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E-learning + ITS + CBR + Simulation a new perspective of learning

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Summary

The paper shows how the integration of several technologies (CBR, ITS, E-learning and Simulation) results in a product that can bring new pedagogical horizons to academic or industrial fields.

Introduction

Education and professional training have been looking, for some time, for new pedagogical methods that aim a faster knowledge transmission and the improvement of student's global performance. In the purely educational field, failure indicators and a strong assiduity lack, clearly show that something has to be done. Besides that, the dynamic world resulting from globalization and information society, leaded to constant adaptation necessities in which retention and divulgation of know-how inside the organizations has emerged has a critical survival factor. However, this dissemination has considerable costs and results in productivity breaks due to the necessity of taking personnel away from its usual production place.

E-learning is sometimes pointed out as a miraculous solution for these problems. In fact there are many examples of success, such as Cisco Systems and DEIS – Dptº de Engª Informática e Sistemas of ISEC - Instituto Superior de Engenharia de Coimbra – that tried hybrid learning for some lectures [1], hoping to extend it to some others in a short time.

However and in our opinion, e-learning behaves in an excessively passive way, in the sense that it lets all the initiative to the student. So, in a great part, success or failure depends on the way it is used. We believe that, if it'll be possible to give it a more active and interactive role, as well as more real environments – let's say "virtual worlds" – then it'll be possible to achieve much more ambitious objectives. The following sections show how the integration of several technologies can contribute to the solution of this problem.

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E-learning: Model, Norms and Impact

E-learning, the most recent form of distance learning, essentially consists in the utilization of computer and Internet resources as a support to distance teaching. Synchronous sessions are provided, where students and tutor interact in real time using virtual classrooms; the trainee has also asynchronous sessions at his disposal, where he can use e-mail and forums, being free to access the web site at any moment [2] [3].

E-learning is quickly spreading all over the world, but especially in United States of America and Europe, where the EC – European Community - supports some research programs. In the United States, England and Australia, many universities offer graduations based on e-learning or incorporate it in the traditional courses. E-learning has been adopted by many important companies such as AT&T and Cisco Systems that, by means of the Cisco Networking Academy program, supports tens of thousands of students distributed over thousands of programs in many countries. In India, South Africa and China, e-learning is faced as a fundamental mean of population teaching. Figure 1 presents the estimated growth of e-learning in the United States according to the IDC – International Data Corporation [2].

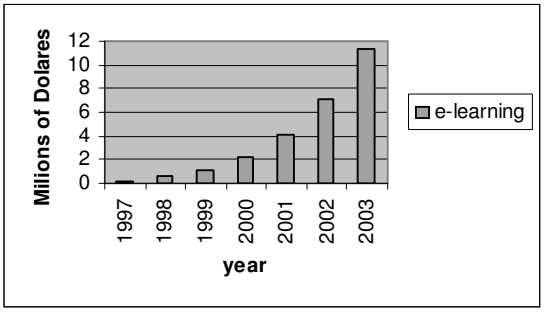

Figure 1- Growing of the *e-learning* in the United States (prediction 2003)

E-learning is basically composed of two pieces: the *contents*, as the name suggests, are the study elements on their own; the *platform* is the computer application that divulgates these contents and controls the training process. In terms of platforms we must emphasise, in Portugal, the role of PT Inovação that provides FORMARE [3]. Centra, founded in 1995 and based in Boston, is the world leader presenting its platform CentraOne. The contents naturally depend on the course being lectured. That's why they are generally developed by specialized partners or in cooperation with the entities that want to teach them. However, the development process takes long due to the level of detail needed and the means that must be used to capture the user's attention. For these reasons

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it's desirable that these contents be cross-platform. Many organizations have developed efforts to define standards (ARIADNE - *Alliance of Remote Instructional Authoring and Distribution Networks for Europe*; ISO - *International Organization for Standardization*; EdNA - *Education Network Australia*; IEEE, etc.). The SCORM - *Sharable Content Object Reference Model* – is a collection of technical specifications based on the work made by the AICC- *Aviation Industry Computer-Based Training Comittte-*, the IMS *Global Learning Consortium, Inc.*, the ARIADNE and the IEEE. It allows searching, import, share, reuse and export of contents in standard formats. To describe them, meta-data and XML are used.

From this analysis it can be concluded that actual e-learning platforms are similar to portals with authentication and a series of associated services (text and multimedia; information exchange; help; etc). However, all these "services" are part of an integrated environment, comfortable, accessible by the Internet. The knowledge is provided externally, not created nor captured by the system. The pedagogy is supposedly implied by the content but it's not found in the platform that has an essentially passive role leaving all the initiative to students and teachers.

Intelligent Tutoring Systems – ITS

ITS are computer based educational platforms which, given their nature, reach the ratio of 1 teacher to 1 student, ideal from the learning curve point of view.

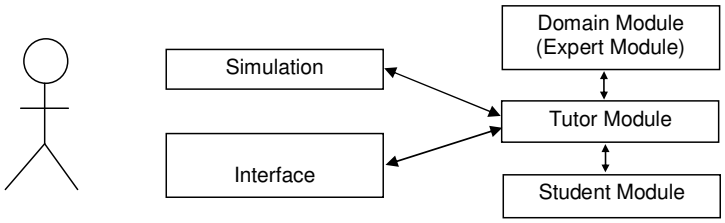

Figure 2- Generic Architecture of an ITS

They consist of computer applications that, making use of AI techniques, try to capture the student's profile, identify difficulties and mistakes, selecting contents, examples and problems according to this. ITS attempt to reproduce the traditional teacher in an environment that emulates a pedagogical attitude; and they may use, for example, multimedia and simulation tools. A CMU – Carnegie Mellon University – study reveals that, in a programming language competition, the students which learned using ITS obtained higher classifications, also solving more complex problems in less time. A comparative architectural and prototype

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study can be observed in [4]. Figure 2 shows the basic architecture of an ITS [5..9]:

The Domain Module stores the course contents and problem solving methods that can be represented by rules or by templates that contain correct action sequences. In this module resides the knowledge. The Student Module attempts to evaluate the acquired knowledge of the student, his difficulties and reasoning capabilities. It compares actions and options with those stored at the Domain Module. An ITS is capable of identifying difficulties as simple as the non-recognition of a carry in an addition, or as complex as a procedural error in a sequence of actions for regulating weapons in a navy vessel. In the later case the ITS may use a simulation tool. The Tutor Module decides, according to the performance of the student, the approach that should be followed in the presentation of a certain subject: for a beginner it can choose to show solved examples before presenting an unsolved example; some following questions can be increasingly complex; and it may allow the free exploration of a certain subject. This module contains pedagogy. The Interface Module may vary from simple dialog boxes to natural language and voice recognition.

In conclusion, the ITSs make use of sophisticated knowledge transmission mechanisms by means of Artificial Intelligence techniques, simulation and even virtual reality. However, since they are used locally, their capacity to spread knowledge is clearly below that of e-learning. The knowledge is previously embedded in documentation, examples, rules, action and templates. Their role can be active, guiding the trainee's actions. Briefly, ITSs give priority to quality, motivation and diversification, in detriment of quantity.

CBR – Case Base Reasoning

Information systems (ISs) and Expert System (ESs) based on the CBR paradigm, can be used as knowledge repositories and information, ready to be used or treated for posterior spreading. Their function, however, isn't that: they simply provide searches and elaborated reports (data warehouses in the case of IS and past occurrences in the case of CBR) lacking a specific way of knowledge transmission. They're able to capture information during its creation phase. CBR ESs are even able to create tacit knowledge by establishing complex relationships (cases) between the supported information and by generating new solutions by adaptation [10..14]. We may conclude that this type of ES is useful for supporting case studies that act as examples of the teaching subjects, what is pedagogically essential. However, all alone, they behave in a totally passive way.

E-learning+ITS+CBR+IS

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Table 1 resumes the most important characteristics of the models discussed in the previous sections.

	Knowledge					**Role in training**		**Pedagogy**	
	Creation	Capturation	Retention	Utilization	Spreading	Active	Passive	Present	Absent
E-learning			X	X (1)	X (2)		X		X
ITS			X	X	X (3)	X		X	
CBR	X	X	X	X	X (4)		X		X
IS		X	X	X	X (5)		X		X

Table 1 – Comparison of some characteristics of e-learning, ITS, ESs, CBR and ISs

(1) Only as support in knowledge spreading
(2) Large scale
(3) One to one basis
(4) Search form
(5) Searches, reports, data warehouses

As can be seen, in an educational and training context these models complete each other. In the authors' perspective, and limiting the integration process to the industrial maintenance field, CBR and maintenance management systems will play the role of occurrence and solution example providers, i.e., they may illustrate the organizational decision methods. Beyond this, the methodologies used in ITS today will allow these real situations to be proposed under the form of exercises, where inappropriate actions can evidence their consequences by means of simulation. The occurrences can range from a simple fault in equipment to changes in planning / production / maintenance caused by radical changes in provision chains or marketing strategies, in the dynamic scenario of nowadays. In this context, VRML – Virtual Reality Markup Language – is one resource to keep in mind: the trainee can situate himself inside the production line, interact with equipment, etc. directly confronting (although virtually, for his happiness) the results of less appropriate actions... The result of IS, CBR ES, ITS, e-learning, simulation and virtual reality integration in a single system dedicated to the education and training of industrial maintenance staff is MKM – Maintenance Knowledge Manager -, under development[15]. Just as e-learning provides courses while integrating services, MKM will provide experts by integrating systems. However, the extension of such model to virtually any field, is immediate.

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