Available online at www.sciencedirect.com

SCIENCE DIRECT®

Journal of Visual Languages and Computing
15 (2004) 333–345

Journal of
Visual Languages
& Computing

www.elsevier.com/locate/jvlc

Perspectives and challenges in e-learning: towards natural interaction paradigms

Virginio Cantoni*, Massimo Cellario, Marco Porta

Dipartimento di Informatica e Sistemistica, Università di Pavia, Via A. Ferrata, 1, 27100, Pavia, Italy

Received 16 March 2003; received in revised form 16 September 2003; accepted 16 October 2003

Abstract

The role of Information and Communication Technologies (ICTs) in educational development has been world-wide recognized as a priority in order "to reinforce academic development, to widen access, to attain universal scope and to extend knowledge, as well as to facilitate education throughout life" (Council of Ministers of Education, Canada, Report of the Canadian Delegation to the UNESCO World Conference on Higher Education, Paris, October 5–9, 1998. http://www.cmec.ca/international/unesco WCHE98report.en.pdf). As a consequence, developments in ICTs have had a significant impact on conventional higher education, as the university of the 21st century takes shape. By analyzing traditional learning models as opposed to new e-learning paradigms, this paper provides a global overview on future learning systems, from both technology- and user-centered perspectives. In particular, the visual component of the e-learning experience is emphasized as a significant feature for effective content development and delivery, while the adoption of new interaction paradigms based on multi-dimensional metaphors and perceptive interfaces is presented as a promising direction towards more natural and effective learning experiences.

1. Introduction

Technological advances offer new paradigms for university training. In particular, multimediality has strengthened the distance learning approach, insomuch that, in a first phase, a clear dichotomy has emerged between the traditional in-presence

*Corresponding author.
E-mail address: virginio.cantoni@unipv.it (V. Cantoni).

1045-926X/$ - see front matter
doi:10.1016/j.jvlc.2003.10.002

modality and the more aloof distance modality. With effective metaphors, the terms "brick university" and "click university" have been used to indicate this separation.

Initially, the two paradigms were presented with opposed traits:

(i) while the in-presence modality is characterized by the class (often active in full-time), the distance modality is personalized for the student;
(ii) while the first is centered on the teacher, who chooses topics and operational rules, the second is focused on the student and is directly controlled by him or her;
(iii) while the first has predefined schedules and time extents, the second occurs only when required and has the strictly necessary duration;
(iv) while the first may make use of technology on the basis of the teacher's competence, the second is conveyed by means of technology on the basis of the student's acquired knowledge, through a "query and discovery" process;
(v) in synthesis, while the student plays a reactive role in the in-presence paradigm, he or she assumes a proactive role in the distance modality.

The traditional university, as an institution offering on-site courses, needs to recognize the opportunities (and risks) being offered by new technologies, to maintain its prestigious position. The challenge is to rethink their higher education environment in the light of new technologies in order to meet the challenges of a global context [1]. For this reason, several countries are promoting technological development measures for education policy, either from government or from university associations. This implies the establishment of strategic lines for the development of a more open education.

2. The e-learning evolution

After a first period in which several only-virtual universities were created (e.g. the British Open University, the Globewide Network Academy in Denmark, the World Lecture Hall of the University of Texas, the Athena University, etc.), some prestigious institutions have joined their efforts to build non-profit alliances aimed at creating distance-learning programs. A significant example is represented by the agreement among the Universities of Stanford, Princeton, Yale and Oxford, in October 2000. Subsequently, on-line education entrepreneurs and for-profit associations, with or without traditional university partners, have appeared: today, there are more than 700 university institutions of this kind (with initiatives distributed in all the continents), as well as more than 2000 corporate Universities. At the end of April 2001, the MIT announced that, within a 10 year program, its almost 2000 courses will be put on-line, available for free to everybody.

In addition, technological advances have increased permanent education demands, which are becoming more and more widespread, eventually leading to permanent links between institutions and their graduates. In fact, life cycles of new technologies not only require new teaching paradigms, but also recurrent updating of courses. According to Christopher Galvin, President and CEO of Motorola, "Motorola no longer wants to hire engineers with a four year degree. Instead, we want our employees to have a 40 year degree". Thus, besides institutions providing certified courses with a final diploma, there are a growing number of university consortia, organizations, publishers and industries aimed at developing and distributing on-line permanent instruction programs.

This lays the foundations for the development of open higher education, its main objective being the development of human resources in the new technology age. However, beyond the adoption of institutional measures for the technological development of education, the expansion of open universities (some of which have already become macro universities capable of overshadowing the classical university model) has already begun to transform the traditional university, while at the same time increasing the diversification and development of higher education models, such as postgraduate courses, masters degrees, vocational training and skills recycling.

The activity of the Information Technology industry in the multimedia instructional sector has been very intense in the last few years. Currently, on the market, more than 100 different Learning Management Systems administer libraries for course storage and production, provide related information, and control course distribution and student interactive access. Like for all technologies approaching maturity, standardization activity is very intense in this phase to assure interoperability and ease of update and reuse of multimedia instructional products.

Major changes are then taking place also in classical higher education institutions and universities, owing to the impact of new technologies and on the basis of the newcomers in the field. Universities have become pioneers in adapting to this new reality through the introduction of new technologies as a complement to on-site courses.

In Europe, in particular, the use of e-learning for enhancing quality and improving accessibility to education and training is generally seen as one of the keystones for building the European knowledge society [2]. At the Member State level, most countries have their own Action Plan for encouraging the use of ICT in education and training, often involving direct support for local e-learning pilot projects in schools and higher education.

Compared to the USA approach, Europe is following different paths in a few directions: greater government involvement, more emphasis on creative and immersive approaches to learning, more blending of e-learning with other forms, a greater use of learning communities (mainly in southern Europe), and a strong emphasis on simulation and mobile communications (in Scandinavia, in particular).

E-learning standards are recognized as being useful, even essential, to encourage the reuse and interoperability of learning materials. It is therefore essential to sustain the exchange of experience within Europe on the use of ICT for learning and to develop a common understanding of what is good or *Best Practice*.

European institutions believe that effective e-learning standards can only be established as the result of a profitable collaboration among different entities, operating in different contexts, with different objectives. Only by sharing problems, solutions, and evaluations of various outcomes, the real essence of potential drawbacks and advantages can be assessed.

3. Advantages and disadvantages of e-learning

As anticipated, e-learning differs from classroom-based training in many ways. Therefore, converting a traditional course to e-learning may represent a complex endeavor, and as such it requires accurate planning, monitoring and control, to make the conversion effective and economical. In the first place, unless the advantages of e-learning outnumber the disadvantages for both the educational institution and the learners, converting to e-learning may not represent an efficient solution.

Among the several benefits of e-learning, we can list the following: it is usually less expensive to deliver, it is self-paced (usually, e-learning courses can be taken when they are necessary), it is faster (learners can skip material they already know), it provides consistent content (while in traditional learning different teachers may teach different material about the same subject), it works from anywhere and any time (e-learners can take training sessions when they want), it can be updated easily and quickly (online e-learning sessions are especially easy to keep up-to-date because the updated materials are simply uploaded to a server), it can lead to an increased retention and a stronger grasp on the subject (because of the many elements that are combined in e-learning to reinforce the message, such as video, audio, quizzes, interaction, etc.), it can be easily managed for large groups of students.

E-learning can improve retention by varying the types of content (images, sounds and text work together), creating interaction that engages the attention (games, quizzes, etc.), providing immediate feedback, encouraging interaction with other e-learners and e-instructors (chat rooms, discussion boards, instant messaging and e-mail all offer effective interaction for e-learners).

Moreover, since they can customize the learning material to their own needs, students have more control over the learning process and have the possibility to better understand the material, leading to a faster learning curve, compared to instructor-led training. The delivery of content in smaller units may contribute further to a more lasting learning effect.

Students taking an online course may have the opportunity to enter a risk-free simulation environment in which they can make mistakes without directly exposing themselves, eventually receiving feedback on the consequences of their actions. This characteristic is particularly valuable when trying to learn soft skills, such as leadership and decision-making.

On the other hand, disadvantages and risks of e-learning may include the following: it may cost more to develop, it requires new skills in content producers, and still has to clearly demonstrate a return on investment. Additionally, related technology may be intimidating, confusing or simply frustrating, lacking part of the informal social interaction and face-to-face contact of traditional classroom training. Enabling technology might also be costly, especially in case of advanced visually-rich content. Moreover, e-learning requires more responsibility and self-discipline for the learner to keep up with a more free and unconstrained learning process and schedule.

Evidently, the advantages and disadvantages described above are not necessarily inevitable. With careful development and good design most of the disadvantages can be overcome, while without accurate and informed instructional design none of the advantages might be achieved.

4. Instructional design

The technological revolution taking place in higher education is changing the classical models of on-site training and education. Educators cannot underestimate the potential of information technologies when giving classes, students need to learn new technologies and acquire knowledge management skills, understanding where to find relevant information rather than accumulating notions. Additionally, universities, as institutions offering on-site courses, need to know how to make the most out of the opportunities being offered by new technologies, in order to broaden their market on the basis of this new provision.

In e-learning, the teacher plays a new, different role. While devising a course, teachers become designers of experiences, processes and contexts for the learning activity: besides identifying the contents, they have to focus on motivations and active learning processes. Instructional design (ID) is critically important for e-learning. In the traditional classroom, much of the ID is implicit in the experience and wisdom of the instructor, while in virtual e-learning classrooms the ID must be explicit in the selection, sequencing and creation of learning experiences. Therefore, not only analytic and rational know-how are basic requirements in a teacher's methodology, but creative abilities and psychological sensitivity become essential skills to design engaging and effective e-courses.

Even more important are the strategies for teaching at a distance. In few words, we can summarize the differences as follows:

- Classroom teachers rely on a number of visual and unobtrusive cues from their students. A quick glance, for example, reveals who is taking notes, pondering a difficult concept, or preparing to make a comment. The student who is confused, tired, or bored is equally evident. The attentive teacher receives and analyzes these visual cues and adjusts the delivery to meet the needs of the class during the lesson.
- The distant teacher has no visual cues: without the use of a real-time visual medium the teacher receives no visual information from the distant sites. In any case, even if accessible, these cues are filtered by technology and it may be difficult to carry on a teacher–class discussion effectively when spontaneity is altered by technical requirements and distance. The teacher might never really know, for example, if students are paying attention or even talking

among themselves in the room. Separation by distance also affects the class environment: living in different communities deprives the teacher and students of a common community link.

Therefore, even with on-site teaching, but in deep way in the distant case, during the course teachers are engaged as mentors in motivating students, in highlighting pros and cons and in detecting the causes of failure.

The most advanced multimedia technology is not the one that artificially replaces reality or intelligence, but rather the one that increases our skills, adapting itself to the context and evolving while being used. Technology must fit the user, not the contrary: it is really effective when it is ergonomic, intuitive and transparent. By paraphrasing Wayne Hodgins, for multimedial teaching to be really efficient and effective it is necessary to choose "just the right *content*, just the right *person*, at just the right *time*, on just the right *device*, in just the right *context*, and just the right *way*.

Even if the so-called "digital divide" problem (that is the marginalization of computer science illiterates) is not as strong as it was in the past (especially in the young generations), there are still many people who have not approached the new potentialities of technology and remain in the "cybercave" where they can see only the shadows of technology. Even those who are completely tempted by the "hi-tech" can make a big mistake by forcing contents on technology: true effectiveness is only obtained by adapting technology to contents.

5. The visual component in the e-learning experience

Nowadays, it is a fact that using a computer more and more often implies interacting with some kind of visual formalism. Practically, any application has a graphic interface, in which the various operations necessary to interact with it are achieved by pressing buttons, selecting items from menus, manipulating icons, etc. This is the result of a continuing process starting with the birth of computer science and destined to lead human–computer interaction towards models which are ever closer to the user and his or her way of conceiving data exchange with the machine. Now, direct manipulation paradigms typical of iconic interfaces have become natural even for children, and interaction mechanisms based on the use of mouse and direct access to information have found in the World Wide Web a breeding ground for new communication opportunities.

While, on the one hand, the general problems of designing integrated multimodal systems are not yet completely understood, much effort is still necessary to optimize the use of single modalities. For example, although graphics has revolutionized the way people work with computers, allowing the old, rigid, text-based forms of interaction to be turned into more natural models, in e-learning interfaces its potential has not yet been fully exploited, above all in terms of the meaning (semantic content) of graphic elements and their combination.

It is indisputable that, for certain applications, interacting with objects placed in a two-dimensional space may be extremely worthwhile [3]. Graphic elements, in fact, have the advantage of being characterized by shape, dimension, position and possibly color, all attributes which may help better understand the meaning of what is displayed on the screen.

The term ‘‘visual e-learning’’ is generally used to indicate e-learning systems which exploit the two- or three-dimensional visual potentials in some way (typically by means of graphic representations, animations and videos). Visual e-learning includes many applications and processes: from Web broadcasts and self-paced computer-based training to virtual classrooms with instructor-led courses [4]. Among the most effective e-learning approaches are those exploiting streaming video, rich visualization and interactivity to deliver the training experience to the user's machine. Through visual e-learning it becomes possible to deliver clearer and more engaging training, which is more likely to be understood and remembered (especially in case of complex topics). Visual technologies may place heavy demands on PC performance, and therefore the best results can be only obtained with last-generation powerful machines.

Of course, people rarely learn in exactly the same way. They also may vary in their attitudes and abilities from day to day, or even from moment to moment. Designers often oversimplify their approach, referring to the ‘‘learner’’, implying that all learners are clone-like copies of an ideal model. But learning styles, abilities, and preferences may vary considerably. Some learners are primarily verbal while others are highly visual.

Some theories identify different key aspects through which people think and learn.

For instance, Howard Gardner, in his book ‘‘Frames of Mind’’ [5], identifies seven ‘‘intelligences’’ which guide and influence different learning styles: linguistic, logical-mathematical, spatial, bodily-kinesthetic, interpersonal, intrapersonal, and musical. Other researchers underline differences in how people assemble new knowledge (e.g. bottom–up vs. top–down approaches, abstractions vs. exemplification, freedom vs. guidance). In addition, designers should always be aware of differences in language capabilities, physical abilities, and technological skills.

From an overall sensory perspective, different theories have demonstrated that people tend to learn predominantly through one of their senses, i.e. auditory, visual or tactile. Learning styles are therefore characterized as sets of conditions under which learners prefer to work, and are commonly divided into these three main categories: visual (for those who learn best by seeing images or reading text), auditory (for those who prefer hearing or listening), and kinesthetic (for those who learn best by doing).

Nonetheless, research suggests that what is presented graphically in a virtual lesson is almost always more easily remembered, regardless of the user's preferred learning style.

Also the way information is arranged in ‘‘presentation pages’’ (i.e. its layout) can considerably influence student behavior [6]. Evidently, people learn more from what they notice than from what they ignore or are unaware of. Attention is an essential aspect in the learning process. Attention can improve learning, while distractions can interfere with learning, drawing essential resources away from the material being taught and therefore hindering learning itself.

There are various elements of visual layout which are worth distinguishing when considering student effectiveness: particularly significant is the cognitive efficiency of static displays and the way visual cues can be exploited to extract valuable task information. Navigational cues are one main example, providing information about what is outside one's immediate view scope. Whether we are aware of it or not, we rely on such cues to enrich the interaction with our environments. The way documents are laid out visually can have a significant effect on the ease with which we make these decisions, and also on the effort we need to spend to extract deeper meaning from presentations. The main goal of designers of e-learning systems should be to understand the principles which cause cognitive effort and decision making, and incorporate them into the learning environments.

It is indubitable that for an effective learning experience the learners are required to think deeply, as shallow thinking may lead only to shallow learning. On the other hand, instructional designers need to remember that human information-processing resources are finite. And limitations in our capabilities and endurance affect our ability to acquire knowledge.

In particular, perception, memory, and attention limitations are well documented (e.g., visual perception is limited to six or seven items, as is working memory), suggesting that human beings are able to process only a relatively small amount of information at a time.

Yet, not only instructional designers are required to reduce information overload, but they also should be aware of the subtle connections between teaching methodologies and the stages in the learning process, trying to explicitly embed design adaptation in relation with the actual learning outcomes. In particular, the degree of freedom vs. guidance in the user's interactive experience needs to be tuned according to the user's actual status in the learning process, to make sure that the learner is having an active and rewarding experience towards the intended system learning goals, without the possible frustration of an entirely passive and guided teaching module, but also without the possible failure of an entirely interactive and unconstrained module.

As an example, the temporal evolution of a single virtual class may be directly linked with the degree of freedom in the teaching/learning methodology: that is, a *passive* introduction may help the student to acquire the key concept effectively and efficiently (e.g. watching a movie, listening to a lecture); an *interactive-constrained* explanation may then introduce further details, leaving the student free to learn by doing, observing, and reasoning, but allowing some degree of structured control, to make sure that the conclusion is not missed (e.g. moving through a structured game, playing simulations with limited variables); an *interactive-unconstrained* module may then leave the learner to freely explore and discover additional knowledge, once the essential core has been acquired (e.g. exploring an environment, browsing the Web or an encyclopedia); some unguided observations and explorations may also be considered to preliminarily catch the attention at the beginning of the class (e.g. particularly effective in Physics classes).

6. Usability issues

Of course, when interacting with e-learning systems usability issues become essential. Positive experiences with learning tools strongly depend on the global learning system being usable: when someone has a negative experience with a specific tool, that negative experience is very often associated with e-learning per se. And often misunderstandings, biases, and prejudices prevent people from achieving their goals in their future experiences.

Therefore, an e-learning platform which sets itself the target of being successful cannot neglect usability issues (which, in this case, become *learnability* issues). To be successful means to succeed in "attracting" (and "retaining") users, and this is strictly connected to the ease with which they can benefit from virtual lessons. We must not forget that many of the people who will interact with e-learning systems in the near future, outside the academic circle, today have little experience (if any) in using the computer (e.g. in the case of continuous education courses). It is therefore imperative that the interaction with the "machine" be as "untraumatic" as possible. In e-learning, ignoring the emotional factors that come into play may lead to total failure.

7. Interaction perspectives in advanced e-learning systems

Nowadays, we are all accustomed to interacting with personal computers through graphic interfaces, by using keyboard and mouse as input tools. With few exceptions, nobody would accept to give up the convenience of this kind of visual interaction, which conceals the low-level machine-oriented aspects from us. However, we should not forget that current interfaces are the result of a continuous evolutionary process driven by the steady growth in the computational power of computers, which will surely continue for many years to come.

While at the outset of computer science, in the 1950s and 1960s, there was no real interaction paradigm, the "typewriter" model, introduced in the seventies, represented a big stride in the evolution towards computer "friendliness": communication with the machine now occurred through textual commands, by means of a keyboard. Then the 1980s saw the revolution destined to make the personal computer a household instrument accessible to non-experts and usable for many kinds of purposes. Such revolution, the so-called "desktop" paradigm, provides interaction through graphical user interfaces based on the WIMP (Windows, Icons, Menus and Pointing devices) paradigm.

However, although the WIMP paradigm has been very useful for providing a common face to computing, it will almost surely not scale to match all the uses of computers in the future, including e-learning purposes [7]. In this sense, we may expect that if the WIMP paradigm has characterized the last twenty years of human–computer interaction, the near future will be characterized by the "naturalness" paradigm, where the interaction with the computer will be able to exploit the perceptive abilities which so far have been a prerogative of human–human communication.

As a first step towards more natural interactive experiences, multimedia components such as audio and video are already being included in current design practice, going beyond the limits of static visual elements and therefore requiring additional studies, principles and guidelines beyond layout and legibility issues. Much effort is anyway still necessary to assess the effectiveness of different media and their integrated use in a virtual learning environment. Many guidelines are being collected directly from hyper-text studies and World Wide Web usability tests (e.g. design for scanning, avoid visual fatigue), but many results are expected from additional specific research and practice in real-world projects.

In perspective, future developments of natural interactivity paradigms will possibly include advanced *multi-dimensional interfaces* (able to provide 1D/2D/3D/*n*D interaction metaphors) and the so-called *perceptive interfaces* (able to acquire explicit and implicit information about users and the environment in which they operate, allowing the system to "see", "hear", etc.).

In the context of multi-dimensional interfaces, though research is already showing that a proper use of visual metaphors can impact a variety of computer-mediated experiences (learning and knowledge representation included), yet significant research efforts are needed to assess the value of different dimensional metaphors, their possible integration, and their individual and combined effect on learning outcomes.

In particular, 3D virtual artifacts (e.g. objects or environments) may provide a unique medium for *real* communication and interaction among people, beyond physical–geographical constraints and limitations. Active engagement with rich simulated worlds (i.e. artifacts) may help students understand and improve their memory-learning mental models: students may actively explore existing pre-built worlds (discovery learning) and build related internal models (constructivism), or actively create-modify worlds, to fully integrate their own models of the world (constructionism), while eventually sharing their evolving knowledge representations in a virtual collaborative environment.

In the context of perceptive interfaces, great steps forward have already been made in the speech recognition area, insomuch that very cheap software tools are now available which give excellent results. Vision-based user interfaces represent another important category of perceptive interfaces, exploiting cameras to sense the environment.

New e-learning interfaces based on head tracking, eye tracking and gesture recognition will be exploited to enhance the quality of interaction (e.g. by adapting the interface according to those elements which are the most looked at by the user, or by recognizing specific gestures and head movements as input commands, which would be especially useful for disabled users). Moreover, facial expression recognition may represent one of the most exciting research directions, towards more natural ways of interacting with the e-learning environment: by interpreting the user's emotional status, the system could change its behaviour accordingly. For instance, from the fact that the user is knitting the eyebrows the computer could infer that something is not clear and automatically open a help window. For example, a recent attempt at implementing a tutorial system of such a kind is represented by the work of Zhang et al. [8], in which the vision-based interface is able to recognize few basic frontal view facial expressions (then used to infer the degree of user understanding). Although finding the right connections between a perceived facial expression and its mental implications is a very delicate task—wrong interpretations may be highly negative to system friendliness—perceptual interface research should not neglect such an extremely human interaction aspect (especially important in case of high user emotional involvement, like in an e-learning interactive experience).

The program adopted by the e-learning research unit of Pavia University includes several activities, particularly focused on the definition of a common project methodology for modeling, classifying and archiving educational resources that guarantee an adequate level of interoperability and reusability. With an explicit reference to the SCORM standard, the focus will be on the analysis and development of multi-resolution mechanisms for managing data from the atomic level (of individual assets and 'learning objects') to the higher levels of 'semantic resolution', through the adoption of standards and tools for metadata description and packaging of learning objects.

The resulting process should be applied for both classification and retrieval, through the management of learning object metadata, as well as for generating new educational units, through the assessment of techniques for the aggregation and recombination of basic constituents in lower semantic levels, down to the atomic level of learning objects.

This hierarchical metaphor for knowledge management will be analyzed in order to develop a methodology, if not a theory, on the principles and procedures for the generative design of education units at the higher levels. Learning objects will be in fact the fundamental elements in the new overall learning model that originates from the object-oriented programming paradigm.

Following this approach, the efforts will also aim to the creation of basic components, i.e. actual learning objects, which will be reusable in many different contexts. In fact, the very notion of learning objects relies on this fundamental principle: when developing a new educational unit, the objective should be the construction of several basic components about the subject considered and these components should be reusable in other contexts and with different learning strategies.

A central institutional objective of the Pavia e-learning project is that of enlarging the basis of potential teachers by stimulating and promoting the adoption of the new activity, up to achieving course portfolios for the entire traditional university background that range from humanistic, to scientific, to all the applied sciences. Eventually, all the educational units will be accessible through the Internet, i.e. they will be edited and used by many users simultaneously.

It has to be remarked that the objective of the analysis and development presented is not that of achieving another 'Content Management System', but rather the definition of the guidelines for selecting the tools and educational resources that will eventually become the shared infrastructure.

Concurrently, in the Computer Vision Laboratory of the University of Pavia, a few research efforts are systematically exploring the potential of non-immersive virtual reality (VR) for education, as well obstacles to its use. These works are attempting to design, develop, and evaluate computer-supported virtual environments for collaborative learning, with a special focus on non-immersive VR tools for visually rich knowledge representation.

Learner-centered approaches to designing 2D/3D interactive artifacts are being assessed and controlled experiments in virtual and real classroom will be undertaken to evaluate trade-offs in VR-related variables, possibly including:

- dimensionality: 2D vs. 3D representations (i.e. complexity as potential vs. obstacle);
- interactivity: constrained vs. unconstrained artifact manipulation;
- time: static vs. dynamic temporal evolution;
- multi-sensorial capability (e.g. multi-media and perceptive extensions);
- distribution: single-user vs. multi-user (competition/collaboration).

Our current research is also active in the context of perceptive interfaces, with the specific focus on vision-based interaction paradigms for head tracking, gesture-driven input, and facial expression recognition.

8. Conclusions

After centuries of stable evolution, the academic system has entered a period of significant change, revolutionary in certain aspects. Market forces are increasingly interested in advanced education (mostly abroad, but recently in Italy as well), academic competition has increased and technology demonstrates a relevant innovative impact. Students are today more active and aware of technology capabilities, they are used to interaction and to plug-and-play experiences: they now constitute the digital generation and have easy access to the whole academic world (different universities are just a click away one from the other).

This phase of rapid transformation presents broad perspectives and novel opportunities, but many challenges and risks as well. It is primarily essential to develop change capabilities, to help our institutions react to the rapid change necessities required by society. Secondarily, actions are not simply extractable from even glorious tradition, but need to be examined in the wide field of different future perspectives.

References

[1] Council of Ministers of Education, Canada, Report of the Canadian Delegation to the UNESCO World Conference on Higher Education, Paris, October 5–9, 1998, http://www.cmec.ca/international/unesco/WCHE98report.en.pdf.

[2] Commission of the European Communities, eLearning: designing tomorrow's education, Interim Report (as requested by the Council Resolution of 13 July 2001), http://www.dapp.min-edu.pt/docs/eLearning_Report_Jan2002.html.

[3] J.H. Larkin, H.A. Simon, Why a diagram is (sometimes) worth ten thousand words, Cognitive Science 11 (1) (1987) 65–99.

[4] Intel, Visual Computing Enters the Business Mainstream. Intel White paper. http://www.intel.com/ebusiness/pdf/prod/desktop/p4p/wp013305.pdf.

[5] H. Gardner, Frames of Mind: The Theory of Multiple Intelligences, Basic Books, New York, 1993.

[6] D. Kirsh, E-learning, metacognition and visual design, International Conference on Advances in Infrastructure for e-Business, e-Education, e-Science, and e-Medicine on the Internet, L'Aquila, Italy, July 29–August 4, 2002.

[7] M. Turk, G. Robertson, Perceptual user interfaces, Communications of the ACM 43 (2000) 33–34.

[8] Y. Zhang, G. Silber, C. Kambhamettu, Facial expression driven tutorial system, Proceedings of the Sixth World Multiconference on Systemics, Cybernetics and Informatics, Vol. IX, Orlando, FL, July, 2002, pp. 287–292.