# OBSERVATION AND SUPPORT IN A COLLABORATIVE PEDAGOGICAL DEVICE

## *A Multi-agent System to Control and Monitor Pedagogical Activities*

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Abstract: This article discusses the agentification of coordination and control of a collaborative pedagogical device. It presents the advantage of a multi-agent system to instrument some features of a collaborative educational device and describes its implementation in the context of a pedagogical engineering studio. The article interests at first in the context of insertion of the device: why and how the MAETIC device is proposed to work out vocational skills training with ICT. The article then describes the function of the MACCADAM studio and the specific devices it generates. It then presents the benefits of a multi-agent system in this context and described the monitoring system proposed for the management of the actors. The article ends on the progress of work and the prospects so far.

## 1 INTRODUCTION

Teachers must be trained and/or assisted in the educational use they make of technologies.

We work to produce a Pedagogical Engineering Studio (PES) called MACADDAM (Talon and Leclet, 2011). The PES assists teachers in their efforts to design educational devices. Generated devices are dedicated to education through collaborative projects. Devices are designed with available and easily exploitable tools in order to meet the needs of the teachers.

ELearning 2.0 (Downes, 2005) allows teachers to exploit Web 2.0 applications to construct educational devices. An eLearning 2.0 device is then based on a combination of specific features of Web 2.0 applications: Forum (discussion, negotiation, argument), Wiki (collaborative writing), documents management (sharing, storage), Blog (Editorial and comment functionalities, document storage and sharing), etc. The advantage of this type of construction is that Web 2.0 tools are directly available, are generally free and can easily be used in an educational setting (Williams and Jacobs, 2004) (Caron, 2007). These environments are under the complete control of the students and/or teachers who can promote their products. The actors in these environments may be released from the administration constraints generally associated with traditional architectures and easily share access to their resources.

However, in the current version, services offered by the generated pedagogical devices have a lack of monitoring. There is no management of interactions taking place within the educational system. However, in the field of collaborative learning, management of traces is important because it is necessary to analyze information about actors and their activities (Settouti, 2010). It provides the trainer accurate and adequate information to track individual and collective participation. This allows to conduct the evaluation of the devices and favors their re-engineering.

We describe here a multi-agents system (MAS) (Ferber, 1999) to be coupled to the MACADDAM studio. This system allows implementing functionalities to keep a detailed history of actions of students and student groups performed on the eLearning 2.0 platform. This archiving allows analyzing the life of every individual, group and its evolution.

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# 2 THE MACADDAM STUDIO

## 2.1 MAETIC Devices

In order to work out domain and transverse skills, teachers have designed educational devices using Web 2.0 tools. A study of these devices was managed 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 (Leclet and Talon, 2008). MAETIC aims at developing professional skills and guides groups of students in all stages of the project. The part of the system dedicated to students is called "MAETIC e-suitcase". The e-suitcase includes an access to the teacher's logbook (important information, activities of the session, etc.), an access to teacher's resources (course materials, exercises to do, etc.) and an access log of the group of students. That part of the pedagogical device dedicated to the teacher is called "MAETIC Toolbox". A toolbox provides mechanisms to feed the teacher's logbook, to check students' logbooks, to comment on their work, to assess their work, etc.

MAETIC method is based on an in-group project-based pedagogy. The student constructs knowledge through projects and formulates his/her own problems (Schneider and al., 2005). The work interaction is the cause of socio-cognitive confrontations that have positive effects on the representation of the task, on the goals to be achieved and on the procedures to achieve them as well as the control of cognitive activities (Roux, 2004). Figure 1 shows the interactions between users and the elements of the device and the activities performed by each user of the system. Each of actors uses resources, handles tools and implements activities.

So, in a MAETIC device, the teacher:

- Uploads articles and resources on his/her logbook. This logbook informs students about the life of the teaching unit. Posts provide general comments on the work and on 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 on the activities of the groups via the student groups' logbook.

The student:

- Consults or download resources made available and accessible via the teacher's logbook. He must consult the teacher's logbook before each session.
- Uses tools that allow 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.

Once the group is defined, students will choose among themselves a student who will assume the task to manage their logbook. This logbook, aims to keep the teacher regularly informed on the progress of the project. It is used to describe the life of the project, making available the developed deliverables, the report of the activities and information on the project.

## 2.2 The MACCADAM Project

In order to assist the teacher in the production of MAETIC devices, the MACADDAM project is developing a PES. The PES helps teachers to deploy their own educational devices dedicated to the implementation of MAETIC environments. The studio assists them in the formulation of needs (design support) and releases them of tasks associated with the deployment a teaching device (development aid). The devices are designed and instrumented using Web 2.0 tools.

The studio controls the design process. The PES allows the selection of the elements that enable to

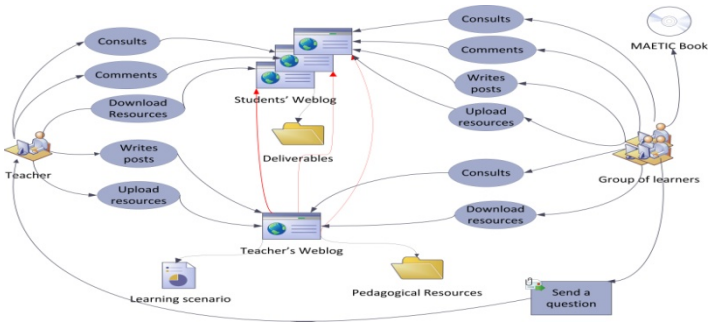


Figure 1: User Interactions in a MAETIC device.

define the device best suited to educational uses. The PES assists the teacher in the formation of his/her pedagogical script and generates the e-suitcases and the toolbox. The studio offers the ability to select and identify activities to implement in the script. However, resources and activities appropriated to the training area are under his/her responsibility.

### 2.3 PES Needs and Contribution of Multi-agent Systems

Communication between users (teachers and students) in a MAETIC device is mainly done via a Weblog. 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 (Al-Sakran and Serguievskaia, 2008).

A statistical analysis of interaction justifies the adding of automatic assistance that should provide MAETIC. The assistance includes tools for the teachers in charge of managing groups.

The statistics about interaction enable to evaluate the group's life and its evolution. The status indicators of progress and sustainability of the group especially interest us. Among indicators, one can cite:

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

The aim is to help students in the realization of the project and in collaborative learning and also to assist the teacher in the monitoring of both individual and collective activities.

The assistance issues need to collect traces of activities performed by the students. Therefore, we are developing a system which collects and analyzes data from the project activities. This system must trace the activity of the actors in order to make the most meaningful analysis. It must analyze the use of the environment and the data generated in this environment (forum, mail, meetings, etc.).

We have opted for an incremental and iterative approach for the design of the observation and assistance system. The devices 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-type system is motivated by several reasons:

1. 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. This allows an iterative and incremental development.
2. We are interested by the ability to solve distributed problems in a multi-agent architecture. We propose to identify agents that are specialized in observation tasks and others that are specialized in assistance tasks.
3. We are faced to a distributed environment. The multi-agent approach offers distributed agents being able to communicate.

## 3 PROPOSED ARCHITECTURE

### 3.1 Analysis of the System

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

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

We have identified three spaces in the MACCADAM studio: 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 studio generates the tools at the beginning of a learning session:

- 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 aim to mark out the behaviour of students, groups of students and teachers. They aim too to analyze traces.

After an evaluation process, we chose MaSE methodology (Multi-agent System Engineering) given by (Deloach, 2004) for the development of our system. The first step of MaSE methodology is the identification of the goal hierarchy diagram of the

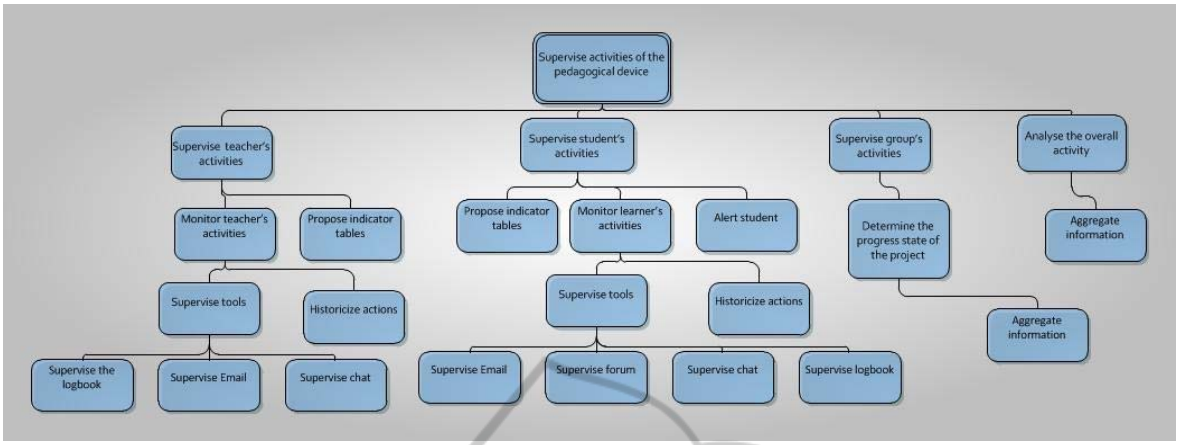


Figure 2: Goal hierarchy diagram.

observation of use and of the support system. This diagram is shown in figure 2.

## 3.2 The Agents of the System

The figure 3 presents an overview of the device, with the different agents of the system. We distinguish two types of user: the student and the teacher, and three workspaces: the teacher's space, the student's space and the group's space. Every user is associated to an agent that 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 and which run on the client. This technology allows a user to run his/her agent directly from his/her client. The superintendent of the space groups lives on the server. This agent is active as soon as one student of the group is connected. It provides meta-information on the activities (beginning date, end date, concerned persons, used tools, etc.) and on the forums (beginning date, end date, etc.). An agent supervises the interaction. It oversees every communication tool (email, forum, chat, blog) and supervises all the actions done during the session. Every event is dated and commented.

We store information of each user: connections into the various spaces, the activities done and communications. By aggregating this information, we can obtain (from an agent which manages the group's space) information that helps us to appreciate the life of the group, the productivity of the members and the level of realization of the educational activities. The analysis of this information, by an evaluation agent, allows 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:

- **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 behaviour during a training session;
- **a-TEACH:** It supervises the teacher's space. It allows supervision of educational resources loading in his/her logbook, of access to group's logbooks and of 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 students and absent students in a group and must provides statistics concerning the progression of each activity. It reminds students about deadlines and notifies the late groups by sending alerts.
- **a-TOOL:** It supervises the use of tools and provides statistics on the use of space tools (Email, Chat, Forum, blog, CVS, etc.).
- **a-EVAL:** This agent's role is to aggregate the information collected, to structure them in order to present it to the Evaluation module of MACADDAM studio.

## 3.3 A Case Study

Let's take the example of the G1 group. G1 has two students Patrick and Sam who must conduct an activity assigned by their teacher Michael.

This activity requires a maximum period of completion of 3 days and consists of two tasks T1 and T2 which can be performed in parallel. The teacher has uploaded the resources R1, R2 and R3 in his logbook. These resources may assist students in

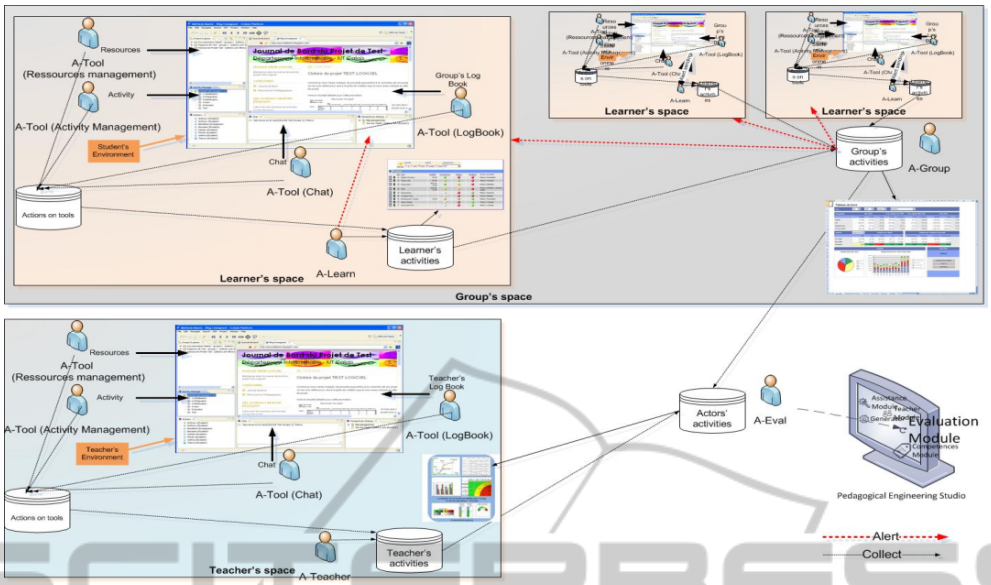


Figure 3: Main agents in their respective spaces.

carrying out the activity.

Table1: Chronology of actions on Michael's space.

| Chronology | a-TEACH Mickeal's space |
|---|---|
| J - 9h00 | Patrick accesses the logbook of the teacher |
| J - 9h01 | Patrick reading the activity to do |
| J - 9h15 | Patrick Downloads R1 |
| J - 9h17 | Patrick Downloads R2 |
| J - 9h24 | Patrick Downloads R3 |
| J+1 - 18h00 | Patrick accesses the logbook of the teacher |
| J+1 - 18h01 | Patrick uploads deliverables for the activity A (task T1) |
| J+2 - 18h00 | Patrick accesses the logbook of the teacher |
| J+2 - 18h01 | Patrick uploads deliverables for the activity A (task T2) |

To begin the implementation of this activity, Patrick connects on the logbook of the teacher and downloads the available resources. He then accesses the chat to send a message to Sam. He proposes to be the leader of the group and offers a division of the activity between them: he should make T1 and Sam should make T2. While waiting for Sam's answer, he begins reading the downloaded documents and he works on the completion of T1. At the end of the next day, T1 is completed. Patrick uploads the deliverables on the logbook of his group. He finally receives an acceptance message from Sam. Patrick offers to help him in the realization of T2 as he has already finished the task T1. But despite this help done via the chat, at the end of the 3 days, G1 has made only 70% of T2. Part of the deliverables has been uploaded on the logbook of the group.

Table 2: Chronology of actions on Patrick's space and Sam's space.

| Chronology | a-LEARN Patrick's space | a-LEARN Sam's space |
|---|---|---|
| J - 9h50 | Chat access | |
| J - 9h54 | Sends a message to Sam | |
| J - 10h00 | Reading R1 resource | |
| J - 10h50 | Reading R2 resource | |
| J - 11h15 | Reading R3 resource | |
| J - 11h30 | Consulting chat | |
| J+1 - 17h00 | | Chat access |
| J+1 - 17h01 | | Read message |
| J+1 - 17h05 | | Sends a message to Patrick |
| J+1 - 18h06 | Consulting chat | |
| J+1 - 18h10 | Sends a message to Sam | |
| J+2 - 8h to 17h | Discussion with Sam | Discussion with Patrick |
| J+2 - 17h45 | | Sends deliverable |

Without the presence of the observation system of use and assistance, the teacher would have considered Patrick and Sam in the same way.

On the other hand, the supervisor agents of Patrick's space and Sam's space were able to collect the traces represented table 2.

The supervisor agent (a-GROUP) noted that Patrick was present throughout the performance of the activity in contrast to Sam who was absent for about 2/3 of the time allocated to carry out the activity.

Thus, the teacher is able to assess the amount of work done by each student, their state (present, absent, inactive), their degree of sociability, the

achievement level of the activity, etc. Alerts are sent when something abnormal occurs.

# 4 ACCOMPLISHMENTS AND FUTURE WORK

We have chosen to deploy the system on the Madkit multi-agents platform because it is intended for the development and the execution of multi-agents systems and more particularly those based on organizational criteria.

The MaSE methodology and the deployment of communication mechanisms on the Madkit platform allowed us to test the feasibility of the multi-agent system for the observation of the learning system and to validate our conceptual approach.

Several issues remain to be explored and implemented. This includes the development of mechanisms to make the device more autonomous and proactive. Thus, the environment would be able to prevent the teacher and the students when a group has a bursting risk or is in a position of educational failure. Collecting interaction traces of different users does this.

Analysis of these traces is used to provide four types of assessments:

- A group level assessment: status related to the implementation of educational activities and to its members' status (present, absent, inactive). The group supervisor agent that resides on the server carries out this assessment.
- A student level assessment: assessing his/her productivity related to the realization of the pedagogical activities, his/her sociability that indicates his/her communication level with other members of the group. An inactive user connects to the platform only to read messages.
- An activity level assessment: indicating the level of achievement of an activity by the group.
- A teacher level assessment: evaluating the predictive pedagogical scenario compared to the effective scenario. This agent will interact with the evaluation module of the MACADDAM studio.

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