A COOPERATIVE INFORMATION SYSTEM FOR E-LEARNING
A system based on workflows and Agents

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Abstract: In the E-learning platform, we can consider three principal actors (Teacher, Learner and Administrator) whose interact or cooperate between them among processes, then in context of enterprise the e-learning process can be seen as a cooperative information system where actors are managers and employees. Many of these processes can be automated and then we consider this work as a workflow process. The learning process is naturally flexible because of different levels of learners and the different ways to present a lesson or training process. We use an oriented object Meta-Model based on UML to describe a process concerning Tutor and Learner and we propose a Multi-Agent System (MAS) based on ITS architecture to support the work of the actors roles "tutor" and "learner".

1 INTRODUCTION

The e-Learning made its appearance following the technological developments of information and communication meanings such as the Web and the Internet. Issued from distant teaching, the first platforms of e-Learning consisted in providing tools and convivial interfaces to three principal actors of the system : *Teachers*, *Students* and *Administrator,* allowing essentially :
For teacher : creation of courses, incorporation of teaching multi-media resources (sound, image, video) and more or less a follow-up of learners.
For learner: consulting courses on line or downloading contents, resolving exercises, transmitting duties for correction.
For administrator: management and control of teachers and learners; management of pedagogical resources and technical maintenance of the system.
Among platforms, we find GANESHA which is very simple or others more elaborated like Web-CT and Web-Tutor (improved tutoring quality). But, in majority of cases, the recommended solutions are directed more towards management of the teaching contents than the teaching itself. In other words, the question is "*how to make sure a good quality of teaching and an effective follow-up of learning in absence of direct interaction with teacher ?".* In traditional classroom, teacher can play several roles. Among these, the tutor role. In fact, our interest is to perceive the e-learning with a different vision regarding the teaching contents built by the teachers or the specialists as necessary resources for training processes.
So, the training process is seen as a transfer of knowledge according to a given pedagogical structure with a planning of work. The learner will have to carry out the planned work in order to ensure a good knowledge acquisition.
Consequently, the training process appears as a succession of activities that the tutor will define and the learner will perform throughout his studies. Hence, the idea is to design e-learning process based on cooperation between tutor and learner.
Each platform's actor can have different *roles* according to objectives of teaching. In one side, the tutor will have also to perform some activities for the follow-up of his learners group. Each actor will need a whole resources in order to achieve suitably the tasks which fall onto him. In the majority of cases, these resources are of various document types such as courses, exercises, multi-media contents, … etc. Then the concept of *route* appears. Finally, the execution of tasks will have to be accomplished according to a certain number of pre-established *rules*.

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Roles, *rules* and *routes* are the basic characteristics of workflow processes (Khoshafian & Al, 1998). Therefore, we propose to design e-learning process based on workflow (for the processes corresponding to this category well-sure) (Cesarini & Al., 2004) (Lin & Al.1, 2002) (VanTroys & Al., 2002) (Lin & Al.2, 2002). We are particularly interested to learner's following-up by the tutor. To do that, we use a meta-model approach designed using UML (Alimazighi & Al., 2002) (Saikali, 2000).

The advantage of using meta-model is to allow the elaboration of working plans for learners with different profiles. Each instance of model (workflow case) will concern a learner and his tutor. Learners can evolve according to their own speed and the tutor can perform a personalized tutoring for each one of them.

On the other side, we are not always teaching in the same manner and all learners have not the same skill's level; so, the learning process is naturally flexible. For this, using workflow meta-model may allow to do changes at the instance workflow level and the model workflow level. Thus, a tutor can operate modifications on an instance of a particular learner. In this case we talk about "instance flexibility". If changes concern all the model instances, then we talk about "model adaptability" (Saikali, 2000). The meta-model cover all the aspects of the workflow process (organizational, functional, behavioural and informational aspects). The behavioural aspect of the system is expressed using extended UML activity diagrams (http://www.omg.org).

Workflow processes are asynchronous; so, tutors and learners are relatively free to perform their work regarding their needs. This leads to the absence of direct interaction between the tutor and the learner and constitutes a lack for good teaching quality as the learner don't have any way to obtain immediate assistance. Therefore, we propose a Multi-Agents System (MAS) based on cognitive agents to support tutors and learners (Garro & Al., 2003) (Pesty & Al., 2001). This paper is structured as follows :

Section 2 : in this part, we locate the e-learning process regarding to the four aspects of the workflow meta-model : organizational, functional, behavioural and informational aspects.

Section 3 : we design an example of e-learning process and discuss about points which necessitate assistance for a best tutoring quality.

Section 4 : this section describes MAS's agents among their roles and their functionalities. A general overview of possible interactions between agents themselves and human actors is also described.

Section 5 : summarizes the obtained results and future works.

2 WORKFLOW META-MODEL FOR THE E-LEARNING

Within the framework of our research's team, a meta-model of workflow process was developed (Alimazighi & Al., 2002) in accordance with the standards of the WFMC (http://www.wfmc.org) which is a consortium of workflow standards. The meta-model covers four aspects :

Organizational aspect : describes the organizational structures, the actors of the system and their roles.

Functional aspect : shows system's functionalities by splitting of a process into sub-processes, activities and tasks.

Behavioural aspect : enhances the control flows, conditions and events attached to the activities.

Informational aspect : presents the part of information system necessary to the achievement of work.

Initially, we locate the e-learning process relatively to these four aspects.

2.1 Organizational aspect

Many organizations of training and education use today Internet for distant formation. In our point of view, a platform of e-learning can be seen as an additive support to university's campus (Mahdaoui & Al.1, 2004). This could contributes to reduce the loads endured in term of capital costs. In fact, the installation of an e-learning platform (equipments, networks, software tools,…etc), could not be higher than costs of real infrastructures (construction of buildings, classrooms, human resources, …etc). We consider then e-learning platforms like a virtual institution of teaching whose actors and roles are :

Table 1: Actors and roles in e-learning platform

Actors	Roles
Teacher	Tutor Author of contents Examiner
Student	Learner
Administrator	System Manager Manager of Teachers and Students Manager of pedagogical contents

Let's note that Administrator roles and examiners are not concerned by this study. The Administrator is assumed to be the system. For considered organisational structures, we propose to dispatch learners which adhere in e- learning formation into groups. Each group will have a tutor by module or

topic taught within the framework of the followed formation. Parameters such as the number of learner per group or a number of groups per tutor are fixed by the administrator (the tutor is concerted). For example, one tutor can propose an evaluation test to detect learner's profile in order to form groups.
The roles described for the teacher can be ensured by the same or different persons. We consider that the role concept is independent from the person who plays it. The following figure shows the organisation of actors and roles (fig. 1) :

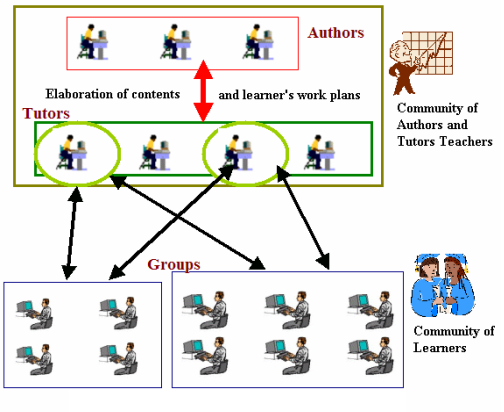

Figure 1: Organization of actors in e-learning process

The following diagram presents the part of the meta-model covering the organisational aspect (fig. 2):

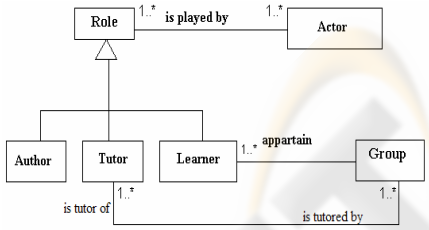

Figure 2: Organizational Meta-Model

2.2 Functional aspect

The functional aspect describes processes in term of sub-processes, activities and tasks independently of rules, events and constraints to which they are subjected. Thus, by regarding to the planning of work established by tutor as a process, we notice that it can be broken up into activities and each one decomposed into tasks to be achieved by the learner. We consider the task as the smallest entity of work, i-e, not decomposable. The functional part of the meta-model is presented in the figure below (fig. 3):

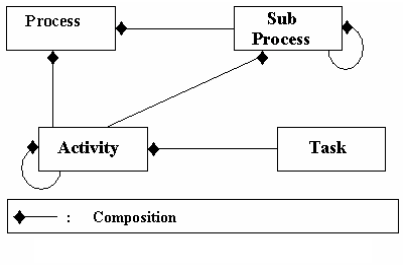

Figure 3: Functional Meta-Model

2.3 Behavioral aspect

This aspect focuses on intrinsic flow of control to a process and allows to show the state of activities and tasks. We can also describe conditions and events stream controlling the process execution. We suppose that the necessary pedagogical resources (tools and support documents) are disposable for the work of learner at each moment.
The activity diagrams of extended-UML (http://www.omg.org) allow to describe these properties. The description of a process always begins with the word "START" and finishes with the word "END". We use swimlane's activity diagrams where each swimlane represents a role (tutor or learner) and contains the set of activities or tasks to perform. A complete example will be shown in section3. Figure 4 illustrates the behavioural aspect :

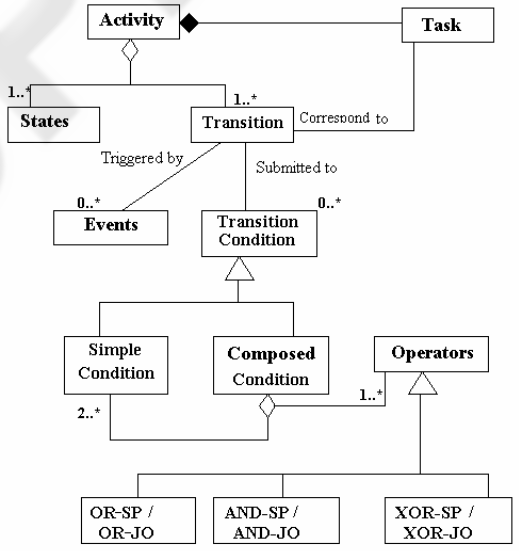

Figure 4: Behavioral Meta-Model.

Transitions express the activities and tasks. An activity or a task is characterized by one or several possible states. An activity is described by a succession of executable tasks. If all activity tasks

are correctly performed then the activity is correctly accomplished. The links between transitions describes relations of precedence, parallelism, choice, … etc. A transition may be triggered by one or several events and submitted to simple or complex conditions. This can be described by following operators : OR-SP, OR-JO, AND-SP, AND-JO, and XOR-SP as shown below (fig. 5, 6 and 7).

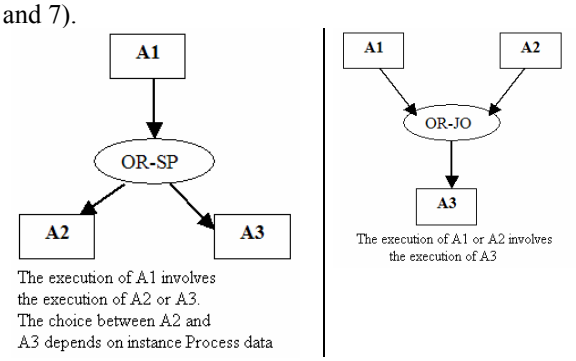

Figure 5: OR Operator

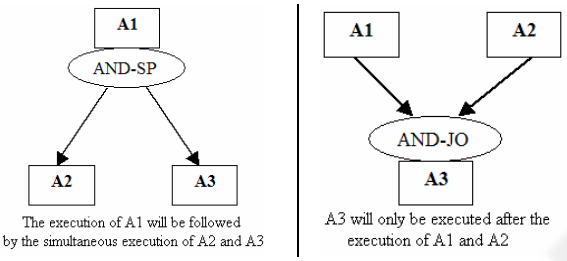

Figure 6: AND Operator

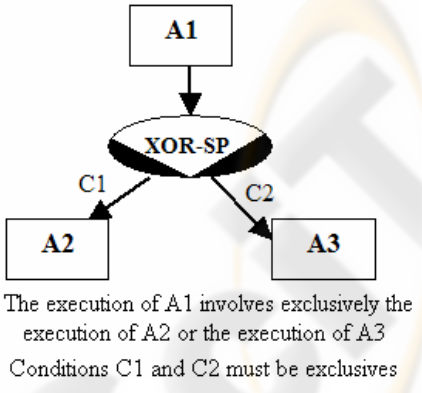

Figure 7: XOR Operator

Let‘s note however that the XOR-JO operator is similar to the OR-JO. Activity can executed iteratively as showed in (fig. 8):

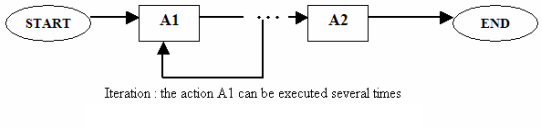

Figure 8: Iterative Structure

2.4 Informational aspect

Finally, the informational aspect presents the information system part in order to extract necessary data for operation of learning and then the execution of e-learning workflow processes. Information can be portions of databases or any other documents (text, multi-media, formulary, …etc). Meta-model part covering this aspect is represented in fig. 9 :

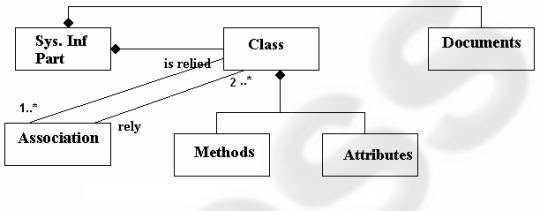

Figure 9: Informational Meta-Model

To extract pertinent information for this part, we carry out a conceptual study based on UML and RUP (Rational Unified Process) (Jacobson & Al., 2000) (http://www.omg.org). We obtain a class diagram covering all the information of e-learning platform. From this diagram, we present only information concerning this work, like showed in figure 10 by the dotted framework:

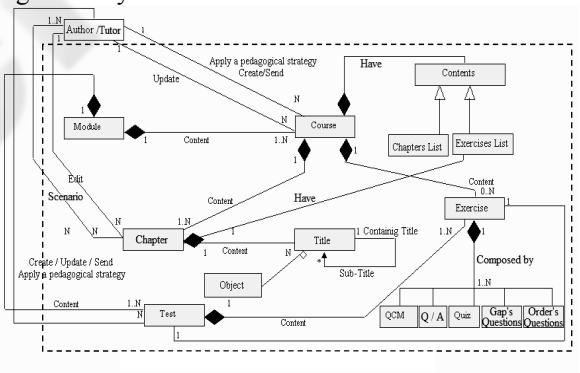

Figure 10: Classes Diagram for the Informational aspect

2.5 Integration of the four aspects

The diagram of figure 11 shows the integration of the four aspects previously introduced. For clearness, the information system part is presented without details.

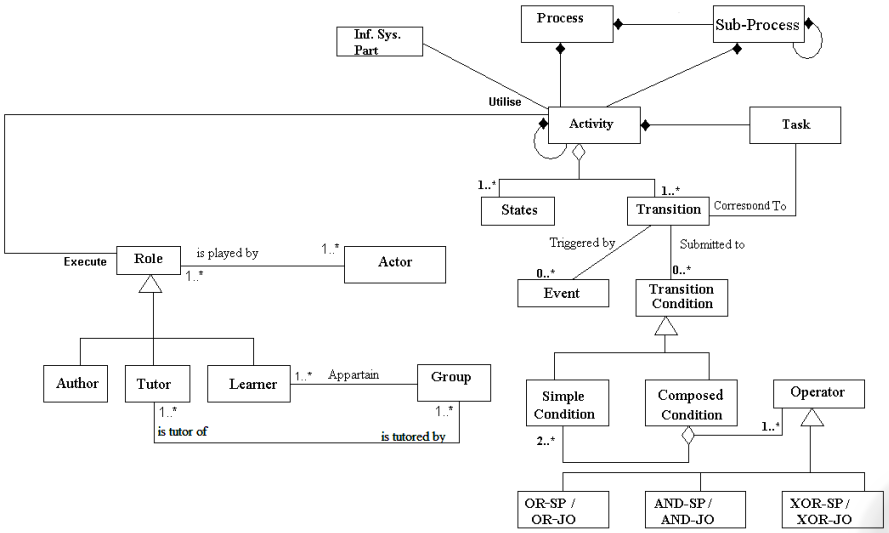

Figure 11: Workflow meta-model for e-learning

3 EXAMPLE OF E-LEARNING PROCESS

3.1 Presentation of the example

In this section, we will present an example of e-learning process model by designing the correspondent activity diagram according to the behavioral meta-model. We consider that a learner's work plan is prepared by the tutor. To do that, he retrieves structured contents (courses, exercises, … etc) established by the author. Tutor can also insert his own exercises. Furthermore, he can consult domain's specialists and pedagogues to improve learner's work plans.

Let's consider a module of "Information System" (a process) where a part of program is described in (fig. 12):

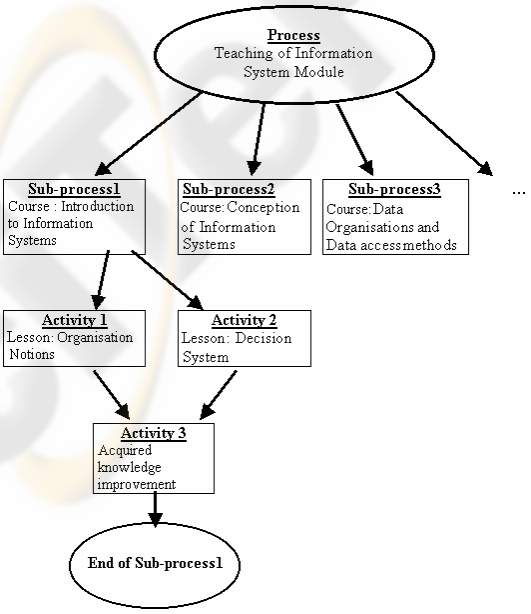

Figure 12: Decomposition of a process into sub-processes activities

The granularity choice in terms of processes, sub-processes, activities and tasks is delegated to the tutor. In this example, "Information System" represents the whole process subdivided into courses represented by sub-processes which are split into multiple activities corresponding to lessons. Each activity contains a succession of tasks to be performed by a learner. Let's note that nothing prevents to see a process differently. For scheme's legibility, we use zoom on sub-processes and activities as illustrated in figure 13:

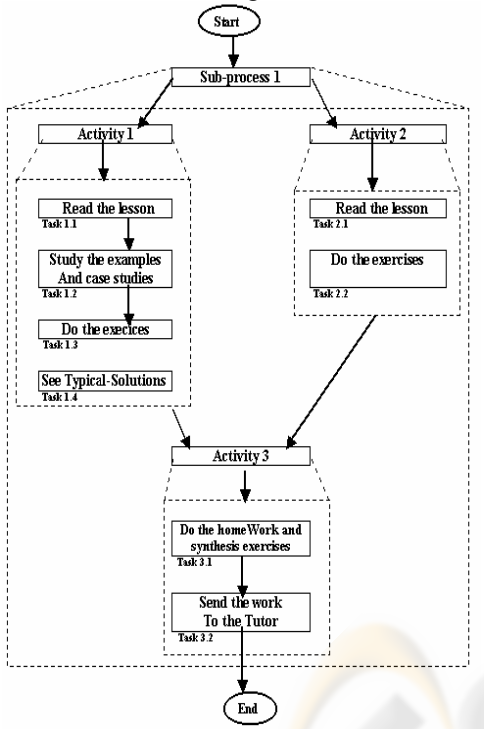

Figure 13: Zooming of a sub-process and activities

In correspondence with learner's work plan, the tutor will define a set of tutoring activities. This depend on his judgment of critical points (for example, need of learner's feed-back) in the work plan. Figure 14 shows an example of tutoring plan for sub-process1 (see fig. 13) :

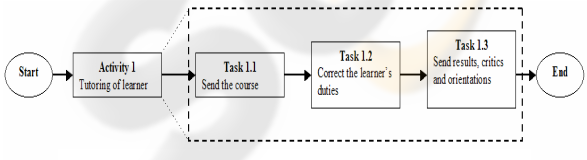

Figure 14: Example of tutoring process

3.2 Activity diagram describing the process

An activity diagram specifies the global process behavior and the work part of both actors learner and tutor. Events and control flows are detailed and learner-tutor interaction is enhanced. Tasks due to interactions are added like "Send a course" for tutor and "Connect to learning session" for learner. See figure 15 for the enrolling of sub-process1 (of fig. 13):

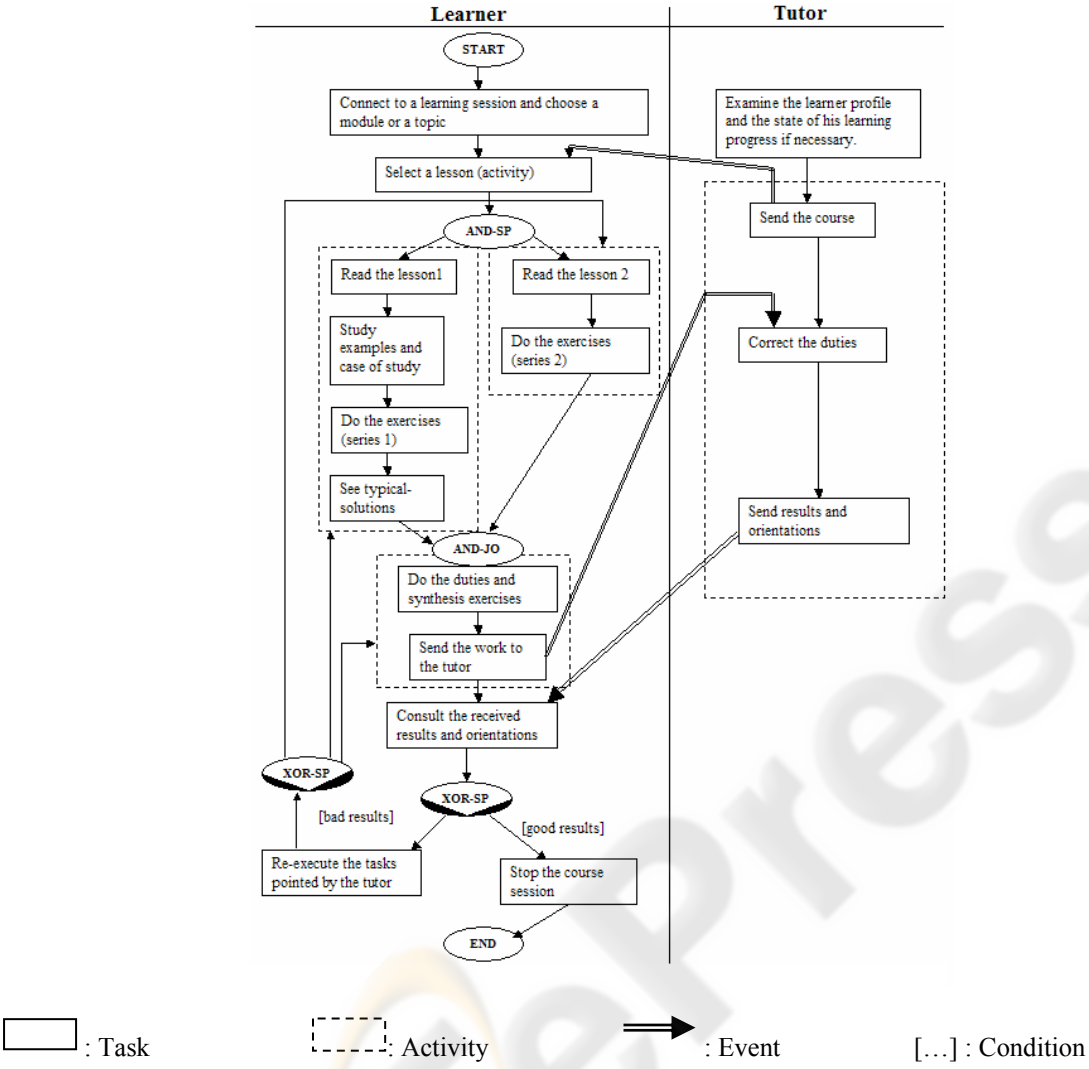

Figure 15: Activity diagram for a sub-process1 learning session

For clearness, we have reduced our example to a normal scenario, but in fact, the procedure can be more complex. We have said in introduction that e-learning is flexible, so when the tutor conceives a work plan, he can prevents possible assistance points besides pertinent points (necessary for tutoring). Here, process modeling becomes more complex and if he (the tutor) don't want to do it, he can ignore exceptional cases and treat them during workflow case (flexibility). If the tutor detects that the same exception arises at the same point in all workflow cases then he can decide to modify the process model (adaptability). That is possible by using of meta-model (Saikali, 2000) (http://www.wfmc.org). Figure 16 presents an example of learner's assistance for a task.

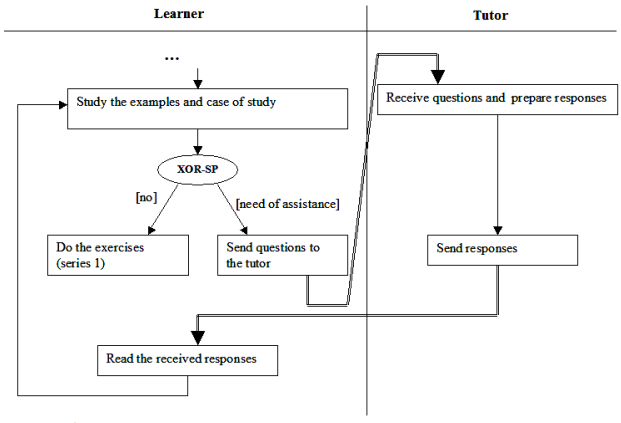

Figure 16: Learner's assistance for the task "Study the examples and case of study

We differentiate between learner's connection to platform and the execution of e-learning instance process. Therefore, when a learner is connected to the system, he must identify himself as adherent to the platform (administrative side). Once the connection is established, he selects the module he wants to study and then accedes to activity list (sub-process). Interactions between tutor and learners are asynchronous, hence it's possible that a learner stands until his tutor sends the results of tutoring before to continue his work (for instance, he wait for an answer to his sent question). Finally, a workflow case concerning one matter (module) can be performed in several sessions of connection, as it's possible that different sub-processes instances for the same module are executed in one connection, depending on learner's rhythm, skills and the process model.

From there, the using of workflow system is benefic in sense that it makes possible to plan both works of tutor and learners. Asynchronous communication allows each one to evolve accordingly to his disposal. But the learning quality may be altered because some types of problems that the learner can meet need immediate response (this is not possible when the tutor is not connected).

In the other side, a tutor have one or several groups of learners. They can solicit him at the same time for different problems from various degrees of importance, so tutoring can become difficult.

Thus, to improve the quality of learning and tutoring, both roles need assistance. We propose to introduce artificial actors in the system. These actors are organized as a Multi-Agents System (MAS) (Garro & Al., 2003) (Ouahrani & Al., 2003) (Pesty & Al., 2001).

4 A MULTI-AGENTS SYSTEM (MAS) FOR THE E-LEARNING ASSISTANCE

4.1 Needs of assistance for tutors and learners

As previously described, tutors and learners need assistance during the accomplishment of their respective tasks. These can be summarized in

- For learner, the primordial thing is to provide an assistance or an artificial tutoring (as much as possible) during his work's session.
- For tutor, the essential is to present and organize all critical information concerning his groups in such way he can takes a good and efficient tutoring decisions.

To realize that, we propose the intervention of artificial actors in the system. These actors are cognitive agents having abilities of reasoning and taking decisions (Garro & Al., 2003) (Ouahrani & Al., 2003). They can communicate between them and with human actors by messages. Agents can also execute complex tasks alone or in cooperation(Ouahrani & Al., 2003). Each agent play a specific role in the system. The MAS is organized accordingly to Intelligent Tutoring Systems (ITS) (Mahdaoui, 2002). Advantages of using MAS in this context are :

- To make tutoring so easy by delegating all automatisable tasks to agents. This will allows tutor to focus on real problems which can not be resolved without him.
- To offer a certain necessary interactivity for learner to evolve, and to allow more rapid progress in training by submission to elaborated learning strategies (Aimeur & Al., 1999) (Mahdaoui, 2002).
- The MAS can collect lot of knowledge and this may considerably contributes to the improvement of tutoring and learning strategies. Tutoring strategy is the "tutoring way" of tutor and the learning strategy is the manner of learner's learning.

Finally, let's note that when adding a MAS, our goal is not the elimination of human tutoring but its improvement with best level of assistance. Organizational meta-model of workflow is extended to agents like showed in figure 17:

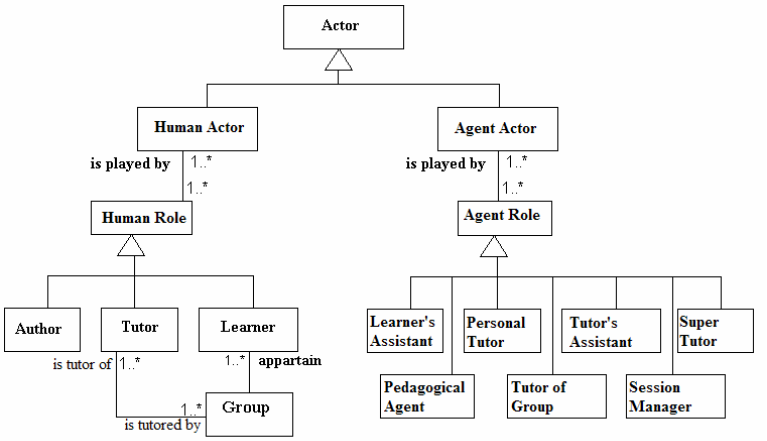

Figure 17: Organisational Meta-Model extended to agents

4.2 MAS's Agents description

Agents are defined by the role they can play in the system. The MAS is constituted by seven cognitive agents : "Learner's Assistant Agent" (LAA), "Personal Tutor Agent" (PTA) and "Pedagogical Agent" (PA) are dedicated to learner. "Tutor's Assistant Agent" (TAA) and "Group's Assistant Agent" (GTA) concern tutor. "Super Tutor Agent" (STA) and "Session Manager Agent" (SMA) are for both tutor and learner. We describe below, each agent and its functionalities.

4.2.1 Learner's Assistant Agent (LAA)

The role of LAA consists to assist each learning session. It's a learner's representative towards the other agents concerning him. One LAA agent is associated to one learner.

Functionalities :

- ✓ LAA is created when a learner is connected for the first time to the e-learning platform. At each learner's connection, it's activated by the system and inactivated at each disconnection.
- ✓ LAA helps the learner in the choice of the module to study. After, it informs PTA agent that the learner is on-line.
- ✓ When learner wants to obtain help from others, LAA make in his disposal a special buffer where he can write his request. Moreover, the learner can precise the receiver of message which can be PTA agent, the tutor or other learners in his group. If the receiver is human then LAA demand to SMA if he (human) is connected.
- ✓ If SMA's reply is well acknowledged then LAA negotiates with the corresponding agent of the receiver (other LAA or TAA for the tutor) to know if he wants to converse. After answer reception, LAA inform the learner.
- ✓ If the learner have not precise the receiver (for example, he search for any connected learner in his group), then LAA demands a list of connected learners from SMA and after, LAA negotiates to find favorable persons to dialogue. It transmits results to the learner.
- ✓ Furthermore, LAA can accede to learner's e-mail once it is activated and classify arrived and non treated messages. Tutor's messages are always placed at the top of the list. Generally, LAA can use the message list to council the learner for choice module.

4.2.2 Personal Tutor Agent (PTA)

PTA is an artificial personal tutor for the learner and assists him for each task he performs. For each learner, one PTA is associated. PTA knows the nature and pedagogical objectives of activities and tasks. We distinguish between two categories of tasks : passive task like reading text or visualizing multi-media and active task like doing exercises, duties or practical works.

For passive tasks, PTA will inspect parameters like estimated duration for example. This kind of task remains very hard to inspect, so, PTA will just try to attract learner's notice that it must be performed.

Generally, an active task always terminates with learner's feed-back. Activities like exercises, for example, are particularly important for a good teaching and presents pedagogical goals as :

- Test of acquired knowledge
- Increase learner's capabilities to analyze and proof

- Evaluate learner's skills and lacks

Functionalities:

- ✓ PTA receives a sub-process (work plan) from GTA and loads learner's work-list with the activity to execute. Each task of an activity corresponds to a work-item and PTA will assist its achievement.
- ✓ If the task is passive, the learner can decide to jump it (for example, because he knows the content) and so PTA will note this fact. After, PTA can use it to direct his tutoring decisions.
- ✓ If the task is active, PTA will stand for learner's feed-back. If necessary, PTA can activate his subordinated agent PA for applying an appropriate pedagogical strategy to the learner. When terminated, PTA will receive a report from PA.
- ✓ PTA knowledge allows it to judge if a task is correctly performed or no (if learner's results are satisfactory or not). Then PTA can take one of the following decisions :

- If results are good then PTA will pass to the next step of work. It can be the next task or activity to do. If the concerned sub-process is correctly finished then PTA will request from GTA the next work to be done. Depending on GTA's answer, PTA may continue tutoring or arrest the work (answer depends on what the tutor have arranged). In arrest case, PTA sends a detailed report to GTA about the learner.
- If results are not good, PTA will try to resolve the problem according to the following steps :
  - ➢ It proposes for learner to re-execute the task in the step which causes the problem.
  - ➢ If problem persists (not conclusive results), PTA will use his own experience and propose other works (complementary tasks) to reinforce learner's knowledge.
  - ➢ If PTA have not required competences or if results remain not good, GTA will be solicited for help.
  - ➢ GTA's reply can be : a new tutoring strategy or information that the problem will be transmitted to the tutor. In this case, PTA stops tutoring until reception of new directives.

Moreover to that, PTA can cooperate to resolve GTA's requests for other PTA's count. If PTA have no response to send, it ignore the request.

4.2.3 Pedagogical Agent (PA)

PA's role is to submit a learner to different learning strategies in order to ensure that he had (the learner) understand and for filling his gaps. PA is subordinated to PTA which solicits it when necessary. According to pedagogical objectives, PA can become "companion", "troublemaker" or "learner's pupil" (Aimeur & Al., 1999) (Mahdaoui, 2002).

Functionalities:

- ✓ PA can apply one of these strategies :
  - Learning with companion : PA becomes a *co-learner* (a friend) with slightly high level of knowledge than learner. PA guides the learner during his work by counsels and suggestions (according to what it knows). The learner is free to choice and to decide.
  - Learning by disturbing : PA becomes a *troublemaker*. With this strategy, the level of exercises is more elaborated and aims to provoke conflict situations (cognitive dissonance) between PA and the knowledge and the convictions of the learner (Aimeur & Al., 1999). So, PA can detect learner's gaps and his performances in analyze and proof.
  - Learning by teaching : it's the ultimate step where PA becomes a *learner's pupil*, i-e, learner have a very high level of knowledge and capacities. Therefore, he must teach to PA.
- ✓ Once terminated, PA transmits a report containing evaluations, marks and observations to PTA.

4.2.4 Tutor's Assistant Agent (TAA)

Similarly to LAA, TAA represents the tutor over against other concerned agents and assist him at each tutoring session. For one tutor corresponds one TAA.

Functionalities:

- ✓ TAA is created when a tutor is connected for the first time to e-learning platform. TAA is activated/inactivated according to tutor's connection/disconnection.
- ✓ Tutor can have several associated groups for different modules. Then TAA assists him for choice. After, TAA informs concerned GTA that the tutor is on-line.
- ✓ When tutor wishes to communicate with agents or his learners, he describes his request in a special area provided by TAA with possibilities to choose receivers.

- ✓ When tutor want to send his reply concerning a problem received from GTA, he also use TAA.
- ✓ TAA treats the request like described for LAA.
- ✓ TAA can accede to tutor's e-mail once it is activated and classify arrived and non treated messages. Learner's messages are always placed at the top of the list and generally, TAA can uses the message list to council tutor for the group and the matter choice.

4.2.5 Group Tutor Agent

GTA is associated for one group of PTA representing a group of learners and one tutor (for one matter). GTA is an artificial tutor for all group members in sense that if any problem PTA(s) cannot be resolved, GTA will try to do it. GTA cooperates with PTA and STA and informs regularly the tutor about group's evolution.

Functionalities :

- ✓ When GTA receives request from PTA, he attempts to answer according to its own experience (knowledge previously collected from others PTA, STA or tutor).
- ✓ If GTA don't find the solution, it requests SMA to obtain a list of active PTA(s) (inactivated PTA(s) have been previously sent all the information to GTA).
- ✓ Based on the received list, GTA diffuses a request for tutoring assistance. If no result is obtained then GTA asks STA for help.
- ✓ Once answers received, GTA analyses and organizes results in a report and sends it to concerned PTA. If no solution, GTA informs PTA that a problem will be submitted to the tutor.
- ✓ GTA can receive request for assistance from STA, thus if it cannot treats the problem, GTA ignore the request.

4.2.6 Super Tutor Agent

STA capitalizes all the experiences concerning GTA(s) that tutors the same module (for the same profile of learners) and experiences concerning the same group of learners for different modules. At present, we consider that only one STA exists for all the groups.

Functionalities :

- ✓ When STA receives a help demand from GTA, it try to treat it according to its own knowledge (results from other GTA(s) experiences).
- ✓ If no results, STA diffuses a request for assistance towards actives GTA(s) (list of actives GTA(s) is obtained from SMA). The rest of the procedure is similar to GTA/PTA scenario.
- ✓ When help's demand is received from the tutor, depending on what is requested, STA treats question under one of the two aspects described in the beginning of this paragraph.

4.2.7 Session Manager Agent

SMA has the responsibility to save all the information concerning connection/disconnection of learners and tutors (and activated/inactivated agents). Actually, we consider one SMA for all the system. SMA is automatically launched by the system when start-up.

Functionalities :

- ✓ Receives and treats demands issued from all other agents of the MAS and tutors.

4.3 General Overview of the MAS behaviour

As previously described, figure 18 summarize the global behaviour of the MAS :

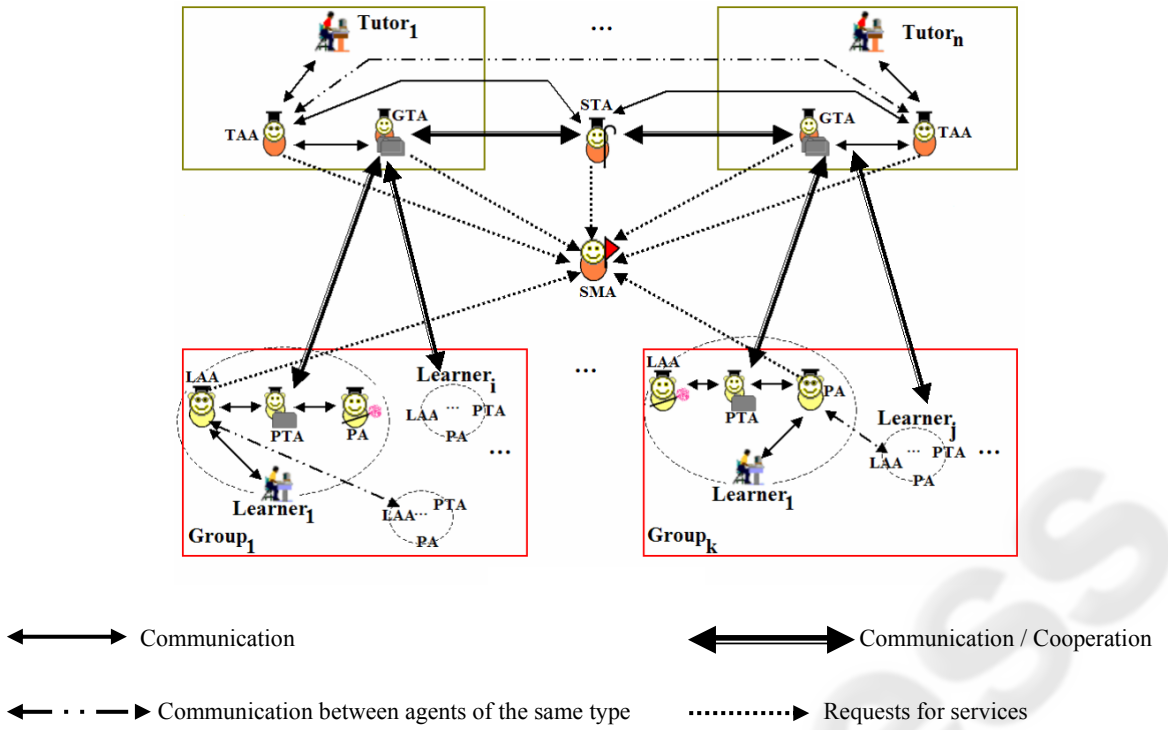

Figure 18: Agents Interactions

The link between workflow system and MAS's agents is activities and tasks received in the learner's work-list and work-items. Agents may communicate and cooperate between them. Communication with human actors is also possible. To realize this system, we are working to specify the MAS with AUML diagrams suitably to the FIPA standards (http://www.fipa.org). AUML allows specification of agents (competences, knowledge, intentions, plans …etc). Moreover, we aim to enhance the conversation between agents and to define the appropriate cooperation/ communication protocols and to avoid conflict problems.

5 CONCLUSION AND PERSPECTIVES

In this paper, we are interested to design an e-learning process as a workflow process. Some related works have considered workflow aspect in the e-learning in different ways. (Cesarini & Al., 2004) (Lin & Al.1, 2002) propose models for teaching staff who interact between them. (VanTroys & Al., 2002) (Lin & Al.2, 2002) propose a workflow engine for e-learning based on Workflow Management Facility (WMF) (http://www.wfmc.org). (Pesty & Al., 2001) (Garro & Al., 2003) talk about using MAS for teacher's and student's partner system.

Our approach, proposes to combine the using of workflow process with a MAS to improve the quality of assistance for tutors and learners. We propose to design both works of learner and tutor, and the interaction between them by workflow processes. We have established an UML meta-model of Workflow process for e-learning. For the behavioural aspect, extended UML activity diagrams are used. These constitute a powerful formalism allowing the expression of control flow using specific operators.

We define a MAS containing seven cognitive and cooperative agents. Like Intelligent Tutoring Systems (ITS), some agents have the ability to replace human tutor in determined tasks and help the learner during his work. Knowledge capitalized in the MAS can be used to improve the quality of teaching in a platform.

As first result of implementation, we have realized an author's tool to prepare pedagogical contents and exercises making it in disposal of tutor for preparing work plans of learners. A tool for definition of pedagogical workflow process is under development.

As perspectives, we are actually working on specification of the behavioural aspect of workflow with Workflow-Nets (issued from PETRI-NETS) (Mahdaoui & Al.3, 2004). In fact, e-learning process

might be very complex and then the need of properties verification is important before any deployment on e-learning platform. Parallely to this we have proposed in (Mahdaoui & Al.2, 2004) an assistance system based on holonic agents an we give a more detailed description of the MAS agents using J. Ferber's Grill and petri-nets in (Mahdaoui & Al.4, 2005). Our future gool is to compare the two approaches respectively to certain properties of efficiency we will define.

In addition to what we said in section 4, we think that the role of some agents can be extended in order to cooperate with other actors like the administrator. Finally, we want to consider other human roles like *examiner* which represents a great importance in e-learning platform as virtual structure of teaching. This role can have important incidence in tutoring.

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