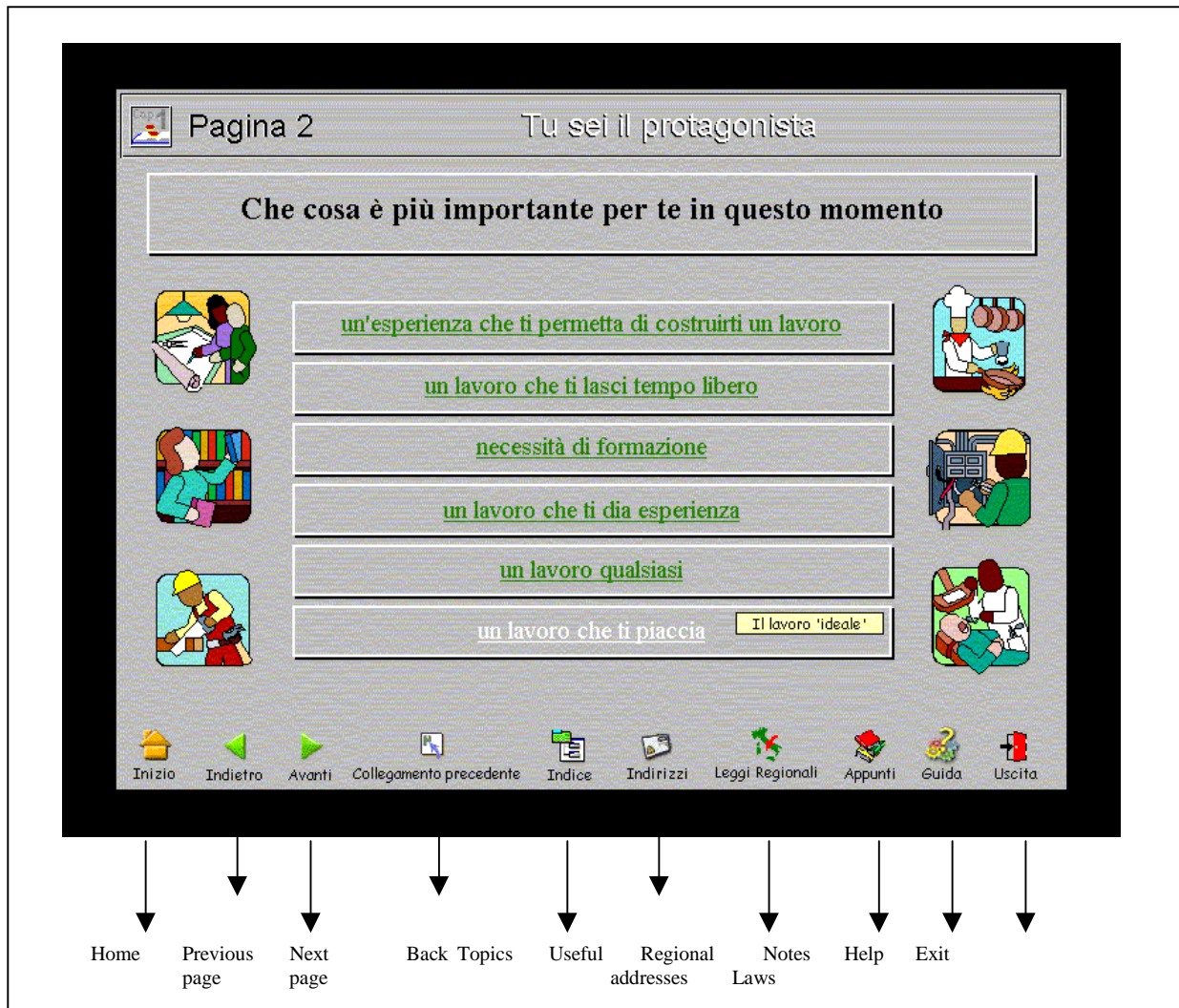


Figure 1. An example of the interface of Looking for Work

Example 4 – Spontaneous group formation

There is a whole host of didactic programs underway in Italy at various school levels and with a variety of objectives. In many cases, however, it is difficult for teachers to get access to the results of projects engaged in by others because information about them is circulated within a restricted community.

Collaborative environments permitting the sharing of information about didactic programmes and their re-elaboration provide the ideal answer to this problem. One such example is *Copernico*, a nationwide project for in-service teacher training that draws on local theme-based networks. The local network in the Genoa area created a Computer Mediated Communication (CMC) environment where teachers store their experiences, provide comments and observations on those of others, form workgroups to discuss those experiences, and so on. The learning path through the environment demonstrates the gradual passage that both the groups of learners and the collaborative objects follow as they emerge from the blur and acquire ever greater clarity and articulation (Chiappini et al., in press).

Implementation of the strategy for reaching the objective

Different strategies can be applied to reach an objective. To be effective, however, they must be guided by individual perception of the objective and be suited to the individual's knowledge; they must take into consideration the context in which the objective is to be reached and must stimulate self-regulation.

ICT offers support in a number of ways when users are choosing a strategy that suits them: by making available a range of vastly different tools that can be used in the same environment; and by allowing the adoption of different approaches to the same topic using a single tool.

The tools in the former case cover a wide spectrum. This ranges at one end from educational planning environments that adopt a systematic and controlled approach in order to lighten the learner's burden and provide rapid feedback, to environments for knowledge organisation and representation that call on the user to take total control of resources. Some tools offer an individual pathway to knowledge building, others foster social interaction so as to develop collaborative learning, while still others combine both of these approaches.

As to the multi-use tools, some of these feature multiple, inter-linked representations of the same knowledge, others combine computer activities with hands-on experiments and observation, while still others allow the adoption of different learning strategies (problem solving, generalisation, etc) in accordance with the path, learning period and level of study that the user sets. Let's look at two examples.

Example 5 – Office Automation

The office automation training that company staff receive in Italy usually focuses on technical explanation of systems, rather than demonstrating through practical examples the impact these systems may have on the way everyday tasks are carried out. What's more, training rarely takes into account personal aspects like technophobia, fear of being shown up in front of colleagues, and lack of technical background. This decontextualisation of training and disregard for individual needs is behind the failure of many a training program.

Taking these ideas as a starting point, we have developed a package of multimedia material called *CBT – Office Automation*. This is an introduction to office automation concepts and tools based on typical office problems. The material allows the user to adopt different learning strategies, such as learning through examples, problems, theoretical explanations or self-evaluation, according to the length and level of study that the user chooses. In addition, learning is contextualised because the contents are learned by applying them in order to solve real problems.

Furthermore, the material can be exploited in two different ways. On the one hand it can be used autonomously for studying concepts, learning to tackle problems individually or for formulating hypotheses and verifying them. On the other it can be used within a distance learning context in a twofold manner: to encourage the construction of knowledge through group work and comparison of different problem-solving strategies; and to analyse the various facets of a single concept in order to build up a comprehensive global image of that concept.

The material was developed within the Qualification 2000 project, part of the EC's ADAPT initiative. It was tested on a sample group of companies in Liguria, yielding very good results in terms of both the learning of the topic and the awareness of the difficulties underlying such learning (Forcheri et al., 1998).

An example referring to the application of data base concepts is shown in Figure 2. This introduction comprises: a textual explanation (left-hand part of the screen) and an operative illustration of the text (right-hand part of the screen). Further explanations on the same page can be obtained by clicking the coloured words. To solve an exercise referring to the topic at hand the user has to clicking the PROVA button. Pressing the DEMO button, the user can see the solution to the same exercise.

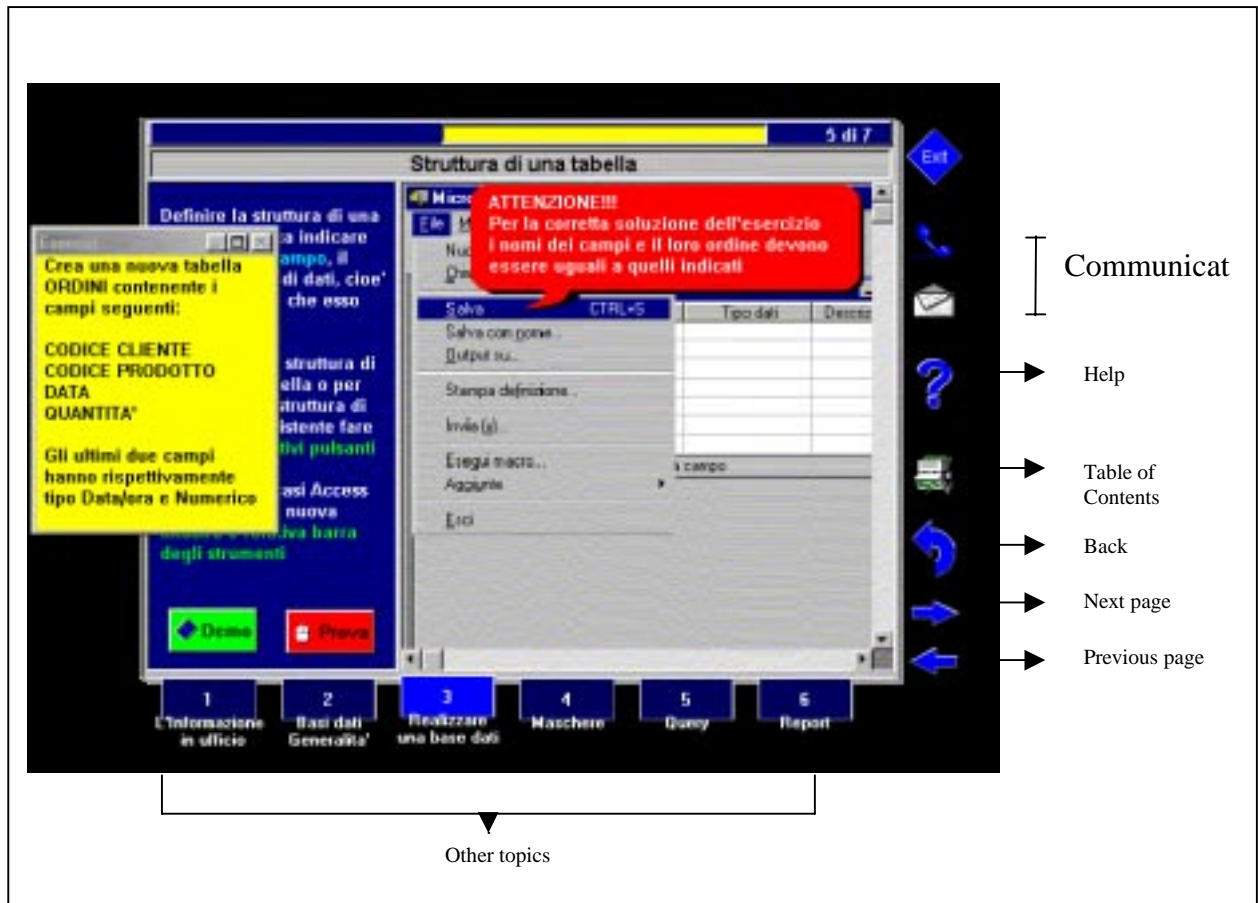


Figure 2. An example of the interface of CBT – Office Automation

Example 6 – Upgrading the quality of teaching

Initial attempts to bring innovation to Italian schools through the use of new technology largely failed because the strategy adopted for achieving the goal was unsuitable. Early efforts were confined to providing hardware and software tools, overlooking the need to help teachers adopt the pedagogical and epistemological tools needed to make the technology effective. This is especially true in science subjects like mathematics, where the computer is a natural working tool.

With these ideas in mind, we recently participated in a project run by the Italian Ministry of Education for the design and production of a multimedia system for the self-training of mathematics teachers. The system analyses the conceptual difficulties involved in several mathematical topics, proposes keys for interpreting those problems and suggests questions to examine when designing activities to overcome them. The problem of comparing the different interpretations, answering the questions, and relating the activities to classroom teaching is left to the teacher. The system was tested with about forty teachers in various regions of Italy: the results were encouraging in that teachers demonstrated particular interest in studying tools aimed at stimulating autonomous reflection on the teaching process, as opposed simply to receiving teaching models (Arezzo et al., 1998).

Conclusive Remarks

Research into educational use of ICT has made an enormous contribution to improving education and to the development of learning theories.

It should be pointed out, however, that for the most part this research concerns the use of ICT tools in supporting teaching/learning processes, rather than as a support for learning how to learn. Individual learning issues involve a shift in focus towards the latter, and in particular call for research efforts to be directed towards reviewing the results obtained so far. This will allow us to understand the features that these systems need in order to help people:

- perceive the need for learning, i.e. become aware of the knowledge already possessed, understand the gap between what is already known and what should be known, and understand the level of mastery they have reached in a topic;
- set the objective for satisfying that need, i.e. make independent decisions about learning;
- identify the strategy for reaching the objective, i.e. systematically widen the range of application of knowledge by dealing with the same subject matter at different times, in different contexts, and for different purposes.

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