Implications of learning environments on the Information Systems of educational institutions

Paolo Maresca[1], Andrea Molinari[2,3]

[1]Department of Ingegneria Elettrica e Tecnologie delle Informazioni (DIETI) – Università Federico II di Napoli (ITALY)

[2]Laboratory of Maieutics – Dept. of Industrial Engineering - University of Trento - Italy
[3]School of Industrial Engineering and Management, Lappeenranta University of Technology (FINLAND)
andrea.molinari@unitn.it

***Abstract*— Since the early years where they started to enter the market, Learning Management Systems (LMS) have reached a very high level of maturity, providing professional solutions to mostly any educational need referring to distance learning. In this paper, an analysis of how LMSs should evolve in the future is presented, according to authors' experience, in terms of functionalities and services provided to users. Behind these new functionalities and services, we foresee research fields that could provide interesting and fruitful stimulus to the market and to these platforms. The foreseen direction is the one that goes towards an expansion of the collaboration services, where virtual learning environments should be mixed with typical Computer Supported Collaborative Work (CSCW) tools and approaches that put collaboration at the heart of the system. Nevertheless, also traditional e-learning services should be improved with additions coming exactly from this integration with cooperative / collaborative services. The reference point is a virtual community platform created and developed along the years, used in the authors' institutions and in several public and private organizations. The platform is oriented towards the support of collaborative processes, where of course e-learning is one of the most important, but not the only one, and where new services supporting collaboration in different ways are constantly added.**

Keywords-component; Learning Management System, Information System, customization, open source software

I. INTRODUCTION

Computers today play a central role in many sectors of our life, by the presence of hardware and software tools covering most of tasks human beings perform. Education is not excluded from this list, both for content providing and for supporting educational tasks with Learning Management Systems (LMSs), Virtual Learning Environments (VLEs) or other labels that refer to software platforms and services devoted to education.

The e-learning sector is well guarded by different groups of LMS platforms. The first group of LMSs is based on open-source solutions, open, free or both, readily available, at no cost of acquisition (if the configuration needed by the educational institution is simple), with source code available, requiring an in-depth knowledge for management and customization. These aspects have created an interesting market for consultancy and services devoted to the customization of the platform for specific needs, like the integration with other services of the information system. Here very well-known platforms are available, being Moodle™ the most famous one.

A second group include the so-called "closed" solutions, in the past linked to major players, now mostly developed on the basis of specific requirements expressed by major customers. In this category many variegated examples can be found, with solutions created from scratch, customizations of open source LMSs, or customization of other software platforms created for other purposes "forced" to become technology-enhanced learning environments. The most frequent case is the customization of Content Management Systems (CMS), like Joomla™, Drupal™, WordPress™ etc. to some educational needs.

Recently, a third group of software solutions for education can be identified that take advantage of the many positive aspects of cloud computing. Normally these platforms are the porting of one of the previous categories, or native platforms only available via cloud services.

This paper is based on almost 30 years of experience of authors in the field of creation of software solutions for education, specifically the creation of Virtual Learning Environments for different public and private institutions. The paper will discuss the pros and cons of one of the aforementioned groups, i.e., the custom solution. It is our strong convincement that, in many situations, a customized LMS provides better services from the educational perspective, but most of all it provides services to other sectors of the information system of the institution that normally are not labelled as "educational services", but that could be found inside LMS. Moreover, equipping a LMS with services not only devoted to the pure educational context, but related to the support of collaborative tasks, could provide a lot of advantages for the institution and for the administrators of the information system itself. The paper is organized as follows: section 2 will present the testbed for our argumentation, a custom virtual learning environment created to support digital training processes. Section 3 will be a frank analysis of the implications of open-source learning environments on the information systems of educational institutions, with respective pros and cons. Section 4 will discuss the relation between LMS and more general information systems of educational institutions, while section 5 will present an example of integration related with tools for decision support systems.

DOI reference number: 10.18293/DMSVIVA2018-010

II. THE TESTBED: A CUSTOM VIRTUAL LEARNING ENVIRONMENT

This paper presents an analysis of the opportunities related with the use of e-learning services in different contexts respect to pure training, and the integration of these tools with the rest of the information system of the organization. Normally, e-learning is perceived as a separate world respect to the information system. However, when the size and variety of e-learning needs grow, turning the platform from a simple repository of material to a tool devoted to integration, collaboration and cooperation between virtual communities, at that point the management of e-learning services becomes much more complicated. It is exactly in these contexts where both open-source platforms and closed-source mainly fail, and in our opinion this is due to their conceptual foundations. What has been experienced is that distance education is nothing but a tool for collaboration between teacher and participants, but extending these tools to other contexts significantly expands the application fields. In what follows, however, an adaptation of the platforms, their customization, or assembly of different tools in "patchwork" often reveals to be inefficient and unusable. In general, this means for organizations to heavily intervene through customizations on platforms created by others, often distorting and then losing or compromising compatibility with future releases, or devoting considerable efforts to keep this compatibility. The growing phenomenon of MOOCs, for example, sees a proliferation of platforms created to handle these complex contexts of massive training, thus forcing educational institutions to adapt their educational model, services, processes etc. to what the LMS provides.

In our opinion, the flow should work in reverse: software platform should be customized on the educational processes that the institution decides to apply, and this creates a competitive advantage for educational institutions. Secondly, the integration with the rest of the information system is crucial to the success of the institution, or at least of the educational initiative. Nowadays software educational platforms should provide services that include the administrative components of educational services, like enrolment, taxes, exam records, students' secretary, single sign-on, certifications, online payments etc., being these services typically provided by the main information system through the organization website.

To validate our argumentation, the authors will present their experience in the creation of a custom platform constantly developing since 1998. Some cases and situations of partners that adopted our platform and collaborated with the team to implement the integration with the respective information systems will be presented,. The system development started at University of Trento for blended teaching 20 years ago. The development started in 1998, largely before the advent of Moodle™ or similar platforms: at the time, there was a market of web-based Learning Management Systems, and the dominant player was BlackBoard/WebCT™. After having finished the first version, in the academic year 1999-2000 the Faculty of Economics of the University of Trento decided to adopt our software system in order to enhance its traditional educational activities. This platform should have absorbed the many different personal initiatives taken by several teachers who had activated autonomous web pages to support their courses. Three options were presented to the Faculty: purchasing commercial software, using free software or building from scratch a new platform: a very similar situation compared to today's alternatives. The decision to build its own platform was a consequence of various reasons [1], which can be summarized as follows. At the time, the use of commercial software appeared to be impossible due to very high costs, considering the total cost of ownership of such solutions: acquisition, maintenance, management, training, software insurance, hardware required, personnel etc. On the other hand, at that time free software was rather rudimentary (if not in a prototype stage), and was limited to very few examples mainly created by single research groups / Universities / freelance consultants.

After a first 5-year of extensive usage, our team focused on carrying out a platform based on the idea of virtual communities. Facebook was probably still in the creators' mind, so the idea of virtual community, according to our interpretation, was not the result of a process of social networking. In fact, it was (and it is in the current implementation) a virtual space shared by people with a common goal, following approximately the original definition of Rheingold back in 1993 [8]. A community's virtual space can be simple or complex; for example, it can contain further virtual communities, thus establishing a hierarchical "parent-child" relationship. The (virtual) community can be an open space accessible to anyone, or can be a restricted space, the access to which is reserved only for some people authorized by the community administrator. The users can have different roles with rights and duties, which vary in the use of space and collaboration services activated in a virtual community. The system maintains the consistency of the completely social environment of the virtual communities, which are active at a given time, in that it provides users of a community with a range of on-demand services that can be activated and used in accordance with the permissions granted and the roles assigned.

Respect to the change of paradigm from a LMS based on the traditional metaphor of a "class" to the metaphor of a "virtual community", here some observations are summarized:

- Models of teaching / learning (such as learning by problems, learning by projects, cooperative learning and their combinations) can hardly be connected to the idea of a class, especially when the software directly represents the metaphor of traditional courses;
- The needs for cooperation within the academic environments can be extended to all the activities that constitute the context in which didactics takes place, not only to the simple activity of teaching. The organization of a research group, for example, is surely a (virtual) community that requires many of the services used in a (virtual) classroom: file repository, videoconferencing, forum, FAQ, blog etc., but surely should not be organized as a (virtual) class: different roles of participants and different services needed;
- The organizational scenario is changing under the effects of new regulations or exogenous decisions, and these changes will inevitably reflect on the LMS functionalities. It is important to note that these changes are usually the result of a debate process in which both

elements of cooperation and negotiation interact, and very often are on a national scale if not regional if not of the single University. Expecting that a world-wide software platform (like Moodle) will add features (sometimes very impacting) for such specific context is rather unlikely, while respectable local attempts to create special plugins can clash with Universities that adopt internationalized versions of the platform;

- The educational processes of a University are not built only as a set of lectures and exams, but these activities are inevitably intertwined with the university's organization and its information system;
- In academic contexts, not everything concerns teaching: for example, the entire Faculty is more than a container of degree courses, and a degree course is more than a container of lessons. So the hierarchy of the organization is relevant for any software platforms, LMS included, for example for the propagation and sharing of documents at different levels of the hierarchy. A general communication of the Dean to all the communities of the Faculty could be propagated without replicating the file in any classroom by simply implementing an inheritance mechanism among communities. The hierarchy mechanisms and the connected propagation effects are normally not implemented in mainstream LMSs, while our platform has these mechanism built-in by design.

To answer these (and other) needs, it was necessary to find another founding metaphor respect to what LMSs have implemented implicitly or explicitly in their code, which had at least three basic characteristics: a) to be general to support any collaboration process, not only learning processes; b) to be capable of modelling adequately the organizational aspects of an educational institution c) to be flexible to provide services to the rest of the information system. This metaphor was found in the concept of virtual community. The system that arose, called "Online Communities", started to offer its services in 2003 and runs uninterruptedly since then. It is still the platform at the Faculty of Economics and at other Faculties of our university, and since then has been adopted by large public bodies and private organizations.

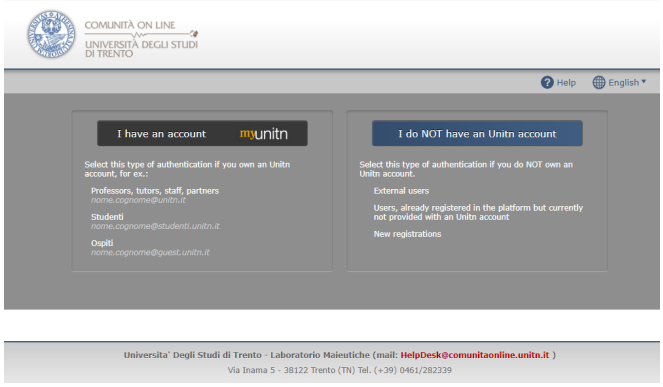


Fig.1 The internationalized home page of "Online Communities"

The complexity of managing virtual communities is objectively quite different from managing a course [2]. It requires a different approach also in the management of roles and permissions. In the logic of integrating systems, there is an ever increasing need to provide a single point of aggregation of the various services in order to enable subjects and systems with different interests (if they are not divergent) to access the same object, acting according to their own competences.

The architecture of Online Communities is based on five fundamental entities: Person, Community, Role and Permission, and the combination of the roles and permissions that gives the Profile for each user. The central entity of the platform is the "virtual community". The main characteristics of a community could be summed up as follows:

- each Community encapsulates a certain number of services.
- The services are general applications that enable users to publish contents, to communicate in synchronous and asynchronous way, to exchange files, to coordinate events, to manage their personal learning environments etc.
- Services for each community are activated by an administrator of the community according to the community members' needs, and the users of a community can use them with different permissions that are specific for each service. The role of the administrator of the community is clearly crucial, not complex in technological terms but in an organizational sense.
- The communities can be aggregated into larger communities with hierarchic mechanisms and infinite nesting levels. The communities can also be aggregated in any arbitrary way into larger communities disregarding the possible position in a hierarchical structure.
- There is no anonymous access to the platform: being the user's profile the base for every operation, all users are profiled in the platform at least with one role and one community of belonging.

Over the last few years the system has evolved into a platform for professional training oriented to life-long learning outside academia, being preferred to mainstream LMSs because of three main reasons:

- the complete knowledge of the University development team on every single part of the platform, due to the complete in-house, from-scratch development;
- the metaphor of the virtual community that particularly fits with many organizational needs and educational methodologies used, more oriented towards a peer-to-peer, equal relationship within the participants of a community;
- The predisposition to be integrated with other components of the information systems, and the provision of services to be encapsulated in other components of the hosting information system.

The new implementation of the system (fig.1) has retained certain basic features of earlier versions, while also extending its functions in order to allow the application of business logics to

the training processes. Such evolution has been required, for example, when the Massive Open Online Courses (MOOCs) idea came into the market. This brought the need to develop previously neglected aspects, especially with the aim of controlling the students' activities more extensively, and the accounting issue of invoicing participants precisely the amount of usage of the platform for their training processes.

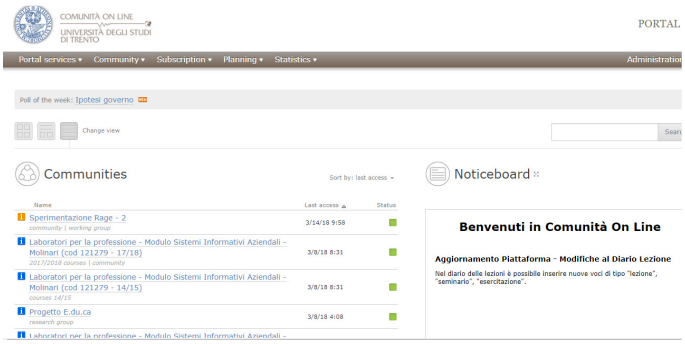


Fig.2 The User's home page, with the communities of interest

The connection with the Enterprise Resource Planning (ERP) software of the hosting organization has been another good example of our argumentation, being this the need of evolution of LMSs from a general-purpose platform of a generic educational institution, similar if not equal all over the world. On the contrary, what should be highlighted is that such an effective technological tool should embrace the (social and technological) context where teaching and learning processes take place, including other processes of the information systems. Going back to the origin of ERP, the problem was exactly the same: different silos of information systems treating the same data, but separated and not interconnected, with the consequent mess of customization and integration that created so many issues in the management of information systems. The solution and the time, still valid today, was to have a centralized system with a unique database where one single copy of information was managed. What proposed is an update of this idea to modern Restful web services, cloud computing, distributed databases etc. where best-of-breed services are provided to users by whatever platform inside the information system has been elected as the most suitable platform for that service.

III. Implications of Open-Source Learning Environments on the Information Systems of Educational Institutions

First, the authors want to clarify that the technical and organization value of platforms like Moodle is not under discussion. Moodle and the like changed the world of education because they supplied an easy and quick way to address the request of providing educational services through the web. Our argumentations start from a different perspective, i.e., the need of a mature institution that wants to apply a unique, customized, "personal" set of educational practices, being convinced that customized educational practices instead of standardization imposed by a software platform could be a competitive advantage. (differentiation from the other educational institution)

Public and private educational institutions adopted mainly open source solutions for various (quite obvious) reasons, substantially choosing the no-cost (or this was what they believed), easy way. Respect to this, authors experienced different issue. As a first element, the need of a development team that knows the platform, but being the platform developed by others (many others, in the case of Moodle), substantially the development is confined to a very limited customization, with the general motto "don't touch what you have not coded". So unless the institution has the technical background to fully manage the LMS, from hardware to software to network, having the source code of the LMS (like in Moodle) has a very limited value, and in the end leads to hire external consultants for the installation, the maintenance, the personalization etc., thus vanishing the expected benefits of "free" in the sense of zero-cost. To complete the matter, many Moodle owners know very well the famous "security patch" hassle, and the costs associated with mistakes on this side. There is clearly nothing new respect to any other software platform, but the lack of awareness of many (especially small) educational institutions created a very bad reputation to LMSs, thus hiding the enormous benefits they could bring.

Even if it is a technical issue, scalability is clearly something that in large organizations became a sort of buzzword, while Moodle was mainly created as a single-server box, one for each customer. If the institution is experimenting, for example, peaks of usage during the early days of an academic year, scalability becomes a serious issue. If we use the platform, for example, for a social event where all participants (students) will get a gadget, and in the meantime there are some online exam sessions, then scalability will become a serious issue. Theoretically, no problems exist in putting Moodle in the cloud, but then a) you'll need to spend extra money and resources to deliver this, but especially for public institutions b) not every organization is happy to publish online material dealing with internal topics (for example on security training policies and processes) on a cloud-based platform.

There is also an over-emphasis on the capabilities of customization of free/open source LMSs. If Moodle is taken as a reference, at the moment of writing the core components of this platform are around 800k of PHP lines of code, and close to 100k for Javascript. This excludes all the external libraries, modules etc. It is clearly a huge software effort, and whoever wrote a single line of code knows perfectly the possibility for an external person to safely and consciously put their hands inside this mass of code. Therefore, most of the time, when people claim "we have customized Moodle", they refer to some CSS style changes in visual aspects, labels, some logos, menus and very few other things. Real customization means, for example, to change the structure of a database table in order to add information coming from another component of the organization's information system, in order to connect the two systems, and to create this connection bi-directionally. The closest way to this request is to install a Moodle plug-in, but here other problems rise, related with the enormous amount of plugins from different sources of different quality, their reliability and stability in case of version change, the overlapping of functionalities among different plugins, the availability of more plugins for the same function etc. Even the

simple change of the layout of a page, or of some pages of a certain service, or modifying some dashboards becomes complex, available only to seasoned developers with core competences in Moodle and with a deep knowledge of what will happen if that feature will be changed. Again, it is very well known, and also comprehensible from the perspective of Moodle's maintenance team, that in order to avoid instability and incompatibility situations, there are many roadblocks to (even) modest customization, forcing you substantially to consider the forking of the entire platform as an alternative. Forking is the very last resort for any institution, and the main reason why our "Online Communities" platform found some believers is mainly in this point.

Respect to this limitation in customization, another element could be considered positive in some contexts, but negative for other contexts. This could be label as "boring uniformity", in the sense that most of the institutions that adopt Moodle are stuck with the same layout Moodle provides in the default installation, and any deeper customization of the layout finds the same roadblocks seen before. This leads to a "boring" uniformity of most of the Moodle installation: the authors' never found a person that said "I change my University because I found the same Moodle".

There are many other issues that could be found, like in all software platforms, but this discussion does not want to appear like a demolition of one of the milestones of Technology-enhanced learning (TEL) like Moodle. The argumentation deals with the empty spaces left by the approach carried out by Moodle (and similar platforms) respect to a significant part of the TEL market, where there is a need of new services customized to implement new educational processes and approaches, and on the other side to connect the LMS with the rest of the Information system.

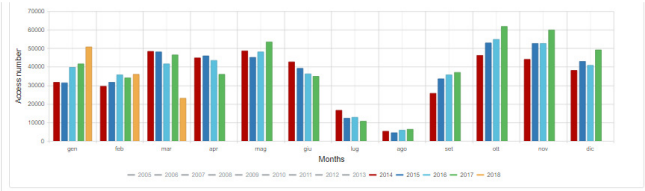
IV. LEARNING ENVIRONMENTS AND INFORMATION SYSTEM

After having presented the issues related with some approaches to LMS and their implementation, the central aspect of this paper deals with the relation between LMS and more general information systems of educational institutions. As previously stated, e-Learning platforms seem to be built to act in a restricted circle made up of teachers, tutors and students. On the contrary, in our system the community is a container ready for didactic processes, but not only: research teams, recreation groups, friends, secretariats, board of directors, sport teams, colleagues, anything that could be an aggregation of people around a scope using virtual spaces on the web.

At present, considering only the instance of the system used by the University of Trento, there are more than 7.500 active communities, 16.000 active users and in 2017 almost 500.000 unique accesses has been achieved (see Figure 2).

The evolution that Online Communities is going through implies increased implementation complexities respect to "simple" LMS settings, considering that the differences between the two approaches refer at least to four dimensions.

The first dimension is a temporal dimension. The concept is amplified on larger spectrum, that is to say, the life of the subject, not necessarily dependent on standard educational path (high school or University). At the moment, on of the largest implementation of "Online Communities" manages all the educational tasks of the largest public body in our region, i.e., the Autonomous Province of Trento, with approx.. 20.000 employees, and thousands of online courses delivered every years. The interest of the Province is clearly a long-term interest, in the perspective of managing an "educational portfolio" of the employee, thus implementing a life-long learning platform.



Anno\Mese	gen	feb	mar	apr	mag	giu	lug	ago	set	ott	nov	dic	Totale
2018	50.896	36.086	23.194	0	0	0	0	0	0	0	0	0	110.176
2017	41.637	34.134	46.627	36.113	53.461	34.961	10.703	6.496	37.141	61.832	60.007	49.174	472.286
2016	39.851	35.817	41.765	43.692	48.138	36.276	12.943	5.859	35.914	54.923	52.857	40.901	448.936
2015	31.579	31.749	48.079	46.054	45.330	39.210	12.281	4.664	33.545	52.905	52.894	43.178	441.468
2014	31.789	29.694	48.586	44.926	48.607	42.731	16.639	5.424	25.831	46.424	44.115	38.224	422.990
2013	34.738	35.189	38.009	38.239	43.888	33.607	14.325	4.760	22.012	42.877	40.157	31.817	379.618
2012	40.755	40.245	46.494	34.213	44.114	32.273	13.921	4.945	23.053	45.498	39.551	33.756	398.818
2011	40.332	38.348	50.906	40.500	52.708	38.877	15.363	7.543	30.385	44.947	44.505	38.866	443.280
2010	24.592	37.789	44.017	36.870	41.071	38.942	14.186	6.307	26.883	42.269	41.676	36.099	390.701
2009	29.638	43.823	41.867	37.224	34.200	36.523	19.775	8.291	32.003	41.336	40.053	30.531	395.284
2008	42.563	34.947	34.913	43.748	33.086	30.825	19.176	5.498	30.962	41.047	42.819	31.528	391.112
2007	37.670	30.050	35.917	35.130	30.617	28.492	16.316	5.734	24.880	40.290	34.868	27.252	347.216
2006	28.245	22.680	33.656	36.087	28.154	26.827	18.646	5.096	25.201	37.403	36.122	26.395	324.512
2005	0	345	663	2.435	15.817	14.055	6.681	1.637	18.250	28.184	27.100	20.033	135.200

Figure 3. Online Communities accesses (14th march 2018)

A second dimension is the social dimension. The platform could be used in social contexts of totally diverse life-long learning settings, even in conflict with each other. Let us take as example subjects who, while interested in continuous learning, change the country of their residence, company where they work, training needs, etc. Not necessarily all the information contained in their educational portfolio are relevant for other stakeholders, or vice versa, they are very interesting for them but not the owner of the portfolio.

A third element is the spatial dimension. The place where the learner is conditions the modality of delivery of the educational contents. Let us think, for instance, at the various situated learning needs of a person responsible for maintenance, or a medical doctor when facing an emergency case, or a tourist in front of a work of art in a museum.

A final dimension, more complicated to analyse in this paper, is the anthropological one. The subject uses the platform in completely different life periods; starting with pre-school age until the end of working activity and, not to be excluded, even beyond. The problems linked to these aspects represent something extremely stimulating and yet unexplored, as it is clear (and first evidences are emerging) that our social and even mental behaviors are affected by technologies in general, and social media in particular.

The platform provides, as a set or core services, the "traditional" services provided but full-fledged Learning Management Systems: asynchronous services (like forum, agenda, upload & download of learning objects, newsgroup, notice-board, classroom and users' management, forums, blogs, wikis, FAQ etc.) and synchronous services (chat, streaming audio/video). Other than these, some customized services, closer to the

aspects of life-long learning and "training on the job" (tutorship, training on demand, research tools with problem contextualization, ticketing tools etc.) have been developed for specific partners, like the Autonomous Province of Trento.

A second set of services relates with specific integration needs with external information systems (for example, the Personnel information system of the organization) and with the acquisition of forms for external enrolment of students to university's programs. These services have been developed for institutions that have a selection process of candidates, mainly for master degrees, doctoral schools of private business courses. The Chamber of Commerce of Trento, for example, through its associated training Academy, provides many courses to affiliated companies and institutions, and heavily uses these kind of services to process enrolment, subscription to courses and even payment of fees.

A third set of services provided by the platform regard the fruition of "off-line" courses, i.e., courses already held and recorded, digitalized and made available to controlled communities of users (with the possibility to synchronize the video with slides, podcast, webcast, SCORM modules, etc.). These services are more typical of Learning Management Systems, but the issues related to the integration with a SCORM player provided us the stimulus to develop our own "meta-SCORM" engine, a service call "educational path" where many issues related to size of SCORM packages and rigidity of SCORM standards have been overcome.

As a fourth group of services, services for the creation of evaluation tests, exams, self-evaluation tests, quizzes, polls etc. could be mentioned. Together with this set, personalized reports with statistics about the users' behavior have been developed, using an internal data warehouse enriched by activity logs that overcome some problems of traditional LMSs in extracting detailed information about user performances. These specialized, business intelligence-oriented services have been developed avoiding the creation of sophisticated charting tools (already available on the market), but focusing on providing detailed information about every action that the user is performing while interacting with all the services of the platform. This allows us to follow some requirements for internal certifications.

An important category of services has been added for managing the interactions among members of the community, like project management services, agenda organization, time management, tenders and respective application forms, etc. These are the services that continuously see additions, improvements, new requests etc.

Finally, a set of mobile services to support mobile learners are provided. There are some innovative services which meet the mobility needs of the subject who wants to learn "on the move", performing learning/collaboration activities directly through his/her mobile device (mobile phone, tablet PC, smartphones, phablets, etc.).

Type of Service	Services
Syncronous Communication	Chat; Webmeeting
Asyncronous Communication	Whiteboard; Forum; Memo; Mail management; WebCast, mini-sites
Presentation and Course Details	Teacher information; Users Gallery; Users CV; Community Cover; Course Diary; Course Organisation; Syllabus; Links
File Management	Upload; Download; File Management; SCORM Player; SCORM Management and Statistics, mini-sites
Events Management	Calendar (Personal and Community); Appointments; News, sticky notes
Activity Management	Call for thesis; Tasklist (Project Management), todo-list, ticketing, face-to-face booking
Collaboration and Web 2.0	Wiki; Blog; Workbooks; Exercises, FAQ, glossary
Test	Polls; Questionnaires; Test; Statistics

Figure 4. A partial list of services provided by "Online Communities

The platform is constantly extended with new services, coming from research projects, users requests and the results of our almost 20-years' experience in designing, developing, implementing and using e-Learning system (LMS), with a specific approach in mind. This approach is, in some sense, "against the current" of standardization and "normalization" of LMSs, in our opinion too flattened over these pre-defined, pre-designed software platforms. From our experimentation, it is clear that an e-learning platform is not an external system respect to the rest of the information systems, but it is a crucial component for any organization. When such a platform enters into an organization, its effects are immediately visible:

- needs for integration with sub-systems existing in the organization: just to mention the simplest ones, integration with the single-sign-on system implemented in the company;
- overlapping of some functionalities of LMS/Virtual communities' platform with pre-existing functionalities in the information system of the organization. Examples: document repository, mailing distribution, virtual room management, forum, etc.;
- Competition with possible new systems entering in the organization, mainly due to the web 2.0 functionalities that nowadays most of the companies intend to implement, and that normally any (serious) LMS is able to supply:
- partially overlapping and competition with some functionalities already present, somewhere in some software.

These are the most insidious aspects, because none of the systems (LMS and other information systems) are able to satisfy the specific needs, but all of them are able in some way to supply part of the functionalities needed. The typical example found in the authors' experience is the support to document sharing for groups of people without having to mount some network disk for file sharing, normally not appreciated by system administrators, and most of the time not accessible via web. In this case, virtual communities are better candidates, as the on-the-fly creation of a virtual community with a set of services

available for the members is a perfect solution for many of these situations, not necessarily related with educational activities.

The last example is what mainly led us, in 1998, to build a new system with virtual communities as the center of our approach. At the time, Moodle™ or similar LMSs did not exist or were not accessible to most of the people, and other solutions were particularly expensive, proprietary or not available. In our vision, a virtual community is a (virtual) space of aggregation for participants, thus supporting cooperative activities among users instead of just learning activities.

As previously stated, our platform has been created to be adapted and connected to the information system of the organization. Considering e-learning and collaboration platforms as external bodies, relegated to secondary roles inside the information system, is in our opinion losing an excellent opportunity to improve collaboration and open innovation inside an organization.

Integrating eLearning systems with existing information systems is not an easy task, mainly due to some resistance and ostracism against learning applications that are seen as not relevant for the organization by the ICT departments. Other difficulties come from the technical side, due to the diversity in these systems.

Universities are using LMS mainly for issuing educational services, but many other services could be provided, expanding the role of LMS more towards information systems and collaborative platforms. It becomes essential to have advanced tools to support activities that often are not limited to training, but that widen the horizon in different contexts in which the availability of a web-based software platform is not only a big help, but an essential element to reduce space and time barriers and enable collaboration "anytime - anywhere" so much desired by the digitalized institution.

In these contexts, limiting LMSs to educational services, limitations of the conceptual and engineering nature of training processes will have to be faced. What is the authors' experience is the need of new tools and services for the educational tasks that expand the idea of training activities to the more general collaborative activities: A non-exhaustive list of these activities found very profitable if integrated in a LMS follows:

- time management at different levels of implementation: calendars, event planning, meeting management etc.
- project management, where projects can be managed with their tasks, durations, critical path, constraints, resources etc. This is profitably integrated with core services provided by the platform, like the file repository (for attaching documents to tasks and resources), forums (to discuss topics about a task with resources assigned to it), or the decision support system, for example for supporting the qualification of a duration through the interaction among experts using a multi-criteria, multi-expert fuzzy algorithm;
- processes related to support decisions in different educational contexts (exam, vote, polls, questionnaires, community participation, group democracy etc.)
- enrolment services in different situations, from enrolling in a course to a single lab session, from organizing a walk with classmate to enrol in a serious game session

Similarly, with the increase of complexity of educational activities, tools for collaboration are becoming increasingly central, like sharing and distributed decision support systems within learning communities. This is the first example described as a significant moment of integration between LMS and other technologies that normally are not available in mainstream platforms.

V. DECISION SUPPORT SYSTEMS AND LMSS

In this section, a module of the platform that provides functionalities added in order to provide support to one of a partner, the local Developing Agency (Trentino Sviluppo S.p.A.) is presented. In e-learning settings, the evaluation of different alternatives regarding learning paths' proposal is nowadays crucial, due to the great attention devoted to the construction of learning objects (LO) available through Learning Management Systems (LMS). Learning processes are normally implemented through the interaction of the learner with a LMS and, in some cases, through the usage of learning, or e-learning, paths. A learning path, as referred inside a LMS, is represented by a set of LO mixed with other tools and services available in the LMS, like questionnaires, forums, wikis, FAQ etc. This combination of information chunks and services is devoted to obtain the educational objectives defined by an instructional designer.

While testing large scale implementation of virtual community systems, authors noticed that SCORM objects and pre-defined learning paths, are more and more important in educational settings today. The market is responding to this request, thanks to adequate technologies for the design, realization and delivery of these pre-constructed educational tools. SCORM packages themselves, if well designed, could be self-consistent learning paths. According to this scenario, educational institutions and specifically the industry rather than academy, are very often in front of the process of evaluating different possible learning paths, composed by different learning objects, composing different contents and representing different approaches and responses to the educational needs stated by the educational stakeholders. The criteria for choosing which alternative better fits with these needs are most of the time based on simple considerations (mainly cost of the learning objects), taken by people with no complete view of different aspects of the learning paths, not taking into consideration all the aspects that should be needed for such an important step.

E-learning has many advantages, but for sure the best application field of its pros is in presence of large numbers of users, where a wrong choice about the learning path to be offered could have serious consequences. In order to support the decision making process aiming at selecting the most suitable e-learning path(s), a multi-attribute, multi-expert model has been introduced, where several attributes are used for evaluating different e-learning paths, according to the rankings expressed by a group of experts. Then, a consensus modelling

mechanism is introduced to find an agreement among the individual rankings. The multi-attribute evaluation is based on fuzzy TOPSIS while the consensual ranking is obtained through a constrained optimization model. Fuzzy logic in e-learning has been used according to different perspectives. Some fuzzy approaches to e-learning have been presented in [3], where fuzzy logic has been applied to the identification of e-learning design requirements and to select the most suitable e-learning service provider. Other approaches [4] use fuzzy inference to analyze students' way of working and group's behavior, while in other research areas fuzzy logic has been used to improve search capabilities of Learning Management Systems (LMSs) [5]. In the field of evaluation, under different perspectives the application of fuzzy logic to the evaluation of students' performances according to their profile [6], or to an evaluation teaching systems' quality [7] has been applied.

The same mechanism and the same attributes, or variations of them, can be applied to a different granularity of objects inside our platform. For example, very frequently in e-learning settings a teacher can use collaborative tools like forums or wikis to discuss over a topic. The comments of the users are often summarized or even pointed as "the best", the most representative response to the original post even coming from participants in form of a question. The provided model could be applied also inside these contexts, where a panel of experts (teachers, students or a mix of them) could evaluate the different alternatives (the different answers to a question) expressing linguistic values in correspondence of pre-defined appropriate vocabulary of linguistic labels for the attributes. In our opinion, e-learning systems (and virtual community systems) will need these extensions that go in the direction of cognitive computing, thus transforming the e-learning, passive environment (where actors simply download slide-ware) into an intelligente cognitive system able to support us in decisions related with our daily life, education included.

VI. CONCLUSIONS

The paper presented our point of view respect to the current state of evolution of LMSs, specifically their capabilities of reacting to new stimulus from end-users that require a deeper integration with the hosting information system. Our view is that customized platforms could perform largely better in these context rather than general purpose LMS. The research will be expanded with some extra comparison, but the empirical evidences collected so far seem to confirm that, when learning processes are not isolated islands inside the information system but core component of internal processes, LMSs provide a much higher rigidity and total cost of ownership. On the contrary, a customized platform, where the source code has been developed internally, could have its' Return on Investment exactly in these situations, furthermore providing extra advantages like seamless integration with the rest of the information system, greater customization capabilities and a much higher flexibility in adapting educational processes to the changing organizational needs.

Looking onwards, it rarely happens that we will witness a radical change in technology and business. It typically happens every 25 years or so, and it's happening now. What this will entail is mainly related with exponential learning, a process of exponential growth of training demand because new knowledge and skills must be delivered at a speed never seen before (see Industry 4.0 but also other community programs, cognitive managers, cognitive architecture engineers, cognitive system programming, etc.). So the paradigm should be extended, shifting from classrooms to communities, talking no longer of men *or* machines, but men *and* machines, then the technology will be an appendix extending the learning processes of individuals, enhancing their faculties and assisting them in the transformation of skills. This will happen through the definition, design and use of cognitive services that can be implemented in a platform like the one presented in this paper, that has already acquired and historicized its big data, but will have to offer a new set of cognitive services. We will be forced to respect two fundamental constraints: time and content, with contents that will have to be ready within the time learners will need them. Probably the services will be profiled for different users levels, such as learning professional and learning business consumer. We are on a turning point of training processes, a very challenging and important moment in which cognitive approaches will transform everything, and e-learning processes and platforms are not excluded.

REFERENCES

[1] Colazzo L., Molinari A., (2007) Shifting from Traditional LMSs to Virtual Community Systems. Journal of e-learning and Knowledge society, NuovaSerie, v. 3, n. 2, p. 95-104. , DOI: 10.1400/77970

[2] Molinari A. (2015) Designing Learning Objects For Italian Public Administration: A Case Study, Problems of Education in the 21st Century, 2015; 68(68) 52–63 ISSN 1822-7864

[3] Kazançoğlu, A. P. D. Y., & Aksoy, M. (2011). A Fuzzy Logic-Based Quality Function Deployment For Selection Of E-Learning Provider. TOJET, 2011, 10(4).

[4] Redondo, M.A., Bravo, C., Bravo, J., Ortega, M. (2003) Applying Fuzzy Logic to Analyze Collaborative Learning Experiences in an e-Learning Environment.USDLA Journal. (United States Distance Learning Association).17.2, 19-28

[5] Perakovic D., Grgurevic I., Remenar V. (2008), Possibility of applying fuzzy logic in the e-Learning system, In proceeding of: Information and intelligent systems CECIIS 2008 : 19th International conference, September, 24th - 26th, Varaždin, Croatia, 2008

[6] Hogo M. (2010), Evaluation of E-Learners Behaviour using Different Fuzzy Clustering Models: A Comparative Study, (IJCSIS) International Journal of Computer Science and Information Security, Vol. 7, No. 2, 2010

[7] Yongqiang H.; Jianxin W., "A Study on Fuzzy Evaluation of E-learning Teaching Quality," e-Business and Information System Security (EBISS), 2010 2nd International Conference on , vol., no., pp.1,4, 22-23 May 2010 doi: 10.1109/EBISS.2010.5473769

[8] Rheingold, H. (1993). *The virtual community: Homesteading on the electronic frontier*. Reading, Mass: Addison-Wesley Pub. Co.