Learning Management System and the Underlying Learning Theories: Towards a new Modeling of an LMS

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***Abstract*—The problems of most Learning Management Systems (LMS) are first of all of a pedagogical nature and then of a technical one. Studying these problems, which are interrelated, provides a useful conceptual reference that enables us to design a new model for a more relevant solution. In this paper, a conceptual model of an LMS is presented, based on the hybridization between four learning theories, namely the traditional pedagogy, the behaviorism, the cognitivist, and the social constructivism. We will present at first each of these learning theories by discussing both their advantages and limits. Then, together the main principles of these learning theories and the technical functionalities of the proposed LMS that result from the hybridization of these principles are outlined, fit the needs of their final users, in particular learners.**

***Index Terms*—Learning Management System, learning theories, conceptual model, the modeling of LMS**

I. Introduction

During the last decade, e-learning platforms have evolved considerably. However, a number of comparative studies [1], [2], [3], [4], [5], [6], [7], [8], [9] have shown that their life cycle continue to change at a fast pace. Therefore, we have conducted a comparative and analytic study on free e-learning platforms based on our own approach of evaluating the e-learning platforms quality [10], [11], [12], [13]. Our main objective was to provide a useful tool that can help educational institutions to make the right and best choice among the available e-learning platforms. Different approaches of evaluating the e-learning platforms quality have been already proposed [14], [15], but no one of them has been adopted here because they focus only on technical aspects and neglect other important aspects such as security, maintainability, portability, compatibility, performance efficiency and usability.

In light of our studies and the previous ones we think that most of e-learning platforms including the LMS were initially developed a decade ago, based on a classical training model. The teacher is considered as the one who holds the knowledge and transmits it, according to different modalities, to future learners in order to foster their learning. They are mostly TMS[1], that is to say tools at the teacher's service to create and manage courses rather than at the service of learners and the learning process. Therefore, we have decided to work on a new conceptual model that combines between learning theories in order to promote both the teaching and learning processes.

The proposed LMS which results from our new conceptual model and which we plan to implement at a later stage, will be based on collaborative learning. Both teachers and learners are able to create, organize and propose different types of activities (forum, wiki, blog…) as they like. Furthermore, they are able to access and manage their interactions via these activities where and when they want according to their needs and objectives in terms of learning.

Our LMS will be built on the idea that we should give the same possibilities of action to both teachers and learners by distributing their control on the platform.

It is evident that the use of any tool in the field of education must be justified according to its pedagogical support and its capacity to address the real needs of its final users, particularly learners. However, it should be noted that although seen as an effective solution for overcoming space-time restrictions, the platforms might be an obstacle for the learning process to the extent that the pedagogical principles are neglected during their design. Thus, when designing our LMS we have tried to answer at first the following questions:

- How an LMS should be modeled to fit better the requirements of standards and norms of e-learning programs?
- To what degree of specificity could the LMS respond as an innovative technical system?
- To what degree of specificity the learning theories could promote the online learning?

These and many other questions were investigated within our work. Our objective was to test and to check if our hybridization is worthy and useful for the design, development and diffusion of e-learning systems, particularly the LMS.

The present study attempts to bring some light into the questions above by exposing at first the four learning theories that were judged the most important and relevant to our modeling, namely the traditional pedagogy, the behaviorism, the cognitivist, and the social constructivism. Then, these learning theories which have inspired for a long time the design of computer applications are combined and put into perspective

[1] **TMS:** Teaching Management System

with several emergent pedagogical functionalities to build an original modeling for our new LMS.

II. LMS AND ONLINE LEARNING

A. Definition

An LMS (Learning Management System) or e-learning platform is a software including a range of services that assist teachers with the management of their courses. Moreover, as defined by the OVAREP, "the LMS e-learning platform is a computing device that groups several tools and ensures the educational lines. Across dedicated platforms to the ODL (open and distance learning), all conduits are preserved and expanded for the learner, tutor, coordinator and administrator within the e-learning platform" [8]. It offers many services allowing the management of content, particularly by creating, importing and exporting learning objects. The set of the available tools in the LMS represent all these services that help in managing the teaching process and the interaction between users such as the access control services, synchronous and asynchronous tools of communication and user administration services.

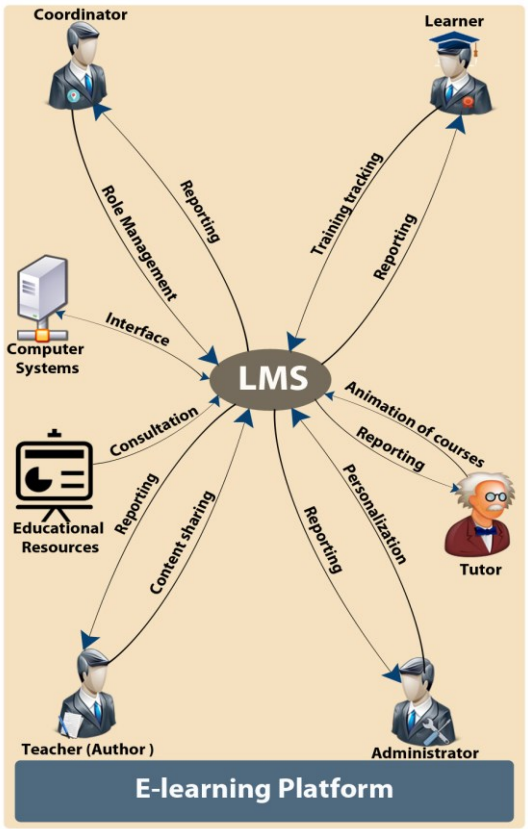

Fig. 1. The general architecture of an LMS

More precisely these services are linked to the following variety of functionalities:

- The management of pedagogical content (creating, importing and exporting learning objects),
- The creation of individual's personal paths in the training modules,
- The availability of sharing tools,
- The distribution of communication tools,
- The student registration and the management of their files (training tracking and results),
- The distribution of online courses and many other pedagogical resources.

Figure 1 illustrates the general principle of the operation of an e-learning platform LMS by presenting the key features associated with the main actors: learners, teachers, tutors, coordinators, and administrators. The learner can consult and/or download the resources made at his/her disposal by the teacher, he/she can create his/her learning activities while following his/her progress in training. The teacher, who is responsible of one or more modules, can create and manage the educational content he/she wishes to broadcast via the platform. He/she can also build tools for monitoring learners' activities. The tutor accompanies and monitors each learner by providing the tools of communication and collaboration. Concerning the coordinator, he/she ensures the management of the overall system. Finally, the administrator is responsible for the customization of the platform having the rights of the administration deriving from it (system installation, maintenance, access management...).

B. Benefits of LMS

The LMS on which we increasingly rely as a means of learning have a considerable potential in the construction of knowledge and competence development. Thanks to the different services offered by these e-learning platforms, individuals can access and use interactively the multiple sources of information available to them everywhere, at all times. They can also compose customized training programs and thus develop their abilities to the highest level of their potential according to their needs [16].

Based on this work [17], the main pedagogical functions that may be assigned to the LMS as computer applications for learning are:

- Presenting information,
- Providing exercises,
- Really teaching,
- Providing a space of exploration,
- Providing a space of exchange between educational actors (learners, teachers, tutors…

These different pedagogical functions, that correspond to one or many learning theories, allow the learner to acquire individual and collective knowledge according to the type of interaction that takes place between him/her and the sources of information made at his/her disposal. In practice, each individual has a set of tasks to deal with such as:

- Consulting and reading the pedagogical resources,
- Realizing the interactive exercises,
- Exploring the learning environment,
- Solving the problem situations,
- Discussing via synchronous and asynchronous tools of communication.

A. *LMS features*

An LMS eLearning platform exists to bring answers to the following problems:

- Expand the training offered through the ODL and allow those who find training constraints to have opportunities to overcome them,
- Access to the best management of time jobs by reducing the supply in presential training,
- Develop exchange, inter-actors of training,
- Innovate the teaching practices by using new technologies for communication and training,
- Introduce other modalities of training such as management of collaborative projects,
- Foster the role of tutoring that allows reducing the sensation of isolation, often the cause of stalling and abandonment.

An LMS eLearning platform fits well in several pedagogical models. We defined our expectations in matters of content and teaching modalities for all the actors: learners, integrators, tutors, coordinators and administrators.

Learners are invited to

- Attend pedagogical activities that take various forms, both specific and general (problems, simulations, QCM, tests self-correcting),
- Include interactive teaching resources in various formats (text, image, audio, video, PDF, Flash),
- Realize situations for assessments,
- Access collaborative working from shared documents.

The learning path is divided into two entities:

- Entity 1 consists of creating modules that are broken into several units that contain various resources (documents, activities, quiz) and learning path-oriented supports (individual or a group),
- Entity 2 consists of achieving a set of activities (in relation to the objective of the module) as part of project-based teaching, courses oriented activities.

Teachers (course designers) are responsible for the preparation of training courses with regard to

- Creation of the teaching resources interface with the training management systems (AICC, SCORM, etc.),
- Sharing educational resources (course modules, evaluations, etc.),
- Planning of pedagogical resources.

Tutors are responsible for

- Taking charge of learners by an individual tracking system, animation and / or moderation of forums,
- Initializing the conversation within the chat, which is responsible,
- Follow-up the learners in videoconference,
- Monitoring activities and proposed projects,
- Planning the interventions,
- Monitoring the groups' management.

Administrators and coordinators are responsible for customizing the platform with regard to

- Establishing the groups,
- Monitoring the activities of teachers,
- Managing the courses,
- Customizing the platform,
- Managing the roles.

III. THE MAIN THEORETICAL CURRENTS

Education sciences draw their theoretical foundations, among others, in psychology, sociology, philosophy and cognitive science. This diversity of theoretical fields at the base of the different approaches to teaching and learning can sometimes be confusing insofar as some authors may find themselves inside of more than one theoretical current. Currently, a majority of educational theorists agree to group teaching and learning models according to four currents: traditional pedagogy, the behaviorist, the cognitivist and the social constructivism.

This paper describes the four previously mentioned currents, in a synthetic way that identify the main characteristics and technological adapted tools. In addition, it contains examples that illustrate the underlying key concepts and make the link with the LMS e-learning platform. Addressed in a historical perspective, this document intends to nourish the reflection of teachers who want to situate their educational practices inside a conceptual framework and who want to be able to appreciate the complexity and impact of their pedagogical actions.

Table 1 shows a schematic summary of the four main currents by linking them to the act designs of teaching and learning that correspond to them. Figure 2 offers a global overview of the chronological evolution of the theoretical currents and allows identifying its most influential respective authors.

TABLE I.
SCHEMATIC PRESENTATION OF THE MAIN THEORETICAL CURRENTS

Traditional pedagogy	**Behaviorist**	**Cognitivist**	**Social Constructivist**
Teaching is about …			
Presenting information in a structured, hierarchical, and inductive way.	Stimulating, creating and reinforcing appropriate observable behaviors.	Presenting information in a structured, hierarchical, and deductive way.	Organizing learning situations conducive to dialogue with a view to provoke and resolve sociocognitive conflicts.
Learning is about…			
Following the course: unfolding the course and the tutor.	Associating, by conditioning, a reward to a specific response.	Treating and storing new information in an organized way.	Co-constructing his / her knowledge by comparing his/her own representations with those of others.
Appropriate teaching methods			
Learning by course, exercises and assessments	Assisted self-study program	Formal presentation, problem-solving situations.	Projects, discussions, exercises and work based learning.

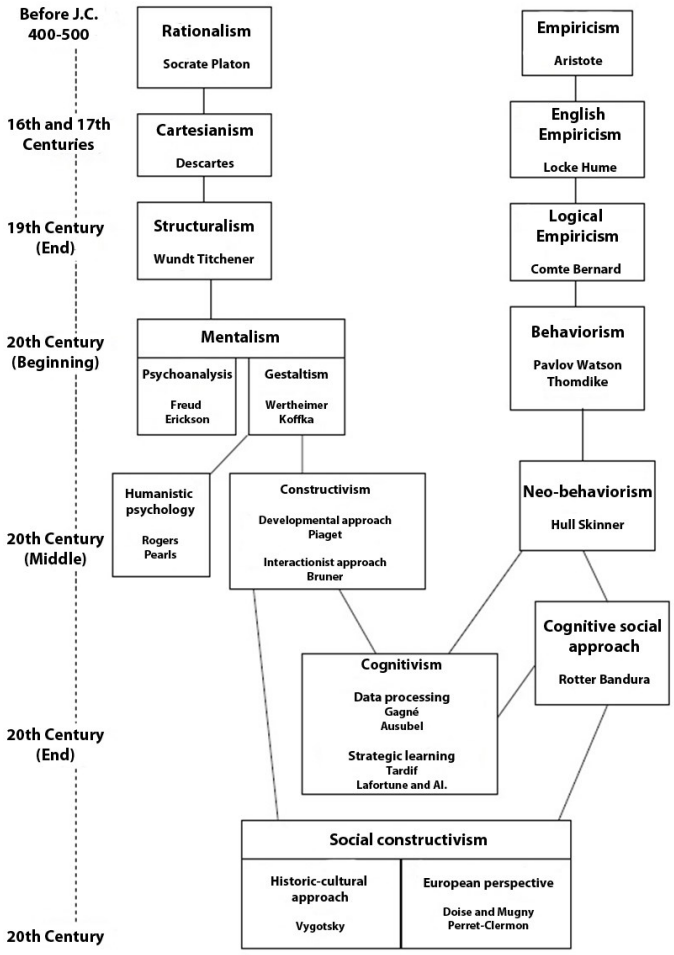

Fig. 2. History and evolution of the theoretical currents of learning adapted from Minier (In Kozanitis) [34]

IV. LMS AND THE UNDERLYING LEARNING THEORIES

Although their considerable potential in the construction of knowledge and competence development, the LMS can generate a real pedagogical success only if, their use relies on solid and proven learning theories [16].

In the next part, we will evoke the transposition of the use of four learning theories in the design and development of LMS. For that purpose, we will do the correspondence between the tools available in LMS and the learning theories to which they refer. As a latter part will show, the hybridization of these learning theories that we have judged more important and relevant to our modeling work can only be a source of enrichment to improve the quality of online learning.

A. LMS and the traditional pedagogy

The conception of learning as supported by traditional pedagogy is essentially relying on a direct and systematic mode of transmission. Indeed, we put forward the authoritarian role of the teacher who must deliver fixed and unchanging knowledge, evaluate and involve learners by following the different stages of a pre-established scenario. From this perspective, learners are only passive recipients of information who respond ideally to external factors provided by their teacher in advance in a particular environment. In this way, they develop their knowledge. Among the main ideas that are associated with the traditional pedagogy [26], we mention:

- Lecture-based teaching: this idea generally refers to the teaching-centered pedagogy in which the teacher is the main provider of subject content to learners. The acquisition of knowledge is assessed through various operations of reproduction such as recitation, examination and practical exercises. Only the teacher has overall authority over learners who must follow his/her instructions and show goodwill to construct their knowledge in a more effective manner.
- The idea of transmission and reception: we consider that the teacher delivers knowledge in ways that are clear, concise and transparent and the learner receives it without any difficulty of memorization, understanding and reproduction. Trial and error learning seems not having its place in that perspective. The learner must listen, deploy efforts to study well and recite in accordance with the teacher expectations. The pedagogical relation is ideal from the teacher's point of view, the learner's spirit and the object of transmission.
- Individualism: the learner is a part of a group but still works individually. No exchange between learners is allowed. Obviously, this implies absence of debate, dialogue and communication. Everything is centralized around and by the teacher. No cognitive and social dimension exists in the learning process.
- The sanction: the role of teacher is to identify errors. Learners are classified in order to generate the spirit of competition between them. Those who fail to learn are those who commit one or many errors. Making errors is not considered as a necessary step for learning but it is seen as being the fault of the learner who had not shown goodwill to learn.

These main ideas from the traditional pedagogy have had an impact on the design and development of LMS, which focus on learning by reception. Indeed, this kind of software integrates different spaces in order to allow teachers organizing, structuring, exposing their knowledge and particularly assessing the learning progress. Thus, a central place is given to teachers, who do have the necessary tools to deliver knowledge and engage learners in the proposed learning activities of reproduction, consultation and execution.

In general, we think that the contribution of the traditional pedagogy is so valuable to the extent that it allows teachers to facilitate and assist learners by making at their disposal well-structured information based on over-prescriptive scenarios. These latter are necessary and useful to those who need it (learners with low autonomy). Furthermore, verifying the acquisition of knowledge is crucial for the validation of skills and the decision-making process on remedial measures to be taken.

However, traditional pedagogy has its limits that rely very much on the fact that learners who are considered as the main actors in the teaching learning process are widely neglected. Their needs are not taken into consideration and they are only

seen as passive receivers of knowledge. Moreover, the teacher uses only one instructional method: the exposé, to teach a heterogeneous group of learners. This goes against the principle of differentiated instruction, which highlights the necessity to address the needs of all learners to ensure the effectiveness of learning. Finally, the interactivity is omitted while it is considered as being the primary driver in the development of skills and knowledge.

B. LMS and the behaviorism

The behaviorism is a learning theory concerned with the study of human observable behavior without recourse to inner mental states [29]. It is built on the assumption that the brain is only a black box that no one can access.

The term "behaviorism" appeared at the beginning of 20th century in parallel with works of the American psychologist John Watson. This latter is considered as the pioneer of the behaviorism. He proposed making the general psychology a scientific discipline by using experimental laboratory methods to set exploitable results that can then statistically evaluated [22]. Works of the physiologist Ivan Pavlov on conditioning of animals influenced Watson. This leads him to admit that all behavior operate on a principle of "stimulus-response" or what is called "classical conditioning".

In the same vision, Fechner compared an individual to a black box, which we do not know what is going inside it, but may help us to predict certain behavior. Indeed, by providing specific stimuli we always get the same output results [44], [27].

Behaviorist theories consider that learning consists in acquiring a new behavior, or modifying an existing one. From a psychological viewpoint, Fablet defines learning as: *"a more or less durable effects process whereby new behaviours are acquired or already existing ones are modified with the environment" [The translation is ours]* [45].

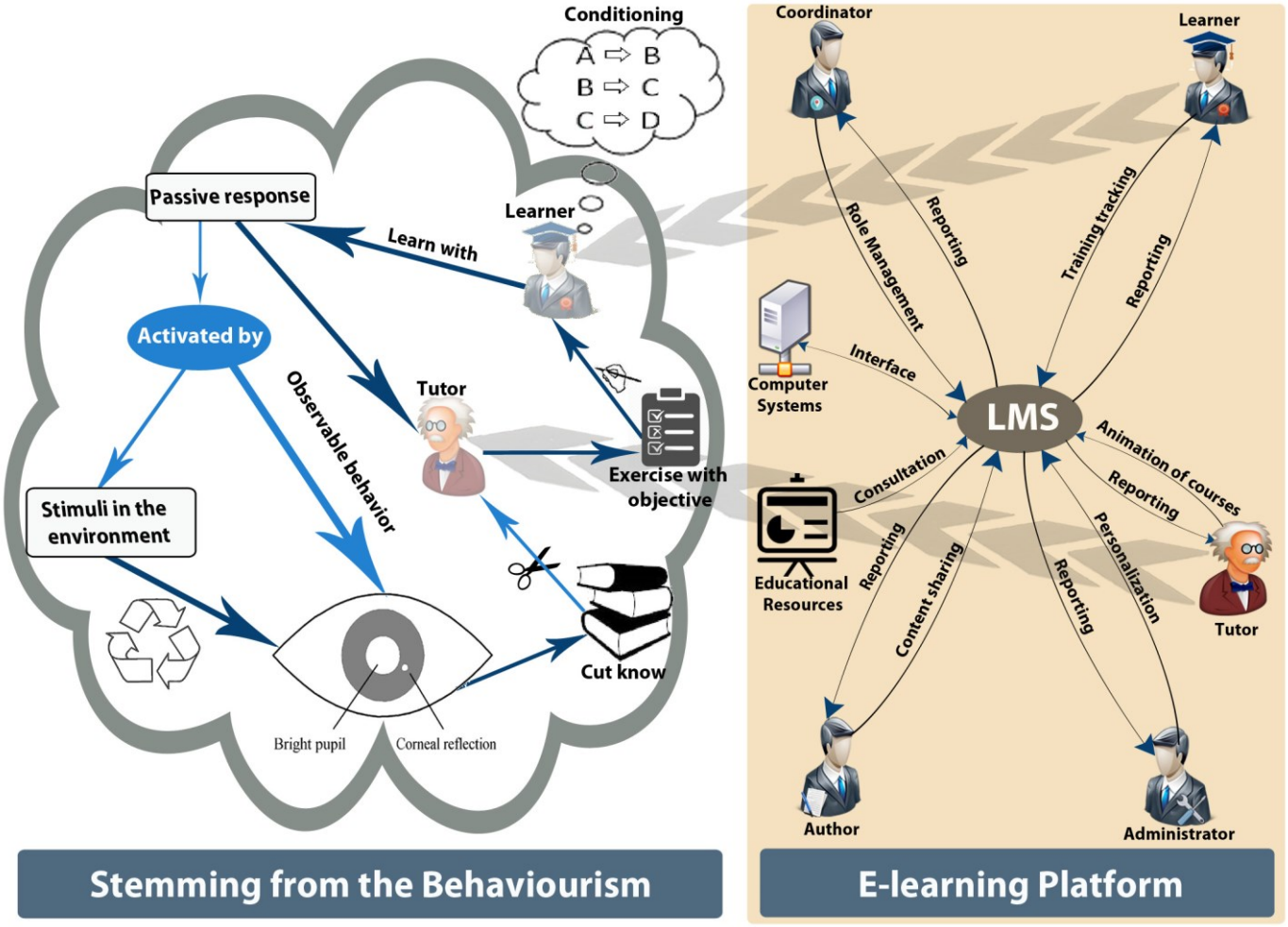

Fig.3. LMS and underlying behaviorism model

For the advocates of the behaviorism (such as Pavlov and Skinner), the learning process is perceived in a very simplistic way as an external change in human behavior which results from a specific instrumental conditioning. This means that the confrontation of any individual with a discriminative stimulus inevitably leads usually to the emergence of constructed responses over time. To teach a certain skill, the behaviorist approach proposes to break it down into sub-objectives, which have to be simultaneously assimilated and mastered. In this perspective, the teacher should be able to present information

to learners under restricted stimulus associated with reinforcement. Obviously, the learners' role here is to respond to these stimuli by adopting the expected behavior. The teacher also proposes progressive practical exercises that allow checking the acquisition of knowledge while giving positive and/or negative feedback based on the responses provided. The type of the pedagogical scenario that prevails in that case is the one, which highlights learning by reception-exercises-test.

The mark of behaviorism (cf. figure 3) can be found in the LMS which display systematic exercises allowing learning by repetition (trial and error) and in which the principles of conditioning are integrated.

Although the behaviorism had focused more broadly on supporting the change of superficial behavior by allowing the development of certain procedural knowledge in an individual and progressive way, the deep understanding of notions is not attainable from this perspective.

C. LMS and the cognitivist

Cognitivist is born at the same time as the Artificial Intelligence, in 1956. It focuses on the ways of thinking and solving problems. Learning cannot be limited to a conditioned recording, but should rather be considered as requiring complex processing of the received information. Memory has its own structure, which involves the organization of information and the use of strategies to manage this organization [25].

Indeed, the initial questionings of Behaviorists designers goes back to the publication by Miller in 1956 of an article entitled "The magic number 7, more or less 2" [34] in which the physiological limits of human memory were highlighted. According to this author, the capacity of human memory is limited to seven isolated elements. Obviously, this is not compatible with the behaviorist design, which sees memory as a virgin receptacle in which knowledge accumulates.

Moreover, the constructivist Bruner is also considered as a cognitivism precursor. During his works on categorization based on ranking of maps with different shapes and colors, Bruner realized that subjects use different mental strategies. Some proceed starting from a reference map; others realize a ranking based on all maps. This notion of mental strategy has made a radical change in learning theories by taking an interest in the cognitive approaches implemented by the subject

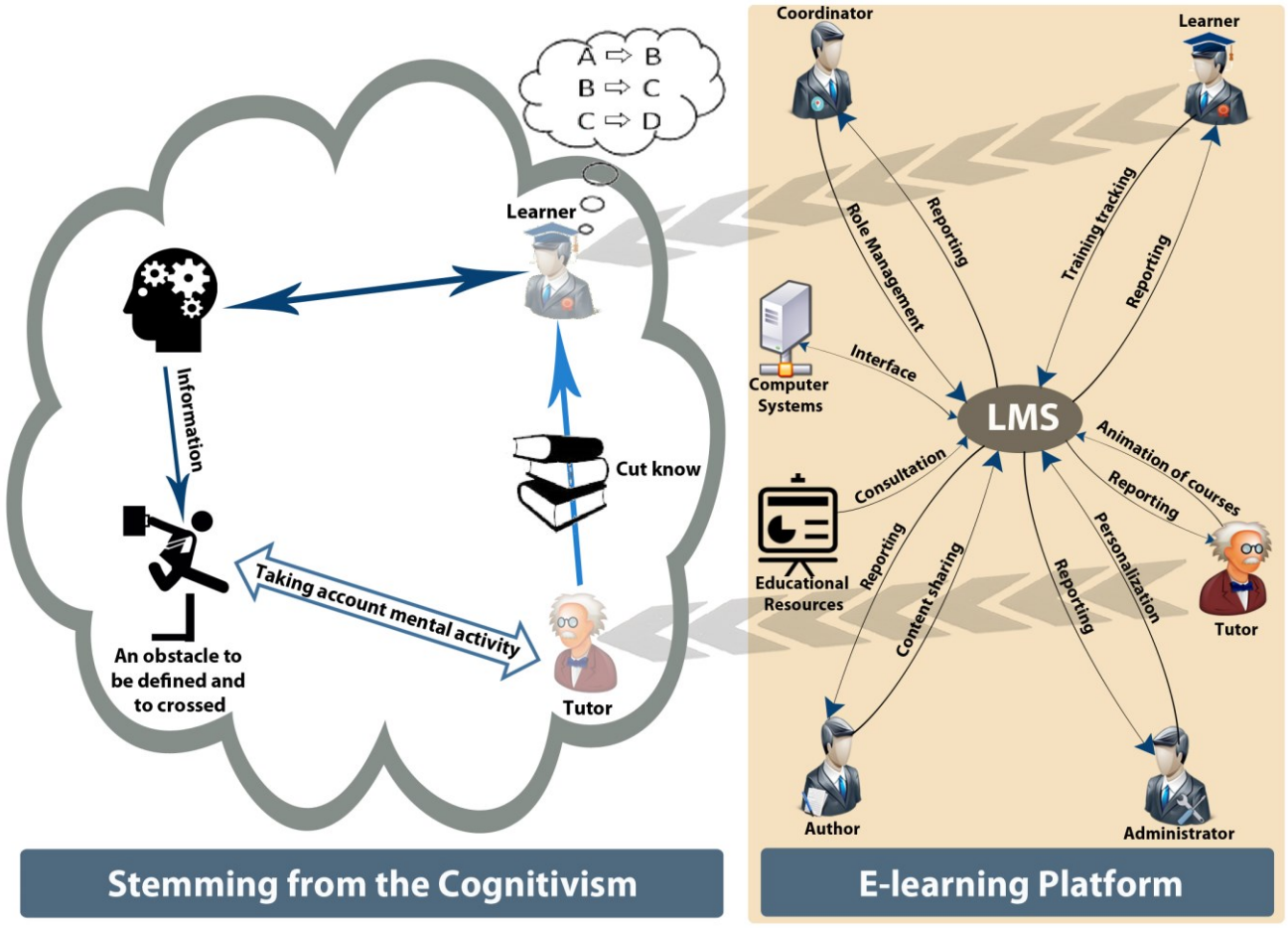

Fig.4. LMS and underlying Cognitivist model

Cognitive psychology considers that there are three broad categories of knowledge: declarative, procedural, and conditional knowledge. It invites the teacher to develop different strategies to facilitate the integration of each of them because they are represented differently in memory; the declarative knowledge gives an answer to the WHAT, the

procedural knowledge to the HOW and the conditional knowledge to the WHEN and to the WHY (In Chekour and al.) [27].

There are different categories of cognitive strategies that contain several types of strategies. Furthermore, cognitive and metacognitive strategies can be the subject of a systematic teaching. In addition, the authors [21], [20] insist for that the teaching of these strategies be carried out in the learning context, in the program course. The teaching of these strategies will be effective if these strategies are integrated in the ordinary curricula, and presented to learners as a necessary means to the achievement of the learning objectives. However, the quality education is not limited about telling learners what to do; it consists also about showing how to learn. Tardif [19] presents a learning model based on the importance of the gradual and effective appropriation of cognitive and metacognitive strategies. This model aimed at stimulating cognitive and emotional engagement, showing the learner how to treat the information in an adequate way and enabling him/her to appropriate knowledge. In this way, the teacher plays a mediation role by guiding the cognitive activity of learners.

In an LMS based on the cognitivist approach (cf. figure 4), the learner is an active information-processing system, like a computer: it perceives information that comes from the outside world, recognizes them, stores them in memory, and then recovers them to understand the environment or resolve problems [32]. The teacher is the learning manager. He/she guides, animates, directs, advises, explains, regulates, and remedies. Knowledge become an external reality that the learner must integrate into his/her mental patterns and reuse rather than acquire observable behaviors [31]. The best teaching method is the one that takes into consideration individual variables particularly the learning styles. Therefore, the cognitivist teacher is the one who uses ICTs that promote high interactivity with learners, such as simulators, experiments and intelligent tutorials. However, the cognitivist model has an important limit, related to the fact that a well-structured material is not sufficient to ensure learning. The motivation of learners is a crucial factor because it provides the required energy to perform learning.

D. LMS and the social constructivism

The social constructivism is the fruit of the development of learning theories under the influence of some researchers, particularly Lev Vygotski in 1934 (In El-Mhouti and al.) [28], who wanted to depart from the behaviorism by integrating other factors that are able to positively influencing the knowledge acquisition. Thus, new ideas emerged in connection with the possible interaction of individuals with the environment.

Doise, Mugny and Perret-Clermont (In Joshua and Dupin) [46], extend the works of Vygotsky and affirm that an opposition between two learners, in the case of sociocultural situations, allows generating sociocognitif conflicts. Thanks to these latter, the acquisition of knowledge is effective.

In this regard, we stress that social dimension is required for learning to occur. In other words, knowledge is constructed because of peers' interactions in cases of problem-solving situations. Consequently, teaching consists of providing methodological assistance to learners by orienting them towards collaborative tasks. Indeed, this type of tasks allows them to structure their thoughts based on others' experiences and the information provided by the learning environment.

The social constructivism outlines learning by construction in a community of learners. In this light, learners are expected to interact with the available human resources (teachers, tutors, other learners…) in the proposed learning environment. In this way, the learners' psychological functions increase through socio-cognitive conflicts that occur between them. These conflicts lead to the development of the zone of proximal development[2] [23] and thus facilitate the acquisition of knowledge.

Learning is seen as the process of acquisition of knowledge through the exchange between teachers and learners or between learners. These latter learn not only through the transmission of knowledge by their teacher but also through interactions [33]. According to this model, learning is a matter of the development of the zone of proximal development: this zone includes the tasks that learners can achieve under the guidance of an adult; they are not very tough or so easy. The development of this zone is a sign that the learners' level of potential development increases efficiently [30].

The teacher's role is to define precisely this zone in order to design suitable exercises for learners. Furthermore, designing collaborative tasks, which involve discussions and exchange (socio-cognitive conflicts) between learners is so important in this model. Errors are considered as a point of support for the construction of new knowledge.

The contribution of Bruner [47] in the social constructivist theory is so valuable. Indeed this author explained that the traditional model considers the teacher as the single operator, which prevents learners from being autonomous. According to him, the teacher should propose the most agreeable tasks to be achieved under his/her guidance by avoiding the dependence of learners on him/her. Keeping learners motivated and involved in learning is required to ensure the quality of both teaching and learning.

Based on the social constructivism approach (cf. figure 5), the design of LMS were oriented towards integrating online communication and collaboration tools. In practice, a wide range of platforms, particularly the social constructivist ones, propose a set of tools, which allow sharing, exchanging and interacting in synchronous and asynchronous mode such as blogs, wikis, forums…

In summary, the ideas of social constructivist authors have highlighted the social nature of learning. Other authors have taken one-step further by emphasizing the distribution of

[2] "The distance between actual development level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978, p. 86)".

intelligence between individuals and the environment. Furthermore, considering that learning occur in a social context is no longer enough to ensure deep learning. Indeed, working in groups can affect negatively the quality of learning if these following conditions are not taken into consideration: Learning styles, the way groups are formed, interaction modality, and the characteristics of tasks.

Moreover, it is very tough to change the habits and conceptions of individuals which makes more complicated the problem situations. Finally, there is always a risk that the subjectivity during collaborative tasks prevails over individual learning.

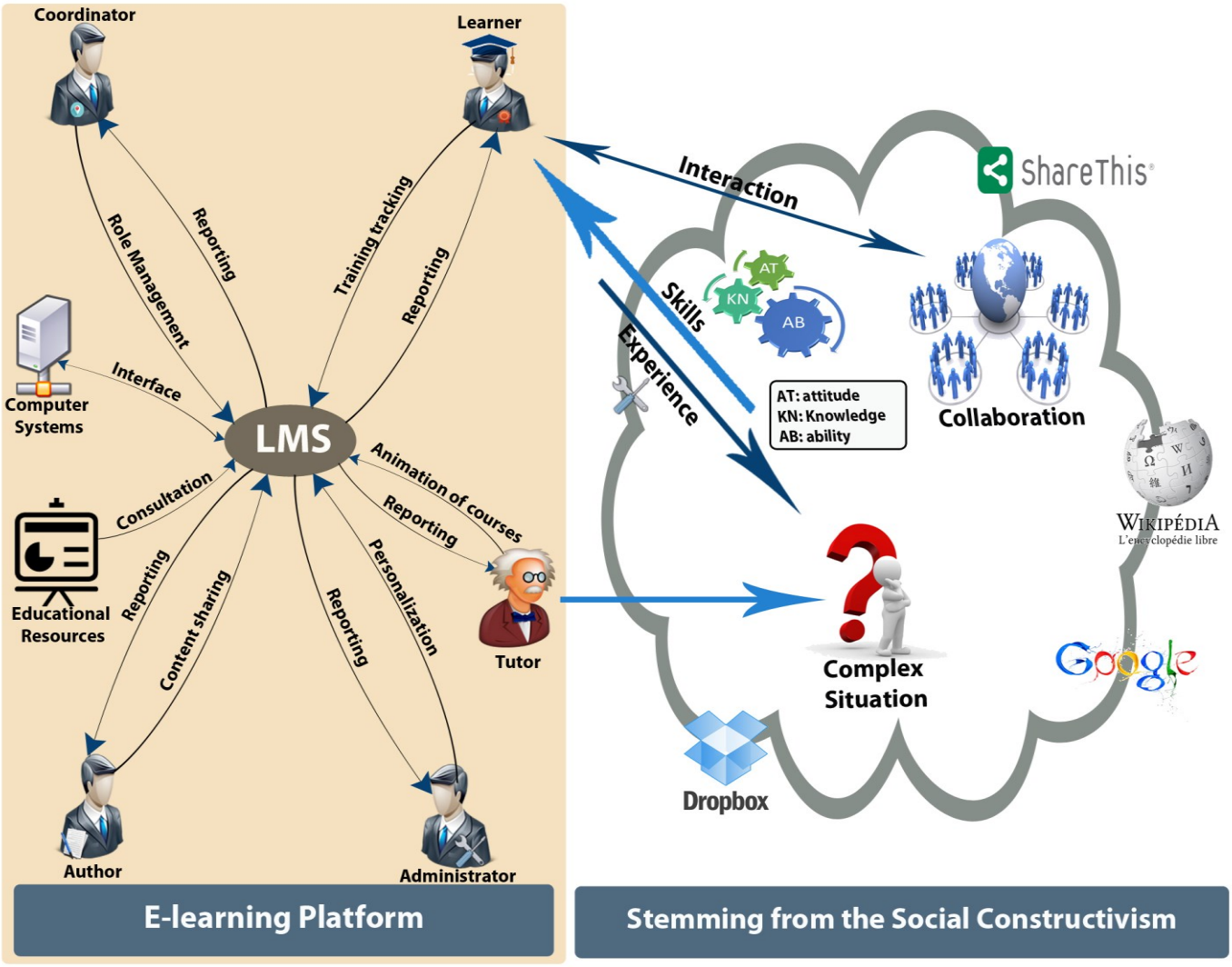

Fig. 5. LMS and underlying social constructivism model

In addition, connectivism can considered as a branch of the social constructivism. It is not necessarily a learning theory, but rather a pragmatic concept of participatory teaching and learning [24], which is relying on assumptions of Latours Actor-Network-Theory [18]. If viewed as a theory by itself, it would also overlap with the social constructivist paradigm in terms of the importance of interaction in social structures.

The exponential expansion of ICT has affected widely our relationships to knowledge in particular and to world in general. Many researchers have tried to propose a new paradigm, which could adapt to the requirements of learning by educational technologies. These requirements that other learning theories have not meet until now.

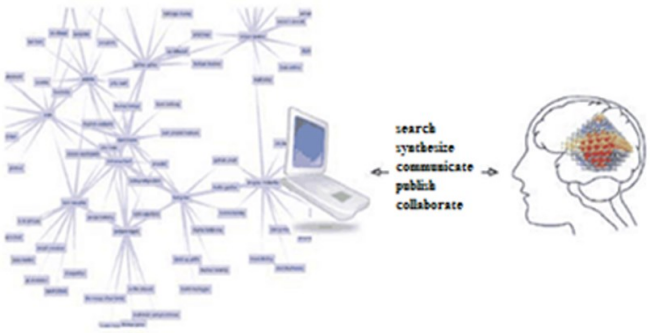

Fig. 6. Siemens's connectivism model (In Chekour and al.) [27]

George Siemens and Stephen Downes who developed the

connectivism, they are based on the principles of connection, online networking and thus interactions between objects of the world (material or symbolic). According to these researchers, other learning theories have been developed in a period of time in which learning was not widely affected by the presence of technologies [49]. They stated that connectivism is based on the use of a network composed of nodes and connections as a central metaphor of learning [35]. In this metaphor, a node can be information, data, feelings, pictures or simulations. Learning is the process of making connections, including the neural ones, the connection between humans, computers and the interconnections between different fields of knowledge [49].

For George Siemens, learning is the process of acquisition of knowledge that is located not only in human brain but also in networks of connections (links) which could be created between the users of a particular learning environment under certain conditions. This means that knowledge is distributed in the technological learning environment and individuals can acquire it only if they develop skills of researching, filtering, analyzing and synthesizing the collected information during the exploration of networks of connections around them [48].

According to Siemens [49], the main principles of connectivism as a new learning theory that focuses on the navigation of knowledge are:

- "Learning and knowledge rests in the diversity of opinions.
- Learning is a process of connecting specialized nodes or information sources.
- Learning may reside in non-human appliances.
- Capacity to know more is more critical than what is currently known.
- Nurturing and maintaining connections is needed to facilitate continual learning.
- Ability to see connections between fields, ideas and concepts is a core skill.
- Currency (accurate up-to-date knowledge) is the intent of all connectivist-learning activities.
- Decision-making is in itself a learning process".

These different principles have given birth to many learning environments, particularly LMS, offering mainly what we call open massive online courses (MOOCs). These courses, which include a set of online resources, are connectivists. In other words, they highlight the creation and genesis of knowledge and not the reproduction of this latter. This is not the case in xMOOCs, which are designed based on traditional pedagogy. Therefore, a wide range of tools has been integrated in most LMS in order to ensure interactivity and so to allow online exchange and collaboration. Among these tools, we mention online social networks, sharing-resources websites, forums… and any other tool that can connect learners together.

The connectivism benefits [49] as a new learning theory reside on the importance given to the principle of connection which leads to the understanding of the learning process by describing how and why connections are formed in different levels: neural, cognitive/conceptual and social.

Beyond that, connectivism seems to be widely criticized since it does not describe in detail how individuals learn in a particular technological environment whereas this constitutes the core problem of each learning theory.

V. MODELING OF AN LMS

A. *Preface*

The problems of most Learning Management Systems (LMS) are first of all of a pedagogical nature and then of a technical one. Studying these problems, which are interrelated, provides a useful conceptual reference that enables us to design a new model for a more relevant solution. This solution can only be a new learning management system (LMS) that has to be developed to address the needs of all its users, particularly learners.

The modeling presented here tries to propose a relevant solution to some of these problems based on the following three principles:

- Describing the type of the learning activities proposed and their paths (free, sequential, conditional…),
- Identifying different actors and/or groups of actors according to their roles and the tasks they have to achieve,
- Describing different spaces of activities in the learning system. Each space includes various resources such as multimedia documents, forums, wikis, video conferencing, mind maps, exercises…

B. *The conceptual model*

The modeling of our LMS that will be presented in detail here offers both pedagogical and technical richness in terms of functionalities. It allows not only supporting the learning process but also the teaching process by facilitating the design and development of online training systems.

Our LMS is based on an original pedagogical reference that combines between four learning theories and their emerging functionalities aiming to improve users' teaching and learning processes.

As seen in Figure 7, each of the four theories of learning involved in our modeling brings benefits in terms of the teaching-learning process and contributes to the enrichment of our LMS.

Based on behaviorism, the LMS that we propose is broken down into learning units, which offers the possibility to present structured knowledge and learning activities (progressive application exercises) and assistance. Social constructivism allowed us to justify the integration of services allowing the installation of internal and external applications enabling communication and collaboration between educational actors. In this manner, the knowledge building in a group outweighs the individualization of learning path. In addition, the cognitivism opened the door for the use of multiple learning pathways to take into account individual variables that may influence the way in which learners' process information. The cognitivist teacher is invited to use ICTs that promote high interactivity with learners, such as simulators, experiments and intelligent tutorials. This obviously does not prevent the development of personal learning environments in parallel to

the services offered according to the needs of each of the actors involved in the training device.

Furthermore, the traditional pedagogy, the behaviorism, the cognitivism, and the social constructivism have allowed us to propose a personal office, which consists of different spaces for activities of teaching and learning within the LMS (cf. figure 2). In these spaces, both teachers and learners can:

- Transmit and present structured information in different formats: text, video... (disciplinary information space);
- Communicate with one or more actors (communication space);
- Sharing with one or more actors (sharing space);
- Interact and collaborate together and/or with other actors (collaboration space);
- Evaluate themselves and evaluate the resources of information produced (evaluation space);
- Produce information (production space); Select and use various tools according to their needs (self-management space);
- Propose and / or receive personalized assistance (assistance space).

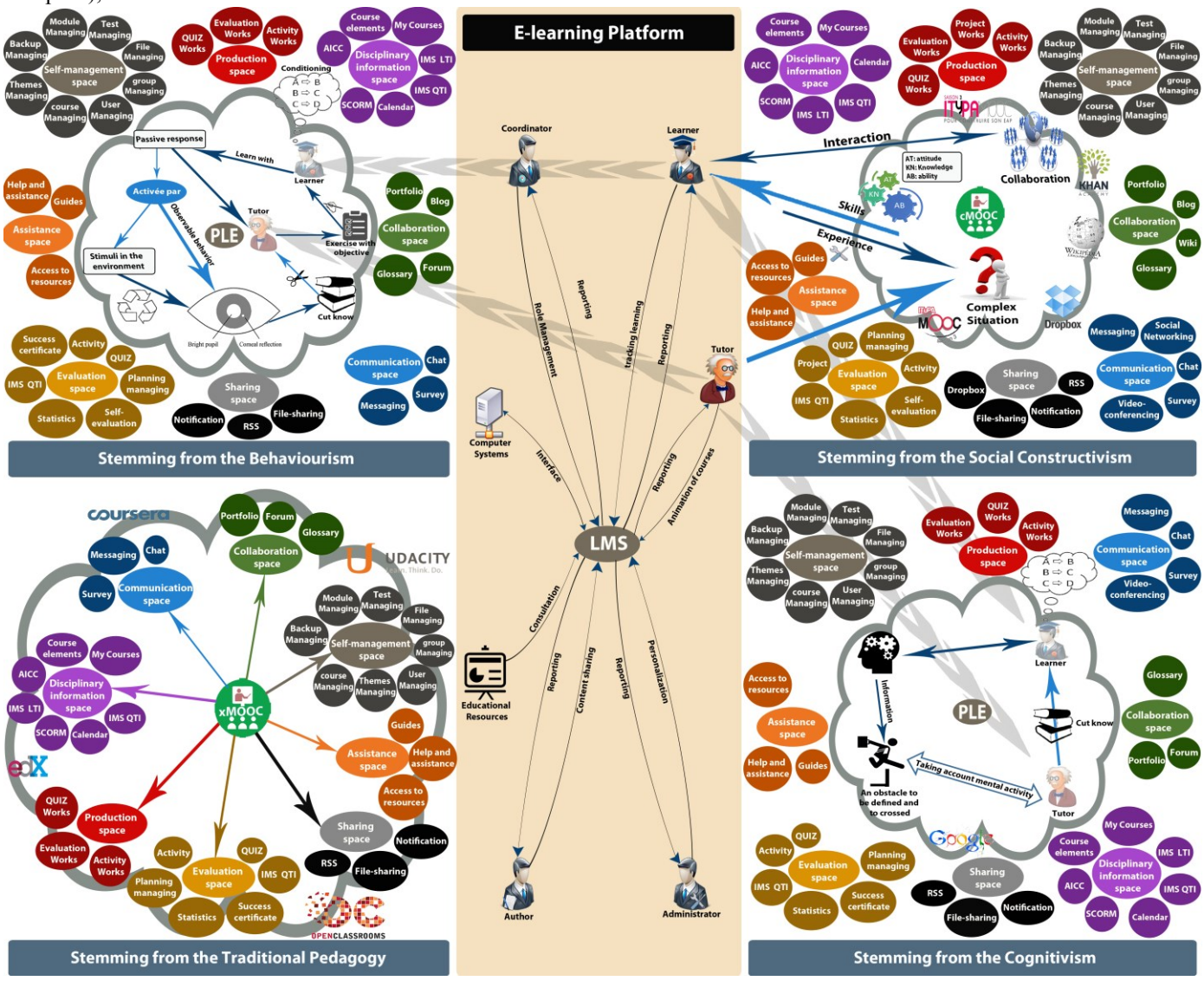

Fig. 7. The conceptual model of an LMS

Thus, the modeling that we propose in this paper makes at the disposal of its users a wide range of spaces for information, production, assessment, communication, collaboration, assistance and self-management in order to enable them to manage well various online training systems (e-learning, blended learning, MOOCs…). In the context of MOOCs which *"refer […] to massive online training[s] relying on numerical technologies and social web" [The translation is ours]* [52], these spaces are presented in a way that ensures more freedom of choice and action for all users, particularly learners. Thus, the latter can control their training and learning. Indeed, whether in xMOOC, which relies on traditional pedagogy [51], and thus focuses on the content, or in cMOOC, which is based on connection that means network-oriented [53], according to our modeling all final users are able to configure the LMS as they like thanks to the integrated web services. These web

services are available through modular interfaces designed independently of the LMS. In this way, the different users can access to the malleability offered by our LMS. According to Hoogstoel, this malleability which *"allows improving the individual motivation of actors and promoting their engagement" [The translation is ours]* [54] is possible through automatic configuration of the proposed tools, adaptation to the proposed interfaces and their customization in accordance to the defined roles.

It is therefore clear that the hybridization of the four learning theories has allowed us to provide the greatest pedagogical and technical richness for both learners and teachers.

Obviously, the principle of reusability and interoperability were taken into consideration when working on the proposed modeling. Therefore, we applied the focused-resources approach, which is mainly based on the notion of *"bricks"* and *"aggregates"* [54]. This approach aims to allow the use and re-use of the learning objects in different contexts regardless of the mobilized pedagogical approaches and the designed scenarios. Another approach that has also inspired us is the one developed by Rob Koper (In Burgos and al.) [54], which outlines the notions of learning units and pedagogical activities. In practice, the final users of our LMS can model their needs and the type of activities they like in accordance with the assumed roles in the proposed learning environment. The latter provides various services, resources, and relevant tools to achieve the objectives in terms of learning.

Finally, it is worth noting that our modeling proposed [50] ensures the best management of online interactions; reinforces the learners' autonomy and sustains their motivations.

C. The modular approach

Adopting a modular approach when designing and developing a new LMS allows us deriving from it a granular structure that can adapt to different contexts. Thus, we have decided to comply with this approach by proposing a learning system based on the needs of all its users regardless their roles and the tasks they have to achieve.

The platform LMS that we plan to implement at a later stage will promote sharing experiences through the following technological advances:

- Activity spaces and generic tools: access to pedagogical resources (texts, videos, webography…) in accordance with different contexts of use: MOOCs, SPOCs, e-learning projects, blended learning…
- Resources and/or activities: text editors, files for download…
- Shared models of activity spaces and pedagogical paths.
- A complete redesign of self-corrected exercises tool for more interactivity and usable offline.
- A range of functionalities for the administrative management of training: management of training catalogues, registration, management of resources (local training, materials…).
- Improving the tracking services of the pedagogical activities and the integration of graphic exercises.
- A chat plug-in (text, audio, video) allowing the organization of webinars and virtual classrooms.
- The "inter-LMS" connection allowing exchanges between several LMS platforms.
- Improving the tracking of users via a dashboard system allowing tracking a user or a user group in a centralized way.
- Finally, an integrated error management and user tracking problems through integrated support Ticketing system for detecting bugs reported by the platform users.

When studying a number of LMS, we realized that most of them are arborescent, linear and are part of a closed course-by-course logic. They focus on teaching instead of highlighting the learner and the learning process. Most of these LMSs are actually TMSs (Teaching Management System), that is to say tools at the service of the teacher and not at the service of the learning process. Thus, our modeling reflects our intention of centering the user around the following two concepts, allowing the entire transversality and the desired personalization:

- Customizable personal office,
- Activity spaces and generic tools.

Therefore, the user will have a personal office that he/she can customize and a personal activity space, in which he/she is the manager. He/she can register in the activity spaces or even create them if he/she possesses the rights.

VI. SYNTHESIS

Several research [36], [37], [38] had for goal to implement and present the functionalities of LMS platforms and their possibilities to effectively manage users assessment approach (teachers and/or learners) within training institutions. Paquette [40] elaborated e-learning portals editor that opens the way to more diverse and evolved pedagogical models on the pedagogical plan. Moreover, in the framework of the European project Mediasite [39], a reference model for the process for distance learning has been developed. This theoretical framework has led to the integration of several applications (video-conferencing, document manager, portal...) in order to define an electronic training platform for online communication and/or collaboration.

Other research aimed at proposing the modeling of new units, approach, architecture, or adaptive, flexible and interactive e-learning devices. For example, Sadiq proposed the modeling of learning units on e-learning platforms, which relies on the application of the standard IMS Learning Design [41]. Tonye proposed a distance education model adapted to the African context [43]. Dahmani also presented an ontology-based modeling for interactive learning. His work deals with interactive learning and focuses particularly on the possibility of using the results of the ontological engineering in the modeling of educational domains [42].

A great deal of research is focusing in one way or another on the platforms engineering for distance education, including LMS. For example [27], presented a synthesis of the main learning theories in the digital era, namely: the behaviorism, the cognitivism, the constructivism and the social constructivism.

El-Mhouti [28] highlighted the ICT use in the service of active pedagogies, based on the social constructivist approach, the principles that structure the instructional design approaches, and the assessment of the social constructivist activities.

These works, among many others, emphasized the contribution of learning theories in the design and development of learning systems. The direct application of each of these theories allows particularly providing supporting methods to the design and development of LMS.

Based on these various research works, which seemed to us incomplete, we propose a modeling portrait of a new LMS platform. This latter is anthropocentric and relies on a learning conception that is located at the intersection of the most used learning theories. Indeed, the idea is to orient the design work research towards a great and optimal compatibility between the services offered by e-learning platforms and the needs of all users, particularly learners, for better optimization of online learning.

VII. Conclusions and Perspectives

In this paper, we propose the hybridization of four learning theories for the modeling of a new LMS platform. Our first motivation was to provide a more learner-centric LMS while opening it up dynamically to the teacher. Indeed the proposed LMS offers a range of customizable web services that fits users' needs. In this way, freedom of choice is left with regard to teaching and learning concerning the creation, adaptation, and personalization of various components of the LMS.

Modeling of the LMS is still taking place. We are looking at the implementation of its first prototype as part of university training with groups of teachers and learners. This will allow us to check the validity of our modeling work with the target audience and therefore take relevant decisions for better exploitation and wide dissemination of the LMS in the future.

References

[1] DOGBE-SEMANOU, DA. Koffi, A. DURAND, M. LEPROUST, H. VANDERSTICHEL, Etude comparative de plates-formes de formation à distance. le cadre du Projet@ 2L, Octobre, 2007.

[2] B. Dimet, "Etude comparative technique et pédagogique des plates-formes pour la formation ouverte et à distance," 15-Jan-2006.

[3] S. Menasri, "Etude comparative de plateformes d'enseignement en ligne (e-learning) utilisées dans un contexte universitaire," Jun-2004.

[4] M. Kaddouri and A. Bouamri, "Usage de plateformes d'enseignement à distance dans l'enseignement supérieur marocain : avantages pédagogiques et difficultés d'appropriation," Questions Vives. Recherches en éducation, no. Vol.7 n°14, pp. 107–118, Dec-2010. http://questionsvives.revues.org/642

[5] N. EL MAWAS, L. Oubahssi, and P. Laforcade, "Étude comparative de plateformes de formation à distance," GRAPHIT-D2.5&2.2, 10-Jul-2014.

[6] S. Graf and B. List, "An evaluation of open source e-learning platforms stressing adaptation issues," in Fifth IEEE International Conference on Advanced Learning Technologies (ICALT'05), 2005, pp. 163–165. http://dx.doi.org/10.1109/ICALT.2005.54

[7] S. Galloy, C. Haas, M. Lodewijck, " Analyse d'environnements de formation à distance," CIFoP – Le Centre Interuniversitaire de Formation Permanente, Mai-2002.

[8] The OVAREP (Observatoire des ressources multimédias), 2000 Étude comparative technique et pédagogique des plate-formes pour la formation ouverte et à distance

[9] S. Caro Dambreville, "Evaluer un dispositif de formation à distance Principes et retour d'expérience," Revue des Interactions Humaines Médiatisées. Vol 9 N°2, 2008.

[10] M. Ouadoud, M. Y. Chkouri, A. Nejjari, and K. E. El-Kadiri, "Studying and Analyzing the Evaluation Dimensions of E-learning Platforms Relying on a Software Engineering Approach," International Journal of Emerging Technologies in Learning (iJET), vol. 11, no. 1, pp. 11–20, Feb. 2016. http://dx.doi.org/10.3991/ijet.v11i01.4924

[11] M. Ouadoud, M. Y. Chkouri, A. Nejjari, et K. E. El-Kadiri, "Exploring a Recommendation System of Free E-learning Platforms: Functional Architecture of the System," International Journal of Emerging Technologies in Learning (iJET), vol. 12, no 02, p. 219 226, Feb. 2017. https://dx.doi.org/10.1109/CIST.2016.7804953

[12] M. Ouadoud, M. Y. Chkouri, A. Nejjari, and K. E. El-Kadiri, "Studying and comparing the free e-learning platforms," in 2016 4th IEEE International Colloquium on Information Science and Technology (CiSt), 2016, pp. 581–586. http://dx.doi.org/10.1109/CIST.2016.7804953

[13] M. Ouadoud, M. Y. Chkouri, and A. Nejjari, "LeaderTICE: A Platforms Recommendation System Based on a Comparative and Evaluative Study of Free E-learning Platforms," *International Journal of Online Engineering (iJOE)*, vol. 14, no. 01, pp. 132–161, Jan. 2018. https://doi.org/10.3991/ijoe.v14i01.7865

[14] A. Lablidi, A. Abourrich and M. Talbi, "Démarche préconisée pour évaluer une plate-forme," Revue de l'EPI (Enseigne-ment Public et Informatique), dec-2009

[15] Aska, Le Préau & Klr.fr (2000). "Choisir une solution de téléformation : 2000 study : l'offre de plates-formes et de portails de téléformation" / [Study conducted by Anne Bouthry, Patrick Chevalier, Serge Ravet, and al.].

[16] G. Paquette, L'Ingénierie Pédagogique : Pour Construire l'Apprentissage en Réseau. PUQ, 2002.

[17] P. Marquet, "Lorsque le développement des TIC et l'évolution des théories de l'apprentissage se croisent," Savoirs, no. 9, pp. 105–121, sept. 2005. http://dx.doi.org/10.3917/savo.009.0105

[18] Anderson and Dron (2011): Three Generations of Distance Education Pedagogy.

[19] J. Tardif, (1992). Pour un enseignement stratégique. L'apport de la psychologie cognitive. Montréal, Québec: Logiques.

[20] C. Weinstein, and R. Mayer, (1986). The teaching of learning strategies, dans M. C. Wittrock (dir.), Handbook of Research on Teaching, 3e éd., New York: Macmillan.

[21] M. Pressley, and K. Harris, (1990). What we really know about strategy instruction. Educational leadership, 48(1), 31-35.

[22] J. Watson, Le béhaviorisme. Paris. Editions Cepi, 1972.

[23] Jo Dugstad. WAKE, "Evaluating the Organising of a Collaborative Telelearning Scenario from an Instructor Perspective œ an Activity Theoretical Approach," PhD dissertation in computer science, Dept. of Information Science, University of Bergen, December, 2001. Thèse de doctorat.

[24] S. Haug, and J. Wedekind, (2013): cMOOC – ein alternatives Lehr-/Lernszenarium? In R. Schulmeister (Hrsg.): MOOCs – Massive Open Online Courses. Offene Bildung Oder Geschäftsmodell? Münster: Waxmann.

[25] S. Crozat, (2002). Éléments pour la conception industrialisée des supports pédagogiques numériques (Doctoral dissertation, Université de Technologie de Compiègne).

[26] F. Morandi, Introduction à la pédagogie. Armand Colin, 2006.

[27] M. Chekour, M. Laafou, et R. Janati-Idrissi, « L'évolution des théories de l'apprentissage à l'ère du numérique », Revue de l'EPI (Enseignement Public et Informatique), feb-2015.

[28] A. El Mhouti, A. Nasseh, et M. Erradi, « Les TIC au service d'un enseignement-apprentissage socioconstructiviste », Revue de l'EPI (Enseignement Public et Informatique), janv-2013.

[29] T. L. Good and J. E. Brophy, Educational Psychology: A Realistic Approach, 4e éd., New York : Longman, 1995.

[30] L. S. Vygotsky, Mind in Society: The Development of Higher Psychological Processes, Revised ed. edition. Cambridge: Harvard University Press, 1978.

[31] R. Bibeau, (2007). Les technologies de l'information et de la communication peuvent contribuer à améliorer les résultats scolaires des élèves. Revue de l'EPI, (94).

[32] R. Bibeau, "École informatisée clés en main. Projet franco-québécois de recherche-action," Revue de l'EPI (Enseignement Public et Informatique), no. 82, pp. 137–147, Jun. 1996.
[33] W. Doise and G. Mugny, Le développement social de l'intelligence (Vol. 1). Paris: Interéditions, 1981.
[34] A. Kozanitis, "Les principaux courants théoriques de l'enseignement et de l'apprentissage : un point de vue historique, " Bureau d'appui pédagogique - École polytechnique de Montréal, pp. 1-14 Sept. 2005
[35] E. Duplàa, and N. Talaat, Connectivisme et formation en ligne. Distances et savoirs, 9(4), pp. 541-564, 2012.
[36] M. Benslimane, O. Zine, A. Derouich, et A. Talbi, « Proposition et implémentation sur moodle d'une approche de conception d'un cours en ligne : cas d'un cours d'algorithmique », Workshop International sur les Approches Pédagogiques & E-Learning, 2016.
[37] X. Zoubaidi, M. Ait Daoud, A. Namir, M. Talbi, et B. Nachit, "La formation de formateurs d'éducateurs du préscolaire : mise en place d'un dispositif de formation à distance," Revue de l'EPI, janv-2014. http://www.epi.asso.fr/revue/articles/a1401d.htm.
[38] G. Chemsi, M. Radid, M. Sadiq, et M. Talbi, " Une plate-forme d'évaluation des enseignements et des formations à distance : EVAL-EFD," Revue de l'EPI (Enseignement Public et Informatique), sept-2011. http://www.epi.asso.fr/revue/articles/a1109b.htm.
[39] A. Bechina, B. Keith, U.Brinkschulte, "Mediasite : Une nouvelle plate-forme dédiée à l'enseignement à distance", IRES 2001, 07-Jul-2005
[40] G. Paquette, 2000 Construction de portails de téléapprentissage Explor@ - Une diversité de modèles pédagogiques Science et Techniques Educatives 7(1), 207-226, 2000.
[41] M. Sadiq and M. Talbi, "Modélisation des unités d'apprentissage sur des plates-formes de formation à distance," Revue de l'EPI, Mar-2010. https://www.epi.asso.fr/revue/articles/a1003e.htm.
[42] B. née Dahmani Farida, "Modélisation basée ontologies pour l'apprentissage interactif - Application à l'évaluation des connaissances de l'apprenant," PhD dissertation in computer science, Computer Science Department, Mouloud Mammeri University of Tizi-Ouzou, Algeria, 28 November, 2010.
[43] E. Tonye, "Modeling a framework for open and distance learning in sub-Saharan African countries," frantice.net, numéro 2, décembre 2010. http://www.frantice.net/docannexe.php?id=339.
[44] F. Raynal, A. Rieunier, and M. Postic, Pédagogie : Dictionnaire des concepts clés : Apprentissages, formation, psychologie cognitive. ESF, 1997.
[45] D. Fablet, Professeur en sciences de l'éducation Éduquer, Enseigner, Former, Séminaire de cours l'éducation tout au long de la vie, Université Paris Ouest Nanterre La Défense (Paris 10 university), february-may 2007
[46] S. Johsua, and J-J. Dupin, (1993). Using "Modelling Analogies" to teach basic electricity: A critical analysis," Dans Caillot, M., (ed.), *Learning Electricity and Electronics with Advanced Educational Technology*, volume 115 of NATO ASI Series F. Springer-Verlag, Berlin.
[47] J. S. Bruner, and Y. Bonin, L'éducation, entrée dans la culture : les problèmes de l'école à la lumière de la psychologie culturelle. Retz, 1996.
[48] Lytras, D. Miltiadis, P. Ordonez De Pablos, A. Ziderman, A. Roulstone, H. Maurer, and Jonathan B. Imber. Knowledge Management, Information Systems, E-Learning, and Sustainability Research: Third Whorld Summit on the Knowledge Society, *WSKS 2010, Corfu, Greece*, September 22-24, 2010, Proceedings. Springer Science & Business Media, 2010.
[49] G. Siemens, "Connectivism: A Learning Theory for the Digital Age," International journal of instructional technology and distance learning, 2(1), 3-10. Jan-2005.
[50] M. Ouadoud, A. Nejjari, M. Y. Chkouri, and K. E. E. Kadiri, "Educational modeling of a learning management system," in *2017 International Conference on Electrical and Information Technologies (ICEIT)*, 2017, pp. 1–6. http://dx.doi.org/10.1109/EITech.2017.8255247
[51] M. Rosselle (2016) Les MOOC : des dispositifs d'enseignement-apprentissage à personnaliser Atelier MOOC, EIAH, Toulouse 2013 p13 – 20. 8p
[52] A. Jézégou, (2015) "Diriger soi-même ses activités d'apprentissage par et dans un Mooc de type connectiviste," International Journal of E-Learning & Distance Education, vol. 30, no. 1, Feb. 2015. [Online]. Available: http://www.ijede.ca/index.php/jde/article/view/868. [Accessed: 13-Jul-2016].
[53] M. Rosselle, P. A. Caron, and J. Heutte, (2014). Prémisse d'une typologie et des principales dimensions d'un cadre de description pour les MOOC. Journées Communication et Apprentissage Instrumentés en Réseau (JOCAIR).
[54] Varga Renata, Caron Pierre-André, Hoogstoel Frédéric, (2010), Adapter des environnements numériques malléables à des dispositifs de formation, Dans G. Leclercq et R. Varga (dir). Dispositifs de formation, quand le numérique s§en mêle. Une approche pluridisciplinaire (p.). Paris : Hermès, Lavoisier.
[55] D. Burgos, M. Arnaud, P. Neuhauser, and R. Koper, (Dec-2005) "IMS Learning Design la flexibilité pédagogique au service des besoins de l'e-formation," Revue de l'EPI (Enseignement Public et Informatique), [Online]. Available: https://www.epi.asso.fr/revue/articles/a0512c.htm. [Accessed: 13-Jul-2016].

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