Design of a Collaborative Learning Management System Based on a Workspace Metaphor and Multi–Agents Vision.

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Abstract **The objective of the research presented in this paper is to describe the design of a collaborative learning management system based on a (work) space metaphor coupled with a multi-agent system (MAS). This MAS monitor serves to extract the relevant data related to the interaction of the various actors with the various functionalities of the environment at different levels of abstractions.**
We show that the multi-agents vision of this system allows the visualisation and the reporting for describing a collaborative distance learning sessions.

Keywords: E-learning, Learning Management System, CSCL, Multi-Agent System, Reporting system.

I. INTRODUCTION

Online learning is now a reality thanks to the development of Internet and to the virtual environments commonly called LMS (Learning Management System). But, the design of devices to support the active activities, collaborative and distributed training constitutes today a serious problems, renewed recently by the explosion of the research on the e-learning. Indeed the development of the telecommunications networks and the Internet allowed the emergence of communities on line learning, in a virtual environments platforms or LMS (Learning Management System). The first research on the virtual campuses was to support the interactions of the various actors intervening in the formation (learner, tutor, teaching designer, coordinator...) and to propose the data-processing tools and artefacts for their giving a support and assistance. Our current research work is interested in structuring a virtual campus and architecture system of assistance to the training which can draw the information collected during the interactions between actors and the various functionalities of the campus. Our objective is to obtain a techno-teaching reflected structure.

The first part of the article presents the general concepts of the virtual campus: the principle of the space

metaphor, grouping in LMS network the actors, resources and diversified tools. The second part is devoted to the description of a multi - agents approach of an observer use of virtual campus. We describe then the design and the realisation of this multi - agents environment suggested. We finish by the description of the experimentation, the presentation of the results obtained and the prospects future with our work.

II. Design of a virtual campus

A virtual campus is an environment of online learning based on the client server concept and Internet technologies. It gathers the tools and the resources necessary to the support of the various actors playing a role in the e-learning system. In the client side, we use a simple navigator (light customer) what simplifies the use of the device and eliminates the cost from the deployment of the client software. In the server side, we use architecture Web 3 thirds: Web server, application server and database server. To be distinguished from a simple Web site, a digital campus must be presented as an integration of several tools and several functionalities. It must be also conceived with a teaching concern in such a way that technology is on the service of pedagogy and not the reverse. Two teaching models are to be distinguished:

- Pedagogy by the transmission of knowledge; in this context the learning support offers the means necessary to the diffusion of the teaching resources multimedia and the individualization of the teaching courses (Learning Space, Course Info, Top Class, Web CT, Syfadis, Academies, Luvit...). The autonomy of learner to manage his training is presupposed.

- Pedagogy by activate construction of the knowledge; in this context the device offers the means necessary to the interaction, within a learners community, with the collaboration and the appropriation of knowledge (Acolad, SPLACH, SYMBA, Sylfide, Ingenium, …). The learner capacity to collaborate, share and build with other new knowledge and new abilities is presupposed.

Another characteristic of the virtual campus would be to organize itself conceptually and structurally starting from the metaphor of the real campus. Basically the metaphor is a cognitive framework of reference and interpretation. It allows the projection of a more familiar concept, more concrete (here the real campus), on another concept which is it less (here the virtual campus) [1]. A user will be able to thus invest a new world with a cognitive framework of reference already established. There are several manners to make metaphor of an LMS with different implications for the user as well on the navigation as on contents comprehension.

Figure 1 represents the organization of our virtual campus in spaces. We assign to each space an evocative name, functionalities, teaching resources, technological tools of which the actors, who attend it, have need to carry out their activities of training and an use monitor (see following paragraph). It should be noted that it is necessary to think the technical integration, graphic and especially teaching of the all accessible means in a space while thinking the teaching relation between actors [2]. A space is not opened for anyone and it requires an actor authentication. The membership of this space can use the whole of these space resources. On these considerations we conceived and carried out a e-learning that we propose to describe below as way of illustration. This device, carried out by our research team in 2002, since is used for the continues formation and a support to the blended learning in telecommunications and networks (DESS Telecommunications and Networking) [3].

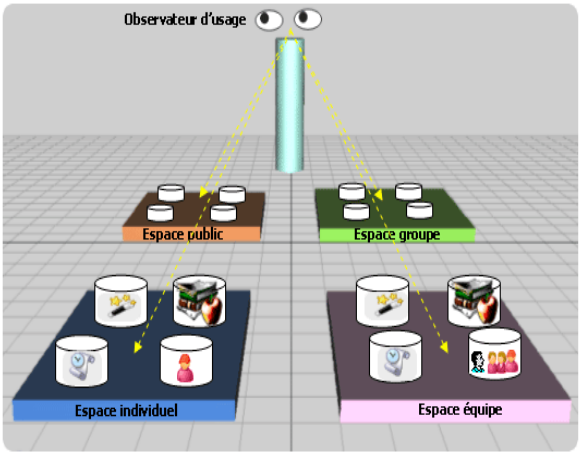

Figure 1. Organization of the virtual campus in spaces

We will describe now the platform **M@roc TéléFormation (MTF),** that we have developed in the Telecommunications & Network laboratory at Chouaib Doukkali University (El Jadida). This e-learning platform, which rests on the Internet technologies, is the first e-learning platform in Telecommunications and networks filed in Morocco.
MTF Platform is founded on a space metaphor which puts in scene the usual places of the formations in order to allow:

- contents consultation of the courses,
- the documents uploading useful for the activities training,
- the contact between tutors and learning how to solve encountered problems.
- collaboration between users on MTF platform thanks to the forums, chat discussion and the e-mail,
- the group realization of the projects.
- the learning/planning management by the diary.

We can find on this platform the principal tools used on the e-learning and collaborative work:
• The e-mail, a space of communication which allows the sending and the reception of mails.
• The forum space allows c learner and the tutors on a given subject
• The Chat (or instantaneous mail) allows a real time discussion between in all MTF members.
• The delivery point of teaching documents which makes it possible to propose documents in digital form (Word, Excel, Acrobat, etc.) to the whole of the group.
• Tools of organization and project management (divided Diary, planning).

Figure 2. The public space of platform MTF

Figure 3. Example of a the activities space on platform MTF

III. Software agents

An agent is a software entity capable of acting intelligently on behalf of a user, in order to accomplish a given task. Agents, like humans, co-operate so that a society of agents can combine their efforts to achieve a desired goal. The characteristic properties of the agents are:

- Autonomy
- Proactive intelligence (agents do not simply to act in response to their environment, but are able to take initiative)
- Temporal continuity (they are continuously running processes),
- Mobility,
- Rationality/benevolence (agents don't have conflicting goals)
- Adaptive intelligence (agents have the ability to learn).

Compared to objects, software agents have their own thread of control, localizing not only code and state but their invocations as well. In other words, agents themselves define when and how to act.
Agent-oriented methodologies and platforms have become a priority for the development of large scale agent-based systems. Several methodologies have been proposed for the development of multiagent systems (MAS), they are either an extension of object-oriented methodologies (for example MaSE : Multiagent System Engineering) [4] or an extension of knowledge-based methodologies (for example: CommonKADS) [5].

We have chosen the MaSE methodology (Multiagent System Engineering) for the development of our software agents. This choice is justified by:

- The simple, modest and pragmatic vision which MaSE gives to the definition of an agent
- The automation process for creating software agents
- The availability of documentation.

The systems based on agents specified starting from this methodology are often difficult to implement directly starting from the standard programming languages like Java or others. Several tools are developed recently for multiagent systems programming: JADE [6], Zeus [7], MadKit [8], AgentBuilder [9]. For our part, after an evaluation of the most popular platforms of multiagent systems development, we have chosen JADE (Java Agent Development Framework) which is a middleware that facilitates the development of multi-agent systems. It includes:

- **A** runtime environment where JADE agents can "live" and that must be active on a given host before one or more agents can be executed on that host.
- A library of classes that programmers have to/can use (directly or by specializing them) to develop their agents.
- A suite of graphical tools that allows administrating and monitoring the activity of running agents.

Basing on our model of a virtual campus and on an approach centred on the roles and competences, we can specify and identify the agents which will build our reporting system of use. This process is located in an iterative step of design whose results presented here are those after the most recent iteration. We present in figure 4, an observer system of use for a given space.

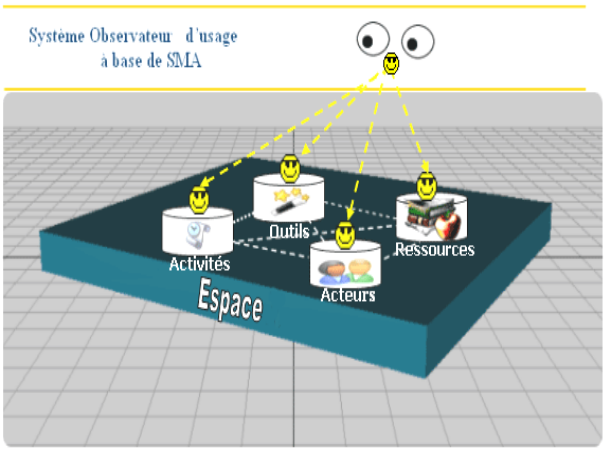

Figure 4. An observer system of use for a given space.

The agent hierarchy of our reporting system is made around several supervisory spaces agents. In occurrence public space, the group space, the team space and individual space. Each supervisory space agent communicates with four agents: the supervisory agent of the actors, the supervisory agent of the activities, the supervisory agent of the resources and finally the supervisory agent of the tools. Each one of these four agents can supervise other agents of lower hierarchy. For example, the supervisory agent of the tools can supervise the mail agent, the forum agent, the discussion agent, the document agent and the diary agent. Finally the communication with the user must be ensured by an agent interfaces graphic. We summarize the specifications of the agents here constituting our reporting system:

• Graphic interface agent (GUI Agent): its role is to ensure the human/machine communication trough a simple and convivial graphic interface.

• Supervisory Agent of space (public, group, team, individual): This agent is the access point to the space of which it is monitor. It answers the lower hierarchy agents for a reporting of a given period of use.

• Supervisory Agent of the actors: It supervises the whole of the actions carried out by an actor while providing a decision on its behaviour during a training session.

• Supervisory Agent of the activities: It indicates the degree of project respect and the level of activity success.

• Supervisory Agent of the tools: Its role is to provide statistics concerning the use of the tools with a relation of a given space.

• Supervisory Agent of the resources: It gives information on the use of the resources of a given space.

IV. Experimental validation

1. Description

Now, the majority of the universities in the world study how to introduce distance learning into their program. In the case of the Moroccan university, since 2003, we have conceived and tried a blended methodology combining classical learning with distance learning. This experiment is within the framework of the initial Training, where 27 students prepare a Master in Telecommunications and Networks (2002-2004 promotion). The distance training proceeded over six weeks and consists of three activities.

Activity 1: The first activity corresponds to the collective choice of a name for promotion. The objectives referring to this activity are: to carry out a research and a synthesis on the history of the telecommunications networks, to identify the outstanding people in this history and having contributed to the development of telecommunications and networks and to make the final choice of a name for promotion, by consensus or vote. The design and the teaching architecture of this activity are defined starting from an analysis of cl@p methodology (Michinov and Al, 2003). The originality of this method consists primarily in the fact that it insists on the need for a good online activities scenario, where learner is the principal actor of his training.

Activity 2: The objective of the second activity is to draw up a panorama of high flow networks technologies and their architecture (services and protocols). Learners are invited to follow a multimedia course, to answer QCM questionnaires and to realise interactive exercises founded on simulation.

Activity 3: At the time of this third activity, the students make a comparative study of the various solutions "high flow networks ", by working out for each one of them the principle of operation, the material necessary, the cost, the advantages, the disadvantages and the field of application. Learning carried out this activity of training per team in a given time and with the assistance of the tutor. The principal objective of this activity is to initiate the students with the collaborative training.

2 A first assessment

All the interactions between the actors and the environment are available at ends of analysis at the end of the training course. The observer of uses, which we have developed, us made it possible to collect information concerning: i) the whole of the actions carried out by an actor during a remote training course where each event is dated and commented on (figure 5). ii) the success rate of an activity (figure 6). iii) The use statistics of the tools (figure 7).

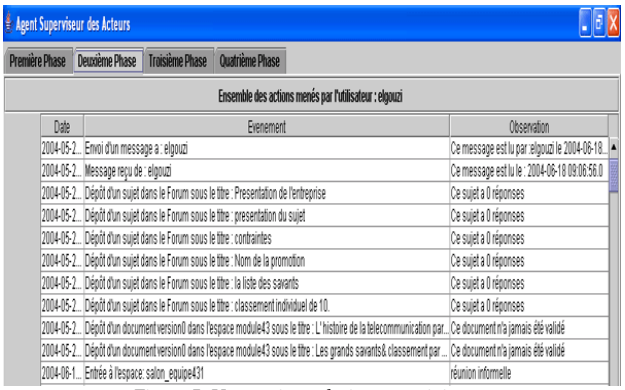

Figure 5. User actions during an activity

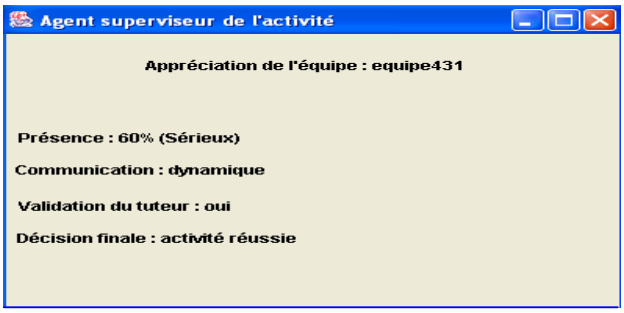

Figure 6. Success rate of an activity.

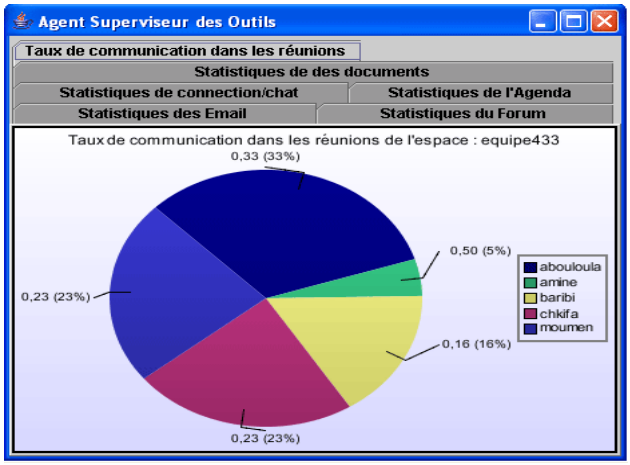

Figure 7. The use statistics of the tools

While being based on work of Arnaud [10] and of Mbala [11], we have exploited these statistics of interaction to appreciate: i) on the level of learner, its productivity and its sociability. ii) on the level of the group, its evolution and its cohesion iii) on the level of the teaching activity its degree of realization. The first author defines the participation of learning in the various synchronous virtual meetings like indicator from assiduity. According to this indicator three profiles are defined: i) Persistent for a value more than 90 %. ii) Serious for a value located between 60 % and 90 %. iii) Independent for a value less than 30 %. The second author is based on the interactions analysis of communication and on the number of active people within a team, to

define five profiles: i) not dynamic: less than 20% of learners are active. ii) not very dynamic: between 20 and 40% of learners are active iii) rather dynamic: between 40 and 60% of learners are active. iv) dynamic: between 60 and 80 % of learners are active. v) very dynamic: more than 80% of learners are active. The results provided by the observer show that the majority of the students are dynamic (the rate of interaction lies between 60 and 80 %), serious (the presence rate in the synchronous virtual conference rooms with the tutor lies between 60 and 100 %). The groups productivity and the level of teaching activities realization are very satisfactory: three groups out of five were considered to be dynamic and two groups rather dynamic. We think that this good result is due to the motivation of learners, who are with their first and single experiment with the distance learning, and that they all are very familiarized with data processing and tools Internet. That is due also to the fact that we explained clearly to learners the teaching objectives and the criteria from evaluation of the online activities. However we noted, according to the results provided by the observer, the reserve of some learners to use the forum. It seems that they prefer the discussion into synchronous within the framework of the virtual meetings. We think that to return the use of the more appreciable forum, one must encourage learners how them to use actively this tool all in their clearly explaining his integration with the teaching scenario of the session. The tutor must also animate the forum and maintain during the session a constant interest and a regular participation on behalf of learning.

V. Conclusion

In this paper, we have treated the design, the realization and the experimentation of a virtual collaborative training environment, coupled with an observer of use. The principal vocation of the observer is to provide to the various actors a whole of information, very useful for the good course of collaborative distance learning session, and for its audit and its evaluation. With the present stage of our work, several tracks remain to be explored. As an example and without being exhaustive, we can cite the design and the implementation of a multi-system agents to expose a proactive and opportunist behaviour. The system would be able all alone to take the initiative at the "good time" to warn the various actors in the event of observation of a difference between the scenarios of training and framing envisaged and the reality of the session. We could thus avoid in time the abandonment of the learners, the bursting of a group or the failure of an activity.

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