Monitoring Activities in an E-Learning 2.0 Environment

A multi-agents system

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***Abstract*—This paper deals with the monitoring of students and teacher's activities in a collaborative pedagogical environment. The specificity is that the learning platform is an E-Learning 2.0 environment. It is complex to track activities because the E-Learning 2.0 environments are adaptive and the tracking is not easy to be anticipated. This paper first presents the general context. Then, it describes the specific pedagogical method and environment and the studio used to generate the pedagogical environment. It continues with the architecture proposed to track activities. Then, the collected traces and provided indicators are presented.**

Keywords-Collaborative environments; E-Learning 2.0; Web 2.0; Monitoring of activities, Multi-agents Systems

I. INTRODUCTION

There are various forms of collaborative learning platforms. Among them, environments reflected in the literature under the name E-Learning 2.0 [1], allow teachers to exploit Web 2.0 applications to construct educational environments. They are a combination of specific features of Web 2.0 applications: Forum, Wiki, documents management, Blog, etc. The advantage is that Web 2.0 tools are directly available, generally free and they can easily be used in an educational setting [2][3]. The empowerment of teachers is at the heart of these solutions because the Web 2.0 tools runs on all browsers. The actors may be released from the administration constraints generally associated with traditional architectures and easily share access to their resources.

Researchers of the University of Littoral Côte d'Opale (ULCO) and the University of Picardie Jules Verne (UPJV) work on a Pedagogical Engineering Studio (PES) called MACADDAM (MAui for Computer Aided pedagogical Design bAsed on MAETIC) [4]. MAui is an acronym for "Méthode de conception de dispositifs pédAgogique Utilisant l'ethnographIe" derived from [5] and MAETIC for "Méthode pédAgogique instrumEntée par les Technologies d'Information et de Communication" [6]. This PES assists teachers in their efforts to design educational systems. Environments generated by MACADDAM are dedicated to education through collaborative projects.

However, in the current version, services offered by the generated pedagogical environments have a lack of monitoring. However, in the field of collaborative learning, management of traces is important because it is necessary to analyze information about actors and their activities [7]. It provides the trainer with accurate and adequate information to track individual and collective participation.

Tracking systems collect traces and interpret them with the computation of indicators. In fact, the indicators enable the evaluation of the learner. This evaluation can be individual or collective which is the evaluation of the learner's group. Different types of indicators can be defined such as indicators to know acquired knowledge during the learning activity or to know the communication and the interaction between the learners of the same group.

Tracking systems have already been developed such as APLUSIX [8], ACOLAD [9], aLF [10], SPLACH [11], TrAVis [12] and other ones. However, each tracking system has a different target. All of these tracking systems are platforms-specific and none of them can be used with a Web 2.0 learning platform. This is the reason that led us to develop a system dedicated to tacking activities in an E-learning 2.0 environment. This developed system is a multi-agents system (MAS) [13] and is coupled to the MACADDAM studio and implements functionalities to keep detailed history of students' actions, group of students' actions and teachers' actions performed on the E-Learning 2.0 platform.

Section II describes MAETIC, the MACADDAM studio, specifies the requirements, and explains the choice of a multi-agent system coupled to this studio to track activities before discussing some related works.

Section III describes this collaborative learning-oriented agent system. Section IV deals with collected traces and provided indicators. The last section concludes and presents some perspectives.

II. THE MACCADAM STUDIO

In this paragraph, we describe MAETIC method and the specificities of the MAETIC environments.

A. MAETIC and its pedagogical environments

Teachers of ULCO and UPJV have designed educational environments using Web 2.0 tools. A study of these environments allowed to extract a pedagogical method called MAETIC. MAETIC is dedicated to the management of project-based pedagogy in-group. It was validated through successive evaluations [14]. MAETIC aims at developing professional skills (transverse and domain skills) and guides groups of students in all stages of the project. The part of the

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system dedicated to students is called "MAETIC e-suitcase". The concept of e-suitcase refers to an environment "which is not bound to a fixed place of education." The e-suitcase includes access to the teacher's logbook (important information, activities of the session, etc.), access to teacher's resources (course materials, exercises to do, etc.) and access to student's logbook. The teacher is informed on the progress of the project via the group's logbook. The logbook describes the life of the project. The developed deliverables, the report of the activities and information on the project are available to the teachers and other members. The logbook is managed regularly. The method is described in [6].

The part of the pedagogical environment dedicated to the teacher is called "MAETIC Toolbox". A toolbox provides mechanisms to fill the teacher's logbook, to check students' logbooks, to comment on their work, to assess their work, etc.

So, in a MAETIC environment, the teacher:

- Uploads articles and resources on his/her logbook. This logbook informs students about the life of the teaching unit.
- Posts general comments about the work and about its progress.
- Handles tools that enable him/her to communicate with students,
- Oversees the work of the groups. Thus, he/she can view, download and comment the activities of the groups via the groups' logbook.

The student

- Consults or download resources. They are available and accessible via the teacher's logbook. Each student must consult the teacher's logbook before each session.
- Uses tools allowing him to communicate with other students or with the teacher.
- Realizes activities related to the planned project. The teacher helps to define these activities. The report and implementation of these activities are recorded on the group's logbook.

Fig. 1 synthetizes the different interactions.

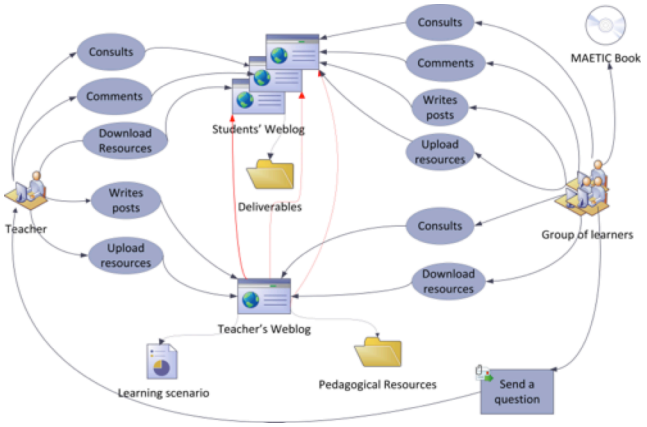

Figure 1. Users interactions in MAETIC

The next paragraph describes the aim and structure of the MACCADAM studio.

B. *MACCADAM*

MACADDAM is a Pedagogical Engineering Studio (PES). It helps teachers to deploy their own educational environments dedicated to the implementation of MAETIC. The studio assists them in the formulation of needs (design support) and releases them of repetitive and tedious tasks associated with the deployment of a teaching environment (development support). The environments are designed and are instrumented using Web 2.0 tools [4].

The PES assists the teacher in the formation of the pedagogical script and generates the e-suitcases and the toolbox.

An assistance module drives the teacher throughout the design process. A generator module generates either a generic environment or a customized one (according to the teacher profile and the target skills). The studio offers the ability to select and identify activities to be implemented in the script. However, resources and activities appropriated to the training area are under the teacher's responsibility.

The next paragraph describes the needs in term of activities tracking and justifies the choice of a multi-agent architecture.

C. *PES needs and contribution of multi-agent systems*

Communication between teachers and students in a MAETIC environment is mainly done via Weblogs. Weblog technology was chosen for its usability. The weblog is accessible to everyone. In addition, weblogs can create a social relationship between students and seem to facilitate the students' writing through the "posts" [15]. However, Weblog technology provides a very consistent material, easy to collect but more difficult to analyze. The time spent by the teacher to monitor and analyze the activities of the student is higher than the time spent in the traditional classroom [16].

The statistics about interaction enable the evaluation of the group's life and its evolution. We are particularly interested in the status indicators of progress and sustainability of the group.

Among indicators, one can cite:

- Identification of work overload for a given student so he/she can be exempted to perform some activities,
- Possibility of extending or shorting completion deadlines of an activity (change the training schedule),
- Assessment of the state of completion of an activity or a task,
- Evaluation of social relationships and productivity of a student, and so on.

Our main goal is to provide a relevant assistance for the progress of the project activity. On one hand, we want to help students in the realization of the project in collaborative learning, and on the other hand, we also want to assist the teacher in the monitoring of both individual and collective activities.

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Our goal is to develop a system that is able to collect and analyze data from the project activities. The system must be able to analyze the use of the environment and the data generated in this environment (forum, mail, meetings, etc.).

To design the observation and assistance system, we have opted for an incremental and iterative approach. The environments generated by the MACADDAM studio will be equipped with this system. It is based on a multi-agent architecture described in the next section.

The choice of a multi-agent architecture for the observation and assistance system is motivated by several reasons:

- From a programming point of view, it is possible to add new agents or modify the behavior of existing agents without affecting the overall structure. In a research context, the possibility of change is a considerable advantage because it allows an iterative and incremental development.
- We are interested in providing the ability to solve distributed problems in a multi-agent architecture. To meet the specifications outlined in the previous section, we propose to identify agents that are specialized in observation tasks and others that are specialized in assistance tasks.

Moreover, in our case, we are faced with a distributed environment. The multi-agent approach allows to have distributed agents being able to communicate.

D. Related Works

Before discussing the proposed architecture, we review the approaches presented in the literature that provide multi-agents platforms for collaborative learning. In the field of Artificial Intelligence and education, several approaches have been developed.

For example, Guizzardi and al. [17] have developed a Peer-to-peer system called "Help & Learn". This system was modeled using an agent-oriented language called AORML [18]. It is an open system that is designed to support the extra-class interactions between learners and tutors. "Help & Learn" is limited to providing assistance to learners who request it. Other systems have been developed. Fougeres and Ospina [19] have proposed a based-agent mediation system for the project management platform called iPdagogique. This system, modeled in AUML, serves as an interface between the human and the application to enhance their relationship and is used to promote collaboration among users. Recently in [20], the authors presented a model for an adaptive multi-agent system for dynamic routing of the grant's activities from a learning environment. This model allows the assignment of activities taking into account the specialization of learners, their experience and the complexity of activities already taken. None of these three systems cares of monitoring learning and therefore, cannot trace user's activities.

Mbala and al. [21] have developed a multi-agent system called SIGFAD to support users in remote education. SIGFAD is modelled using the MASE methodology and uses the JAM model for building agents. It is interested in monitoring learning.

However, it is not sufficiently independent and does not start up alerts to prevent tutors if there's a problem with a learner or group.

In the next section, the architecture of the tracking system is described.

III. PROPOSED ARCHITECTURE

The system uses tools to perform the following functions:

- Give information on the process, the resources and the learning modalities (databases, catalogues, etc.);
- Communicate and coordinate the actors (forum, chat, email, etc.);
- Adjust the schedule of activities during the training;
- Monitor, guide and control (logbook, support the link between learning, support resource allocation, etc.).

We are interested in providing observation and support tools to ensure the following functions:

- Course construction and management (self-diagnostic tools, course management software, etc.);
- Review and validation (assistance to individual and collective reviewing, etc.).

Thus, we have identified three spaces: a teacher's space, a student's space and a group of students' space. Each space has a descriptive name, functionalities, educational resources, technological tools (Web 2.0 tools) and functional tools for the observation of use.

The MACADDAM studio generates the following tools to create the pedagogical environment:

- Technological tools are based on web 2.0 technologies. They are tools that the actors need to perform activities in their space. These include, for example, the student's logbook and the teacher's toolbox.
- Functional agents are tools for the observation of use. These tools mark out the behavior of students, groups of students and teachers. They analyze traces too.

We present in Fig. 2 an overview of our environment, with the different agents present in the system. We distinguish two types of user, namely the student and the teacher, and three workspaces, namely, the teacher's space, the student's space and the group's space. We associate an agent to every user. The agent is located on the server. This agent migrates on the user's workstation as soon as he/she connects. The agent is coded as a Java program; applets are programs living on the server which run on the client. This technology allows a user to run his/her agent directly from his/her client. The agent superintendent of the space groups lives on the server. It is active as soon as one of the students of the group is connected. This agent is in charge of providing the environment meta-information on the activities (beginning date, end date, concerned persons, used tools, etc.) and on the forums (beginning date, end date, etc.). We were also interested in the supervision of the interactions between the various users during the formation. We have defined an agent overseeing every communication tool (email, forum, chat, blog). This agent supervises all the

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actions of a user during the session. Every event is dated and commented.

An agent manages the group's space. It aggregates information about connections, activities and communication. This information allows to appreciate the life of the group, the productivity of the members and the level of realization of the educational activities. An evaluation agent analyses this information to estimate the lifecycle of the formation. This agent can make objective decisions about modifications of the calendar of activities.

The main agents of the system are the following ones:

- A-LEARN: It supervises the student's space. It allows the supervision of all activities of a student and provides an overall evaluation of his behavior during a training session;
- A-TEACHER: It supervises the teacher's space. It supervises educational resources loaded in his/her logbook, access to group's logbooks and used tools to communicate with students.
- A-GROUP: It supervises the group's space during a session. It supervises actors' activities during a session. It indicates the degree of respect, the success rate, the start date and end date of an activity. This agent provides the list of present and absent students and statistics concerning the progression of each activity. It reminds students about deadlines and notifies the late groups by sending alerts.
- A-TOOL: It supervises tools and provides statistics about their use (Email, Chat, Forum, blog, CVS, etc.).
- A-EVAL: This agent aggregates the information collected in order to structure them and to present it to the Evaluation module of MACADDAM studio

IV. TRACES

The management of the interactions taking place within the educational system is done thanks to the collected traces.

Generally, a trace represents the interaction of the user with the system. As it was defined by G. Dyke [122], "informally, the traces of an activity are the marks which that activity leaves on the environment". In this educational platform, we adopt the definition of a trace given by K. Lund and A. Mille in [23]. According them[1], "a trace is a sequence of observations located in time. The observation is either an interaction between humans mediated in various ways by computer, or a sequence of actions and reactions between a human and a computer".

When using the educational platform, traces are collected. The processing of traces (traces observed from various sources - from server-side as well as from client side) provides knowledge about the activity called learning indicators.

A. *Collecting traces*

Each action of the learner or of the teacher can be traced through the agents defined in the system as shown in Fig. 1. The traces are dealing with synchronous or asynchronous interactions of the user with the system.

For example, to facilitate the control of emails between learners, we defined five types of messages:

- Proposition: A proposes something to B (for example, to become a member of the group, to perform a task, etc.)
- Proposition rejection: B uses it when he rejects the received proposition.
- Acceptance of proposition: B uses it when he accepts the received proposition.

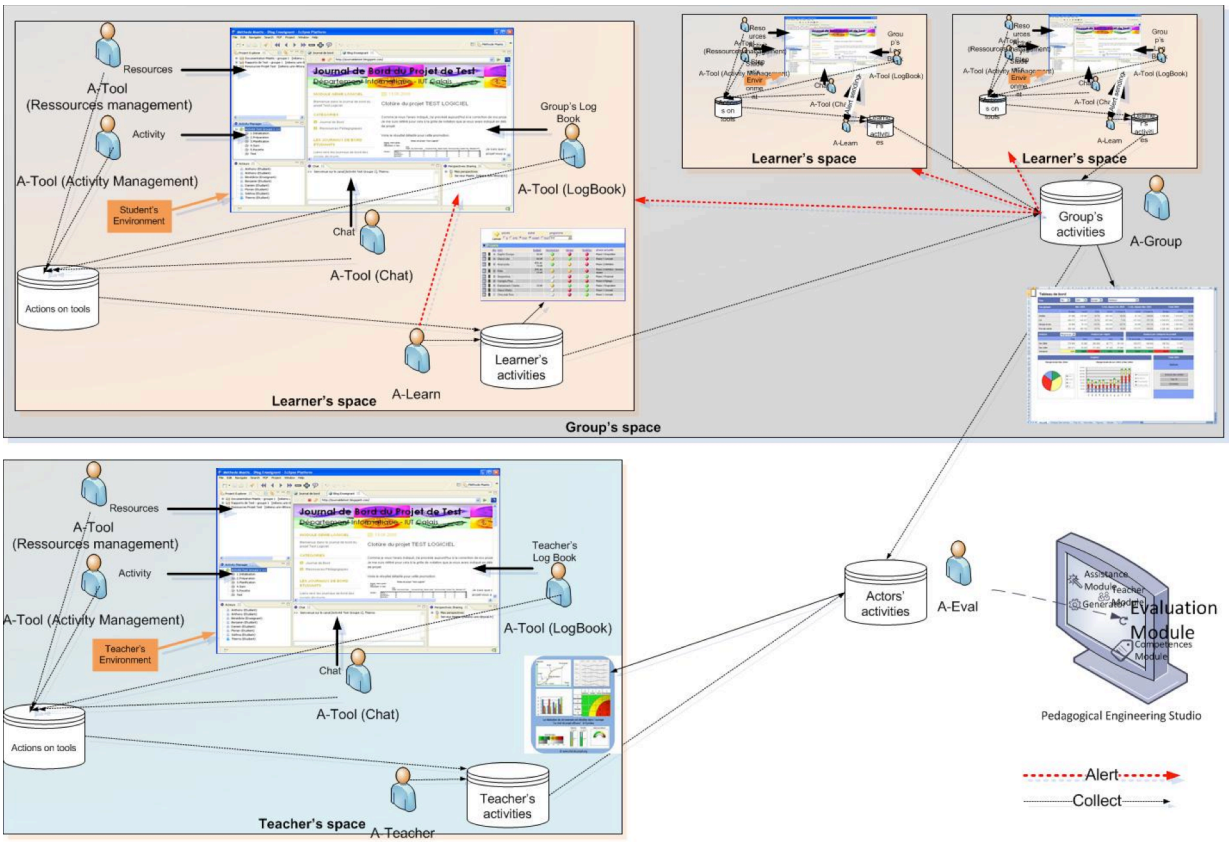

Figure 1. An overview of the environment

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- Information: It is used to communicate information or a result. Reply to this message type is optional.
- Help: It is used when A wants some help from B.

Therefore, the trace observed after transmitting an email includes: the subject, the date and time, the sender, the receiver and the content. When observing the blog of a group, the A-TOOL agent notes for each access of the blog: the date and time, the acceded resource, the learner who acceded, the operation done.

B. Providing indicators

Indicators allow to know:

- Who are the people interacting with the system?
- What has been handled?
- When (time or duration).
- How: through which tool?

The two main roles of the indicators in the platform are alert and appreciation. Table 1 presents some indicators.

TABLE I. SOME INDICATORS

Indicator	Purpose	Target user
Percentage of activities carried out per learner	Alert	Learner/ Group of learners
Sleeping learner	Alert	Learner/ Group of learners
Duration of the consultation of each resource per learner	Appreciation	Teacher
Duration of the realization of each activity per learner	Appreciation	Teacher

C. Use of the defined indicators

The alert indicators are used by A-LEARN agent and by A-GROUP agent. They inform the learner and the group of a problem. Communication between members allows to see what is happening and to find a solution. If no solution is found, the group can inform the teacher. The appreciation indicators are used by A-EVAL to evaluate the educational session. The teacher uses this information to correct his/her pedagogical scenario.

V. CONCLUSION AND PERSPECTIVES

We have designed an Agent Based System generated by MACADDAM during the generation phase.

All agents of this assistance system have not been yet fully developed. Several issues remain to be explored and implemented. We especially want to make MACADDAM more autonomous and proactive. Thus, the environment should be able to alert the teacher and the students when a group presents a bursting risk or is in a position of educational failure.

The proposed system was coupled to the Learning Management System (LMS) ILIAS and can be adapted to other LMS such as Moodle. However, the number of defined indicators in the system is not very important. We intend to define an indicator library and let each tutor select the indicators that interest him.

Several tools were developed recently for the agent-oriented programming, such as JADE [24], Zeus [25], MadKit [26], Agent Builder [27]. We deploy the system on the multi-agents platform Madkit because MadKit is intended for the development and the execution of multi-agents systems and more particularly for multi-agents systems based on organizational criteria.

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