



# Learning Environment With Elements Of Artificial Intelligence<sup>\*</sup>

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## Abstract

The paper describes an innovative approach to implement, on existing LMS platforms, e-learning functionalities based on artificial intelligence (AI). The paper illustrates the characteristics of a Learning Management System (LMS) in which it is possible to activate such an action, the KM contribution and the architecture and the role of AI. Besides, there will be identified those dispositifs that take part in the design (authoring tools), in the knowledge building and in the monitoring in order to support the project team work and the activities of the Learning Entities<sup>1</sup> (LE).

The innovative aspect consists in the architecture and the functionality of AI that don't aim at replacing the teacher/tutor but at supporting him/her in the designing phase, in the monitoring and the redesigning of advanced paths which lead to a conscious learning and to knowledge building activities. Besides the presented model is not subject-oriented and can be used in different disciplinary fields.

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<sup>1</sup> The term "learning entity" defines either a single student or a work group.

## 1 Introduction: from e-l 1.0 to e-l 3.0

In the first generation e-learning, the so called e-l 1.0, we had a content delivery approach or a positivist approach (Guba and Lincoln, 1994). Most of the times study materials and evaluation tests are arranged in Learning Object (LO). This system easily matches with the SCORM standard and holds both its advantages and downsides. It's suitable for instructive learning paths, it's too rigid for processes which aim to a collective, aware and significant learning.

The experiences based on a socio-constructivist approach have got in some cases significant results in knowledge building and community building and in peer to peer review. In these experiences tutors have a central role and the success of the processes depends on the quality and quantity of their work. The roles played by the teacher/tutor require high profiles and didactical, relational and epistemological competences. The environments that uses a socio-constructivist approach have utilized communication tools already present in the web (e-mail, forum, chat) but promoted just in few cases a focused research to create appropriate dispositifs that could support the tutor and student activity.

From the beginning of the new millennium, web 2.0 marks a shift from the syntactic to the semantic web. For what concerns technology, web 2.0 introduces a series of utilities to emphasize communication, material aggregation and users interaction. Such dispositifs have modified the communication modalities themselves.

Is it possible to think that from a rib of web 2.0 was born the e-l 2.0 and the internet itself becomes a learning environment? Blog, wiki, PLE promote the informal learning (Attwell, 2007) but how to integrate them in path in which the learner can acquire awareness and be directed to the zone of proximal development? Is it possible to think about the learning process without an environment that clearly expresses the learning process, that organizes it and maps it?

The initial hypothesis of this paper is that we need a formal environment which could promote also the informal education. Hence the need of models of learning environments that can take advantage of past experiences and that, thanks to the KM contribution, can be flexible and overcome the limitations of e-l 1.0 (Lytras, 2006).

KM tools aim at the semantic text analysis, at a punctual monitoring process of learners at different levels, at the effective punctual data visualization. And we need an artificial intelligence system (AI) to use those data. We define e-l 3.0 a learning process in which KM and AI have a meaningful role.

## 2 Artificial Intelligence (AI)

The first generation AI was based on the principle of rationality and on the

connection between knowledge and objective (Newel, 1982). From the nineties Clancey (1993) states that «knowledge base is not a repository of knowledge extracted from one expert's mind (as in the transfer view), but the result of a modeling activity». In today education the mechanical interdependence between teaching and learning is put under discussion and the concept of mediation arises. Also we can see changes in the way in which the tutor plays the role of Intelligent Tutor (ITS). The firstly used technology used to analyze the final answer of the student and give a feedback and suggestions based on his her answer (Dick, Carey, 1990). The following modality consists in tracking the student in his her task and to provide feedback and proper scaffolding at each step (Beck, Stern, 1996; Shute, Psocka, 1996). It had a complex disciplinary knowledge base. Among the implementations of intelligent systems we have MyClass, an environment for manager training created by IPS<sup>1</sup>, ANDES (VanLehn *et al.*, 2005), an environment which supports students in learning Physics, Baghera, an environment for Geometry learning (Webber *et al.*, 2002, 2004).

The above mentioned implementations are subject matter oriented, that is bound to a specific content and properly built for a specific purpose. The implementation of a knowledge base requires much time and energies and cannot be used in a different field. The debate on how to overcome this problem is wide open. VanLehn, for example, has experimented systems for Physics in the Statistics (VanLehn, Chi, 2007).

To overcome such a problem the proposed approach in this paper is different. The objective is to build a system which is supported by AI but that is independent from the content or, to better explain, that is suitable to a wide range of subjects. For this reason we set two bonds in the project:

- to give a bigger role to the pedagogical- didactical knowledge base;
- to give to the ITS system the function of interacting with the teacher and the tutor (instead of taking their place) in the initial design phase and mostly in managing the course in its development.

The aim is to emphasize the tutor and teacher role who can rely on the machine for what concern reiterate and predictable activities, but can interact with the machine to ask questions and receive information which will be useful to apply direct actions and intervene in a meaningful way in the critical moments of relationships and learning.

From prescriptive systems we pass to systems which emphasize teacher creativity and the professionalism. In the first generation AI and in the eighties and nineties of the last century models of Instructional Design, the objective was to organize an effective process for many students, limiting the role of the teacher to a mere executor in fixed process delivering set materials while the attention towards the theoretical approach defined «Pensiero degli insegnanti»

<sup>1</sup> L'IPS is a corporate that deals with online learning (<http://www.ipselearning.com>) specialized in the corporate sector.

(Shulman, 1987) overturned that model and has identified in the reflexive professional teacher the main resource for a significant learning.

As Gordon and Zemke (2000) state about the classic Instructional Design, «it may have been a viable model for developing formulaic training programs that several thousand minimally skilled instructors could use to teach a million draftees how to disassemble, clean and reassemble an M-16 rifle». In the current pedagogical research we give a crucial role to the teacher awareness in the design and modelling process at first and then in managing the didactical activity. Overcoming the dyadic model, system of learning-student proposed in the introduction of SCORM (2001), the project proposes a triadic model teacher-learning entity- intelligent environment.

### 3 The research hypothesis

The research hypothesis consists of realizing an AI system that interacts with the LMS to support the activity of the teacher, of the tutor and of the learning entity (LE).

The proposed system implies three elements:

- an open source LMS with specific characteristics;
- the presence of expressly built objects suggested by KM for the semantic analysis, the monitoring, the visualization and aggregation of data that can be integrated in the LMS;
- an AI system that analyses the data furnished by the previous objects, interacts with LMS and dialogs with the teacher and the tutor.

### 4 The learning management system

The limitations of the first generation LMS were the rigidness and the closeness (Bonaiuti, 2006) but such limitations come from the didactical-technological structure and are not in the concept of LMS. We don't believe that the orientation and the supporting roles for learning, that can be guarantee by an environment expressly built for learning, can be deleted. The LMS offers united aspect and coherence to the learning process, it visualizes and maps the path, it provides a clear vision of the process and emphasizes the motivation and the orientation of the student. The need of a flexible LMS arises, ecological, autopoietic, enactive.

The flexibility has two faces. The first let the teacher/tutor model and modulate in itinere the environment with authoring systems which require no computer skills. The second let the LE personalize the environment according to the profiles and cognitive styles.

The ecological aspect of the environments comes from the presence of con-

nections among the system different sections. The LMS can be described as the overlapping of three nets:

- the net of dispositifs. The didactical dispositifs are not autonomous but interconnected among them and sometimes play in diachronic modality, in other times synchronic; the net of writings. The writings implemented in itinere from the LE in the forums, in the blogs, in the wikis, connect during the process between them and the materials provided by the teachers also thanks to tags;
- the net of relations. During the process an emotional and cognitive connection establishes between students and between students and tutors thanks to their interaction. Such net is neither static nor obvious but it enhances during the process.

Such nets cannot raise spontaneously but they derive from a starting design, an in itinere redesign, the interaction of the system and are guaranteed by the fractal structure of the LMS. The three nets also highlight the autopoieticity of the system since the connections between the writings and the relationships develop in progress and enrich in quantity and in mutual connections as the process develops thanks to the tools inside the LMS.

To conclude, the LMS is enactive (Varela, 2007). In an enactive LMS, the interaction between all the actors of the system and their interaction with the environment contribute to the meaning construction.

## 5 Knowledge Management

The development of the nets is guaranteed by the presence of objects whose aim is to make data and materials, coming from different dispositifs of the environment, interact. The study of ontology and their integration, the semantic web, the interoperability, the knowledge flow are sectors in which e-l e km interact (Lytras, 2006).

A first category of objects aims to the semantic analysis of texts and their labelling. The three following modalities are possible:

- top-down processes: we start from an ontology and basing on this contents are mapped (Pirrone *et al.*, 2007) and we personalize the learning paths;
- bottom-up processes with the subject intervention: the subject provides tags to the materials and, basing on them, the text are organized and accessed (folksonomies);
- automatic bottom-up processes: texts are filtered with automatic tools that label them and, basing on the labelling, text are organized and accessed (Rossi, 2007).

The second category of objects aims at the aggregation of materials, at the multi-minded production, at the group productions. The tools are directed

towards building kaleidoscopic materials, that is materials coming from the integration of different fragments deriving from materials present in different dispositifs. Tools for collective production are more and more frequent but they need to be potentiated. The wikis are an example. In the model that has been set it is possible to recuperate fragments, scraps from materials of the LMS and build “patch-works”. The e-portfolio, id designed as an organic and connected body (Ravet, 2007; Rossi, Giannandrea, 2006), can be considered part of this category of objects.

The third category is tied to the monitoring process. Nowadays the most of LMS records each click of the user and gathers an almost infinite number of data. Besides from the semantic analysis of texts and from the e-portfolio, additional data come and if they are analysed and integrated, show a wide and detailed overview of the subject’s activities. The quantity of data and their non homogeneous aspect underlines the need of having tools that can analyse them, reorganize them and visualize in away they can be easily and quickly accessible for the monitoring process (Rossi, 2007). Basing on those aggregated data it is possible to create a profile of the LE, verify dynamic processes, personalize the activities. To analyse the data we can also use the algorithms of the SNA to analyse the data in order to provide information about the group activity or the LSA to make comparisons among texts.

## 6 The support of the AI

We will describe the model in its main pedagogical-didactical characteristics which imply the presence of an AI framework external to the LMS which dialogues with him. The AI system is based on a multi-agent structure. The following typologies of agents are present: pedagogical, of the domain, of the learning subject, of communication between LMS and AI. such architecture is not very different from the one present in the existing systems (VanLehn *et al.*, 2005), even if the role given to the pedagogical agent has for sure a bigger impact. The characteristic that differentiate more the presented model from the previous ones is the dialogic relation between the AI framework, the LMS and the teacher/tutor and the flexibility of its structure. If, in the previous models, the expert system directed the student in his/her activities, following him/her step by step and implied, basing on the paths and the student’s choices, the following steps, without any intervention of the teacher/tutor, in the presented model the AI system works in two modalities:

1. it intervenes directly on the student if he/she has predictable and recurrent behaviours, that have been categorized by the teacher/tutor and for which he/she has set proper messages or comments. For example, contacting the student after a definite numbers of days of absence or replying to questions

- whose solution has already been provided in the platform;
2. it dialogues with the tutor to solve complex situations. The AI system, when questioned by the tutor, can show overviews of the situation (texts, graphics or tables) in relation to the cognitive and relational aspect both of the single student and the group; it provides information useful for a didactical action progressing thanks to subsequent approximations – taking in consideration the inputs from the teachers.

Thanks to the first modality the tutor can avoid routine actions and can spend cognitive time to interventions which require stronger competencies and creativity. Thanks to the second modality the tutor can intervene, having wider information on the status of the system and on the behaviour of both the single and the group.

The authoring system has a relevant role, this is the system with which the designer (in the starting phase) and the teacher/tutor (in itinere) define the rules with which the AI works. Such tool is often seen as a tool used by experts for the first design and is not available for teachers/tutors who normally don't have high computer skills. In the presented model the AI authoring system becomes essential to reify the dialogic approach. Its operational modality mirrors the tools for courses creation in LMS like OLAT or Moodle or more refined tools that also work basing on ontology, like eLML. Such authoring system let the AI framework be questioned to get information about users, to get advices on possible dispositifs and to build rules for the functioning of the system. Besides, the authoring system not only memorizes the solutions but also the middle steps of the previous questions so that some processes can become routines with which it is possible to work in the situations that will follow. In other words the modality described in 2. is a tool that produces the modality of point 1. For example if the system shows the teacher/tutor a specific request, the system will memorizes the analysis of the teacher and the proposed solution and thus will be able to automatically reproduce- if the teacher/tutor planned it- the solution to a similar request by the students.

## 7 Conclusions

According to that model the University of Macerata, in collaboration with other Italian universities is creating a prototype for integrated non subject matter oriented systems LMS-AI.

The chosen LMS for the prototype is OLAT, the LMS realized by the University of Zurich since it guarantees those characteristics of scalability, interoperability and portability that nowadays no existing open source LMS. Besides the structure in Java, the possibility of indent without limitations the activities aggregating in xml tools and dispositifs, the storyboard ,that is, the

didactical path, foster the integration with the AI framework. OLAT presents a highly usable authoring system also for teachers with no specific computer skills, a system that focus the attention on the pedagogical-didactical aspects. Thanks to the authoring system the teacher /tutor, beside creating the course, can re-modulate it in itinere and in real time.

In the LMS Km tools for the semantic analysis of texts, for the organization of tags and for the integration of data coming from the monitoring process are integrated and are being integrated.

Two open source AI frameworks based on Java architecture (Cougar and Jade ) are being tested.

The experimentation will have to fulfil two main requests:

- the integration among e-learning, KM and AI can fulfil the need of flexible paths and more and more complex that can activate processes of reflection and awareness;
- the AI support aimed at helping and valorising rather than replacing the activity of the teacher/tutor can provide tools to improve the quality of the both blended and online paths fostering their sustainability.

Currently the environment has been personalized and is being tested in post-lauream courses, rules for AI are being implemented. By the end of 2009, we foresee to reach the creation of the LMS-AI integrated prototype.

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