Intelligent Information Technologies Used For E-Learning Systems

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Abstract: - Creating value people has become the primary objective of any learning systems. In reality, in the last time, this expression is hidden behind a lot of issues often overlooked. Using intelligent information technologies for e-learning systems we are building an information society, which can not be done without research and investment projects in education. Computers become more useful when artificial intelligence techniques are incorporated both in equipment and programs and the tasks are performed more effectively and at lower cost. Competence is the ultimate desire in Romanian higher education system and not even technologies or theories or other kind of approach will not eliminate /neglect professor-student relationship. In this paper, we will analyze the roles of intelligent information technologies used for higher education e-learning systems. Intelligent information technologies used for e-learning in Romanian higher education system are on stage of intensive development and probably each month, year and other period will bring new achievements in this field.

Key-Words: - e-learning systems, intelligent information technologies, higher education system, ICT technologies

1 Introduction

Assisted instructional intelligent systems had began to be notified when the limitations of classical education systems occurred. It was found that within CAI (Computer Aided Instruction)/ CAL (Computer Aided Learning) systems had remained unresolved a number of important issues, even when had been used the most advanced teaching methods or information technologies. Among the most difficult problems faced by developers of conventional education systems, we can mention: - issue of choosing the optimal instructional sequence for each user of the system. - dynamic change, depending on the evolution of user, the pedagogical strategies used by educational information system; - anticipating, diagnosing and understanding the cause of user errors; - acceptance of correct answers, but unexpected; - natural language dialogue with the user.

2 Assisted Instructional Intelligent Systems

Traditional educational systems have occurred and still occur, even if their limitations are sometimes evident. Because they prove efficiency in some instructional contexts, and other benefits (including achievement is noteworthy effort, somewhat less), conventional education systems have been abandoned in favor of the intelligent systems. It can be seen that, after years 70', the two types of educational systems have developed in parallel, each of it been designed for specific instructional requirements and needs. The first attempts to develop intelligent tutoring systems learning (educational systems which are using artificial intelligence techniques) are in the golden age of expert systems.

Being originally designed for main-frame computers or minicomputers, all these first instructional intelligent applications had two common features: a high computing power required and aims to imitate a human expert (teacher) rather than to model the instructional process according with student's
characteristics. These first assisted instructional intelligent systems are considered interesting primarily as practical applications of artificial intelligence, rather than educational systems of value. Theoretical developments for the AI-ED (Artificial Intelligence in Education) domain occurred later, when the failures and limitations of these systems have demonstrated that both teaching and learning are complex processes that are extremely difficult to model using artificial systems (even if they are smart!) without support of scientific fundamental theoretical models. Assisted instructional intelligent systems domain was designated by the terms of ICAI (Intelligent Computer Aided Instruction) or equivalent ICAL: Intelligent Computer Aided Learning) and IES (Intelligent Educational Systems). Note that all assisted instructional intelligent systems have in common a general model, a general structural model which was implemented (either fully or partially) in their internal architecture.

This structural model, described by the researchers Hartley and Sleeman since 1973, has the following architectural components:

- the knowledge domain (expert model or domain model), which is knowledge of the instructional domain that are embedded in the intelligent system;
- the student's knowledge (the student model), which represents all knowledge in the instructional domain that the intelligent instructional system assumes that the user possesses.

The previous structural model remained unchanged until the present and can be detected in nearly all assisted instructional intelligent systems, including the most modern type: autonomous pedagogical agent. Based on this common internal model had been built a whole variety of intelligent educational systems, used in various instructional contexts. The general characteristics of intelligent instructional systems are shown in the Table 1.

![Fig.1 The components of an intelligent educational system](image)

The components of an intelligent educational system

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If we analyze the developments in the last decade, it is difficult to make a clear distinction between classes of assisted instructional intelligent systems. However, we list the main categories of systems that populate at the moment, and we will mention the terminology used to describe them. The main classes (categories) of intelligent instructional systems, with their abbreviated names are as in figure 2.

- **ITS (Intelligent Tutoring Systems)**, intelligent tutorials;
- **ILE (Intelligent Learning Environments)**, intelligent media instructional, a subset of them are **microworlds**;
- **CSCL (Computer Supported Collaborative Learning)** and **CSCW (Computer Supported Collaborative Work)**, Intelligent learning environments for collaborative learning;
- **PAA (Pedagogical Autonomous Agents)**, autonomous pedagogical agents.

![Fig.2 Types of systems intelligent educational systems.](image)

3 **Intelligent Tutorial Systems**

The paradigm of intelligent systems tutorials that appeared in the '70s, had dominated the ICAI domain in '80-'90 decade. It is related to the strong development of knowledge-based systems, so-called "expert systems" in this decade. The idea that these systems were based on can be expressed as: a problem-solver expert system, equipped with an explicit knowledge base, could be used in another context than that for which it was built, namely in education at "novices" instructional.

If the addition of specialized modules may provide "transfer" of knowledge (and hence power) of a domain expert to novice, the system would get smart educational facets. This vision led to the construction of a typical architectural structure for intelligent tutorial systems. This structure consists of four macro-interrelated components:

- domain knowledge representation module, originally called "expert module", subsequently designated by the term "domain model";
- knowledge representation module about the user, called "student model";
- tutorial module or "teacher", which had kept the knowledge about the teacher's strategies;
- interface module, which was sometimes, is included in the tutorial module.

Design of the tutorial modules (indicating their functions and links between them) and their integration into an unified and coherent software architecture, involving, for soft makers, solving difficult problems. The ICAI domain is a very interesting field of Artificial Intelligence techniques as follows: knowledge representation, reasoning modeling, the acquisition of knowledge or human-machine communication. On the other hand, the problems faced tutorial systems designers led to the
development of ideas and showed that the ICAI is fundamentally an interdisciplinary field.

Intelligent tutorials design had began to be realized starting from the psycho-pedagogical theories of learning. Therefore, the functions of these systems will provide support for more complex and varied interactions, interactions that would favor (as psychological-pedagogical theories) the instructional process. New tutorials systems architecture will reflect these developments and, therefore, will include the following main components:

- an expert system that holds the knowledge of the domain knowledge;
- a pedagogical expert system, whose knowledge base contains instructional strategies and selection criteria; the mechanism of choice (selection) of a certain pedagogical strategies will be triggered in certain contexts, such as the evolution of student-system dialogue, the progress in solving a problem or user general evolution in the instructional process;
- an expert system for building user's cognitive profile, whose knowledge base contains a description of what "know" (or what "to know") the user and a representation of its evolution during the instructional process;
- an interface module and user-friendly dialog. A special attention was given to a student model (user model).

In an intelligent tutorial, the student model must contain a set of information - knowledge about the user, mainly on its knowledge level of domain (epistemic model) but also on its interactions with artificial tutor or the taken steps in assisted instruction. This information-knowledge is essential for dynamic adaptation and individualization of artificial tutor interventions in its interactions with the user. Based on pragmatic considerations, it have been developed several student models mostly based on user knowledge reporting to instructions domain knowledge which are contained in the expert module. These user models were subsequently used in other types of assisted instructional systems (Figure 3)

The overlay (subset) model is starting from the idea that the user holds some knowledge included in the expert's knowledge base; this method is called partial expertise and is based on user knowledge incompleteness. The user's knowledge level is usually considered on the basis of grades (numerical coefficients), which tries to express the relationship between what the user knows and what the expert knows. The student model tries to capture in this case the sum of correct knowledge (but incomplete) of the user and to adjust the instructional course to minimize the difference between the user knowledge and the system included knowledge. This model has the disadvantage that does not capture all user errors sources, errors which are always due to incomplete knowledge (partial) but also a incorrect knowledge of the notions, concepts, concepts or domain-specific regularities (misconception). The differential model (buggy model) tries to solve incorrect knowledge issue of the user, accounting it for the subsequent remedy. This incorrect knowledge is reported to general library errors (possible), the tutorial holds the specific pieces of knowledge which must be provided to the user in the case he made a specific error (which is stored in the library). In the case of tutorials which are using the student model, the loading of errors extensive libraries is a very laborious and expensive task. This model is based, as the overlay model, on the assumption that what the user knows is a subset of the knowledge domain which the expert holds. The disturbance model is the most sophisticated of the use of intelligent tutorials. In this case user knowledge and beliefs are not considered as a subset of expert knowledge. User knowledge is not included in the expert knowledge, but it is considered that it should have some knowledge that differ from those of the expert, but are essentially wrong.

The tutorial system will try to detect through inference the cause of these errors and, therefore, to deliver to user the correct pieces of knowledge which could lead to errors remedy. The disturbance model combines and extends the overlay and differential models, trying to carry out a more nuanced cognitive analysis of user error sources. An important issue that arises in the case of making of user held knowledge model is the system diagnosis in order to build effectively the model. Diagnostic methods used by different tutorials systems can be classified according to several criteria:

*After the time of diagnosis:*

- on-line, through user behavior detailed tracking in interactions with the educational system;
- off-line, diagnosis made after a full user working session with the system;

**Input information on which diagnosis is made, which can be:**
- results in performing a single exercise, keeping detailed track of reasoning followed by the user;
- user results after a series of tests;

**Output information to be obtained after the instructional process**
- what knowledge would have to acquire user
- the relation between the "student model" and the expert knowledge.

The most diagnostic methods are essentially based on comparing user behavior during a problem solving with that of ideal solver. This comparison is done in the case of intelligent tutorials through complex inference that attempts to estimate - to evaluate intentions, plans and motivations that lead the user to choose a specific route to solve. Another important aspect is also linked to on-line diagnosis. Although this is the most recommended method, it can not be made unless the system response times are acceptable. These response times are conditioned both hardware performance of the machine, and especially the complexity and depth of the inferences made by the tutorial system.

An interesting development of intelligent training systems can be observed during the last decade. Decade '90 - 2000 marked a new stage in the development of these systems: the emergence of high performance computing equipment and individual workstations, the rapid development of communication software and human-machine interfaces have led to increased growth of degree of user-system interaction. Following the idea that intelligent assisted instruction may also perform other than by solver of problems (systems in which user - machine interactions are limited only to the communication of data or results). Thus, it had began to impose highly interactive systems, to assist the user in problem solving, decision making and its guidance in building represented abstractly objects (forms). A new class of intelligent instructional systems had dominated the '90 decade: instructional intelligent environments.

## 4 Instructional Intelligent Environments

Instructional intelligent environments occurred when has outlining a new vision of learning. This vision proposes a constructivist approach to learning process, in which the learner had "built" cognitive structures through interaction with the working environment. The role of the learner is very important and the idea of transfer of knowledge from the system to the user (specific for intelligent tutorials systems) is confined to broader instructional objectives. In this respect, in a relatively autonomous use framework, to student is proposing new forms of interaction.

The term "intelligent environment for assisted instruction" refers often not only to the computer system itself, but has a broader sense, including all objects (physical or abstract) used in computer assisted instruction. An intelligent instructional environment could allow development of mentoring activities (problem solving or diagnostic), but typically performs simulation of technical devices function. This feature recommends instructional intelligent environments, especially for professional training or experimental sciences domain. Another approach, in which we are focusing on exploration and guided discovery, had led to the emergence of intelligent learning environments called "microworlds".

The "microworlds" environment provides an abstract space where the user can navigate and interact with objects, his actions are constantly monitored.

Intelligent system intervention occurs in a certain context and is carried out in order to achieve well-defined instructional objectives. It should be noted however, that not every "microworlds" system type fits within the class of intelligent instructional systems. There are at present many instructional responsive systems, very popular, that only execute the user commands, without incurring any control or tutorial intervention. The instructional systems have important formative valences and can not be included in instructional intelligent environments, because of the system lack of direct involvement in the instructional process. Instructional intelligent environments implement a great idea: the metaphor of "selfserving", in which the user is free to choose what he thinks it is necessary in instructional process. The experiments have shown that such a system is not appropriate in any instructional context and this instructional model is very useful when the learner is able to manage own the instructional process.

## 5 The Pedagogical Agents

The term "pedagogical agent" is used to describe intelligent agents, built for assist (facilitate) instructional human process. A definition that captures quite well the characteristics of an intelligent agent could be the one formulated by
Lieberman: "An intelligent agent is a user perceived program not as a tool, but as an assistant - collaborator which helps in achieving goals or carrying out specific activities".

The agent may have human intelligence associated characteristics as following: inference and learning ability, adaptability, independence, creativity. "Other authors define the "intelligent agent" term in the same way: a program that "is behaving" as a human being. In essence, both definitions emphasize the same point: the agent is a software product equipped with a social interface that allows it to act and converse like a human being.

Although there is no unanimity of views, the following features (Figure 4) have been proposed as characteristic of an intelligent agent:
- autonomy: an agent takes action and exercise control over its actions;
- temporal continuity: an agent is a process that there is always in a software environment for life and which is self-triggering in a certain context;
- personality: an agent has a well defined behavior, which gives it a personality and interact with human users;
- communication skills: an agent must be able to engage in information exchange with other agents (artificial or human) or to obtain the necessary information to perform a certain action;
- adaptability: an intelligent agent must adapt to changes in the environment in which they operate there, it should be able to change its behavior to suit the human user on the experience of interaction with it;
- mobility: an agent must be able to migrate from one computer system to another, even if they have different architectures and operating systems.

Fig 4. The features an intelligent agent

The pedagogical agents are a particular type of intelligent agents. They were developed from studies and experiments on expert systems tutorials. The pedagogical agents have brought a new perspective on the concept of mentoring and created important openings in ways that were less explored by tutorial expert systems. The moving from the intelligent tutor to pedagogical agents had began in the '90s, when some researchers, dissatisfied with the results until their times, had began to explore new types of interaction between the instructional system and the user.

In the next years, were investigated two main models of user-system interaction:
- the collaboration in a virtual environment populated by "artificial students"; real students could interact with "artificial students" for educational purposes.
- the competition between the student (students) and animated characters which inhabited a virtual environment.

Gradually, it was the idea of collaboration between human and artificial systems and such systems were the first systems which where simulating a companion work for the student. This "companion", which had a collegial behavior and act as a study personal assistant of the user was called "pedagogical agent".

6 Conclusion
The complexity of human learning had often raised difficulties that seemed insurmountable to the learning intelligent systems researchers and creators.
After three decades from the first intelligent educational system elaboration, the increasingly positive outcomes encourage researcher's scientific approach. Perhaps the moment in which the artificial tutor will behave and act (almost) as (intelligent) as human teacher is not so distant as to appear early at the beginning of this difficult developments. In parallel with software systems designed to assist learning process, it had been developed a variety of adjacent methodologies, based on information technology and designed to achieve instructional objectives.

The pace of life in modern society, where knowledge and information are absolutely necessary for social and personal fulfillment of human being, with globalization of communications, has led to new educational trends: e-learning and educational process led by computer techniques. Based on instruction focused on learner personal needs, the instruction individualization and instructional activities displacement from the fixed frame in time and space, the "e-learning", will be undoubtedly one of the fundamental paradigms of human society development of our Century.

References: