A GLOBAL MODEL FOR VIRTUAL EDUCATIONAL SYSTEM

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Abstract: This paper present a virtual educational environment model which makes learning easier by using collaboration (and extension, team-research model) as a form of social interplay. The model represents a universe where human agents interact with artificial agents (software agents). Considering the vision of the system, it can be classified among advanced systems for it is client-oriented (student) and provides value added educational services, due to the collaborative learning attribute. The model proposes an original architecture where elements of the socio-cultural theory of collaborative learning are assigned to the artificial intelligence components (the multi-agent system). The expected results are: conceptual models (agents, learning and teaching strategies, student profiles and group profiles, communication between agents, negotiation strategies and coalition formation), software entities, and a methodology to evaluate the performance of eLearning systems.

Key-Words: socio-cultural models, multi-agent system, multi-agent architectures, collaborative learning, artificial agents, computer-based learning, distance learning.

1 Introduction

Definitely most people using such words as "education", "learning process", and "learning" firstly mean some educational institution where lectures and discussions take place, some researches are carried out and a teacher plays a central role in the learning process. However, nowadays rapid growth of information and communication technologies in addition with traditional ways of learning has provided new opportunities how people can acquire knowledge allowing them to chose learning time, place, pace, and amount. Today different computer technologies are used for creating and delivering of learning materials, for supporting (partly or entirely replacing a teacher) and managing of the learning process. Researchers working in this field use different terms for referencing of possible ways and approaches of teaching and learning.

We chose the term "virtual learning" as an umbrella term for other terms described in this paper. We believe the word "virtual" means "different, peculiar", so under the virtual learning we understand the learning process that differs from the traditional learning process and that has such features:

- the learning process is based on some technology partly or entirely replacing a human teacher;
- if the role of human teacher is partly replaced by some technology then a teacher and a learner can be separated by time and place, but in this case communication between them is provided;
- a learner can choose time, place, pace and amount of learning.

The offered definitions of terms are very often too vague and raise ambiguity in the applied terminology provoking the following questions:

- Why do some authors use the term "computer-enriched learning", but the others use "computer-assisted learning" or "computer-managed learning"?
- Is the term "e-learning" a synonym for "technology-based learning"?
- Why do some terms embody the word "teaching" or "training", but the others- "learning" or "instruction"?
- What is the difference between the terms "Internet-based learning" and "Web-based learning"?

These questions could be urgent for newcomers in the field of virtual learning such as young researchers or anyone, who searches for a kind of

learning appropriated to his/ her needs. All the terms are viewed from the technical position giving special attention to a technology used in the learning process.

E-learning systems and other forms of educational software are present today at all levels of organized learning and training, from primary schools to universities and long life learning programs. Multimedia classes and video-demonstrations have a great impact on the quality of the educational process. Due to the rapid evolution of technology the school is today the beneficiary of uncountable advantages, with an almost natural tendency to allocate less time to face 2 face communication and more to online learning and training. At the same time we must not minimize the side-effects of too extensive use of technology. The new information technologies offer to education many opportunities, but also challenges. In order to obtain the maximum benefits and to answer to the main challenges educational software designers have to approach several learning models, to apply design methodologies centered on the student, adapted to different learning styles, to different knowledge backgrounds.

E-Learning is mainly about *learning* and the "e" can be for *electronic* or *enhancing* or even *enabled*, but it is not the target. E-Learning has to be centered on people that are learning. It has to address different learning styles, different levels of basic knowledge. The technical aspects of electronic delivery of knowledge are, of course, very important, but they must be adapted to the learner and her/his environment. It is obvious that students learn better if the text books are well organized, richly illustrated, with clear headings, etc. And if we can add to all these animation and colors, the results are encouraging. E-Learning applications are manipulating a lot of different learning objects, from courses to projects and home works. The efficiency and the efficacy of these systems depend greatly on how well they adapt to the individual student profile. Many critics have attacked these products for their low psycho-pedagogical validity and a lack of standard quality assessing criteria. Challenges that e-learning software developers have to cope with are linked to these psycho-pedagogical and social characteristics that depend on the student's individuality.

2. Educational concepts

The terms that are used while speaking about the support of the learning process by different technologies typically include the following concepts, which have come from pedagogy: education, instruction, learning, teaching, training, and tutoring. Their meaning will be clarified briefly in this section as these terms are not the focus of this paper.

The meaning of the word "teaching" could be easy captured. It highlights the teacher's role in the learning process and comprises all activities that impart knowledge, facts, ideas or skill. It is necessary to note that not only a human could play a teacher's role, but also a computer system based on a certain technology.

It is very difficult to give a single comprehensive definition of the term "learning", as there exists a variety of definitions. However, it is possible to list the principal features of learning. Learning causes a change in a person's behavior, knowledge, or skill, this change is a relatively permanent change and is caused by prior experience [5]. Some authors believe that the term "learning" emphasizes a learner activity in the learning process, that is, a learner is free to choose what will be studied and in which sequence.

The most specific term among all educational concepts is "training". Training assumes a planned and systematic sequence of activities usually under the guidance of qualified supervisors [17] which has the purpose to develop knowledge, skills and behavior pattern required by an individual in order to perform adequately and effectively his/her job. So, this term emphasizes the practical or vocational direction of the learning and typically is used on the professional or corporate level as Horton [9] specifies or it is pointed out in the definition of computer-based training.

The term "education" is related to learning activities that have objectives to develop knowledge, attitudes, skills and values in general that are not related to specific work area as it was assumed by the term "training". This term is more common within the academic settings as Horton [9] points out and Karlgren [12] specifies describing meaning of the terms "computer-based education" and "computer-based instruction".

The term "instruction" also implies the practical direction of the learning, but unlike the term "training" it is more common within academic settings as it is specified in [12] defining computer-based instruction and in [9]. This term also implies a more planned approach to the learning process and it points out to assistance component as an important aspect of the learning process.

The terms "training" and "instruction" are often used as synonyms speaking about the learning with practical orientation in general. It could be seen in

the definition of computer-based training. However, these terms are distinguished emphasizing the environment, where the learning process takes place. The word "tutoring" is used more rarely than other aforementioned terms. It has the meaning similar to "teaching", but implies that teaching is more individually oriented as it involves two individuals, a tutor and a tutee, or a tutor and a small group of tutees, two or three tutees [20]. A tutor provides specialized or remedial help to the tutee, clarifying major points of a subject matter or explaining difficult concepts [6].

3. Connectives

The formed groups of the terms differ in the technology that is used for supporting or managing the learning process. Namely the connectives show the difference among the terms within the particular group. These connectives are: administered, aided, assisted, augmented, based, delivered, directed, enabled, enhanced, extended, facilitated, managed, mediated, monitored, related, and supported [1].
The connectives may be organized into some categories based on their meaning:

- The words "managed", "monitored", and "administered" point out to the fact that some technology does not contribute directly into the teaching/learning process, but serves as a medium in the managing of the learning process. In this case the computer system based on this technology typically provides such functions as test generation, evaluation of learner performance and analysis of learner's assessment results, record keeping on the learner progress and statistical report generation about individual or group performance, generation of recommendation for the further learning process. However, the delivering of the learning content could be fully human-oriented, not based on some technology.
- The connectives "aided" and "assisted" point out that some technology or a computer system based on this technology is used as a learning medium, that provides presentation of the learning materials, checks learner's knowledge, guides questioning-and–answering sessions, as well as develop recommendations for further learning direction. An application based on this technology could be used as a supplement to traditional learning process with limited teacher interventions or as an independent learning medium.
- The meaning of the connective "enhanced" is similar to the meaning of the words "aided" and "assisted", that is, it points out that some technology is used as an enabler or a supplement to the traditional learning process, but it emphasizes the teacher's role in this process. The teacher plays the central role in the learning process and should be involved in the planning and implementation of learning activities. Thus, direct contacts between a learner and a teacher still remain determinative, but some technology is used as an enabler of the learning process.
- The connective "enriched" implies that some technology is used as a working tool in the learning process and does not provide creating and delivering of learning materials.
- The terms including the connective "based" have a broader meaning in comparison with the terms that embody all previously described connectives. This word points out that some technology plays a central role in the learning process. Its meaning is composed of variety of computer uses, including creating and delivering of learning materials, managing of the learning process, as well as use of the computer by learners. This connective covers the meaning of three words: "managed", "assisted", and "enriched".
- All the aforementioned categories of the connectives, nevertheless, limit the role of technology in the learning process. The words "mediated" and "supported" assign the broadest meaning to the terms. In this case some technology is used as a learning resource or a tool, as a tutor and as a subject to be taught.
- The meaning of the connectives "augmented", "delivered", "directed", "enabled", "extended", "facilitated", and "related" has not clarified yet due to the lack of definitions of the terms that have these connectives. However, basing on the context in which the terms were used within the Web sites, the following conclusions have been obtained:

  a) the words "enabled" and "facilitated" could be assigned to the category of the connectives "aided" and "assisted", but they are used more rarely;

b) the word "delivered" points out that some technology is used for accessing the course (learning materials, collaboration features, feedback), but direct contacts between a learner and a teacher either are fully eliminated or highly reduced;
c) the connective "related" is so broad as the words "mediated" and "supported".

The following diagram (figure 1) shows the degree of narrowness that is assigned to the term by a corresponding connective. In this way, for example, the term "computer-managed learning" is more specific than the term "computer-mediated learning".

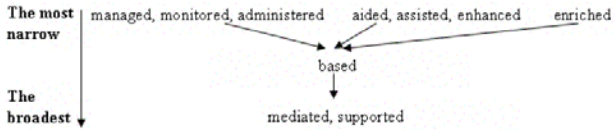

Figure 1. The degree of narrowness assigned to the term by a corresponding connective

4. Learning Management Systems in higher education

Learning management systems (LMS) such as Blackboard and WebCT integrate a range of online tools, including discussion boards, announcements, email, assessment quizzes, group facilities, and online content areas. Since the wide-scale proliferation and adoption of LMS in the UK, Europe, US, and Australia, much has been written about the ways in which such e-learning technologies may afford enhanced experiences for students in terms of improved quality of learning, enhanced productivity of learning (access to education, for example), and/or improved attitudes to learning [14]. In another study, Coates, James, and Baldwin [4] note that behind the rapid adoption of these particular systems there have been six drivers, namely:

1. a means of increasing the efficiency of teaching
2. the promise of enriched student learning
3. new student expectations for advanced technologies
4. competitive pressures between institutions
5. a key means of responding to massive and increasing demands for greater access to higher education
6. part of an important culture shift taking place in teaching and learning in higher education.

Regarding the sixth driver, Coates et al. [4] argue that: LMS offer universities a hitherto undreamt-of capacity to control and regulate teaching. From a managerial perspective, the disorder associated with academic independence and autonomy in the teaching and learning process can appear chaotic and anarchic … LMS may appear to offer a means of regulating and packaging pedagogical activities by offering templates that assure order and neatness, and facilitate the control of quality (p. 25).

Though Coates et al. (2005) view these systems as essentially devices for teaching, they state that attention has been most often focussed on their technical, financial, and administrative aspects. In contrast, our institutional approach seeks primarily to understand the use of LMS as technological environments for learning.

Learning Management Systems offer facilities for managing authors, tutors, administrators by maintaining password systems and catalogues with roles, functions for controlling access to content, but they have a very few options for monitoring students evolution (in general only quizzes and multiple choice grids for evaluation) and deal with feed-back. In spite of all these deficiencies, the fact that LMSs are Web based makes them very popular. Years ago many virtual study programs started by being text based, using HTML, PowerPoint, or PDF documents, eventually incorporating a wide range of multimedia technologies. Today animation and virtual reality (VR) are gaining space (Macromedia Flash, VRML and other animation and VR software) and the list of technologies used to design, develop and present e-learning applications is quite long: hypermedia, classroom response systems, blogs, e-mails, cooperative systems, computer aided assessment systems, electronic performance support systems, learning management systems screencasts, simulation, web 2.0 communities, ePortfolios, games, video and audio based courses, wiki, multimedia CD-ROMs and DVDs etc. In general, an e-learning application is using more than one of these techniques [8].

The advent of web 2.0 had an impact also on e-learning. ***Web 2.0*** is defined in Wikipedia as *a trend in World Wide Web technology, and web design, a second generation of web-based communities and hosted services such as social-networking sites, wikis, blogs, and folksonomies, which aim to facilitate creativity, collaboration, and sharing among users*. Web 2.0 has changed the whole pedagogical approach of learning. Before Web 2.0, we had a hierarchical way of learning and a

collaborative one. In the hierarchical way of learning the teacher has the control of the learning process and the student has a very limited possibility to choose what to learn. The teacher is the source of knowledge to be learned. Moreover, in general, the teacher is in her turn subordinate to an institution that imposes certain directions of learning. If the process is computer-based, the software can give to the learner some freedom to choose the path and the pace through the learning objects, to choose between several kinds of knowledge. We can say that this time the software has the control. The Learning Management Systems is organizing the content, accesses, etc. Web 2.0 is ideal for collaborative learning. It generates ad-hoc communities and learning environments and wipe out communication barrier. When you put a question on your blog, you get answers from the whole world. There are still some language constraints but not for long. In the collaborative way of learning the control of what is to learn is shared between teachers and learners. The learners have something to say about what to learn and they are encouraged to collaborate, to work together and to share their learning experience. Collaborative learning is less formal than hierarchical learning. We can see the birth of group of learners with common goals, groups that are dissolved after the goals are achieved. The experience is socially enriching but may result in poor achievements on the cognitive side.

Having in mind that social aspects are important to be captured in the design of any e-learning application, a team of researchers from *Babes-Bolyai* University in Cluj-Napoca and *Lucian Blaga* University of Sibiu have started a large project **DANTE**-*Socio-Cultural Models implemented through multi-agent architecture for e-learning.* **DANTE** has as main objective the development of a global model for the virtual education system, student centered, that facilitates the learning through collaboration as a form of social interaction. In our vision, the global model requires its own universe in which the human agents interact with software agents. In the virtual worlds of software agents, things must be similar with what is happening in a real world, and this is visible if we look at the metaphor "computing as interaction" or at the "emergent synthesis" design methodology.

5. The DANTE System

The global model is considered the core of an e-learning system. From a pedagogical point of view, DANTE is combining the hierarchical way of learning with the collaborative one.

The proposed e-Learning system has a general architecture with three levels: user, intermediary, supplier-educational space, on each level heterogeneous families of human and software agents are interacting. The main human actors are: the student, the teacher and the tutor. In the virtual learning environment we have the corresponding agents. The human actors are interacting with the e-learning system via several agentified environments. The teacher (human agent) is assisted by two types of software agents: personal assistant (classic interface agent) and didactic assistant. The SOCIAL agentified environment has social agents and a database with group models (profiles of social behavior). The agentified DIDACTIC environment assists the cognitive activities of the student and/or of the teachers. The student (human agent) evolves in an agentified environment with three types of agents. She/he has a personal assistant (software interface agent) who monitors all the student's actions and communicates (interacts) with all the other agents, with the agentified environments of other students and with the teacher's agentified environment. The student has at his/her disposal two more agents: the **TUTOR** and the *mediating agent*. The **TUTOR** assistant evaluates the educational objectives of the student and recommends her/him some kind of activities. The decisions are based on the knowledge of the students' cognitive profile (which takes into account the social component). The **TUTOR** agent interacts with the personal assistant of the student, with the mediating agent and with the social agentified environment. As the system is conceived, the accent is put on collaboration activities between students, which consist in knowledge exchange, realization of common projects, tasks' negotiation, sharing resources, common effort for the understanding of a subject, problem-solving in-group. Based on the student's profile, the TUTOR will recommend in function of the student's activity evaluation, one action or a sequence of actions to be performed by the student. For each action the STUDENT is evaluating a *quality-cost function* where tutor's satisfaction is opposed to real costs of the action (intellectual effort, time consumed, preferred timing). The evaluation of the quality cost-function is influenced also by factors inner to individuals. At individual level we are considering that the evaluation is also influenced by two categories of factors: ***beliefs*** (cognitive) and ***affects*** (emotive). An important component of the attitude toward an action is ***intention***. Intention is a behavioural component. Behavioural intention describes the attitude not toward an action but toward performing an action.

The student's model is tributary to traditional behaviour and learning styles models (Rogers, Jung,

Piaget, Fishbein, Kolb and followers). The model has been previously tested and validated on a sample of 450 students at the university (18-22 years old, computer science and informatics specialties). Data were collected from a set of three questionnaires. In modelling student's decisional behaviour towards educational objects, the Fishbein's "reasoned action" model of relationships among attitude, subjective norm, intention, and behaviour has been used, with a few changes. The theory of reasoned action that states that behaviour is a direct result of intention and that there are involved two factors: attitude toward an act and subjective norm. The decident's attitude toward an act, is the sum of the decident's belief strength in the consequences resulting from performing a certain action (taking a certain decision) weighted by the evaluation of an anticipated outcome (positive benefit or avoidance of a negative consequence). The influence of the colleagues from the learning environment can be modelled by introducing the subjective norm. The subjective norm is the perception of an individual of what other people from the group think she/he should do with respect to certain behaviour, such as reading a specific article or enrolling for a pre-test.

Fishbein's "reasoned action" model of relationships among attitude, subjective norm, intention, and behaviour (Azjen & Fishbein, 1980) and Fazio's attitude accessibility model were tested. The results showed that the Fishbein model was more appropriate (figures 2 and 3).

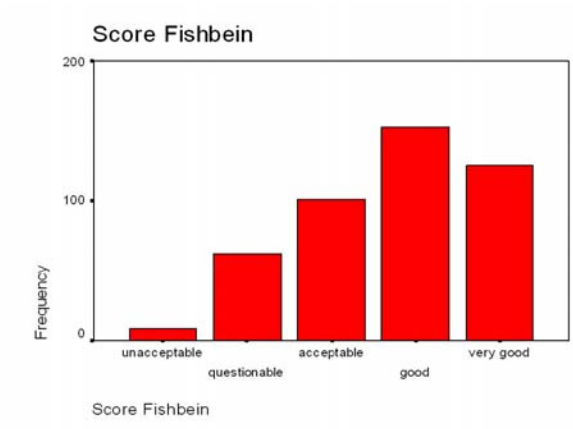

Figure 2. Scores for the Fishbein' model

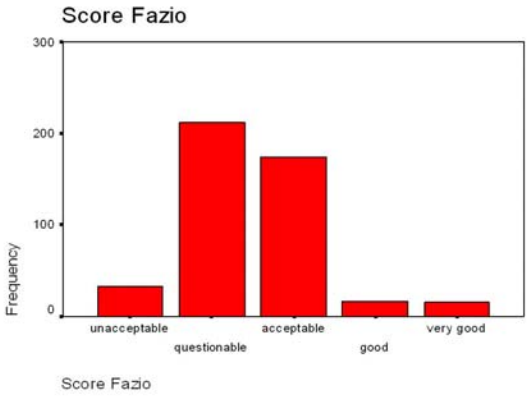

Figure 3. Scores for Fazio's model

In order to describe differences in the way students learn, the concept of learning styles was used. Some students learn better reading by themselves the documentation, others use to ask questions. In the 70s, David **Kolb** was studying the Aristotelian learning by doing paradigm and developed a learning schema - **Learning Cycle** - consisting of four mandatory stages: real experience (concrete experience – **CE**), learning from experience by reflecting and observing (reflective observation – **RO**), abstract conceptualisation – **AC** - (identifying patterns, using theories and models, understanding what happened) and active experimentation - **AE**, trying out and planning for the next experience. Kolb defined four-type learning styles, each representing the combination of two preferred styles: Diverging **(CE/RO),** Assimilating **(AC/AE),** Converging **(AC/AE),** and Accommodating **(CE/AE).** Starting from Kolb's learning cycle, Peter Honey and Alan Mumford have shown ten years later that there are different learning styles and that, in general, a person is favouring only one way of learning. They have design a questionnaire (in fact there are two versions of the Learning Styles Questionnaire, the 80-item and the 40-item) to determine the preferred learning style. The **Honey** and **Mumford** four learning styles are: **Activists** (**Do**) - involving themselves fully in new experiences, open minded, enthusiastic, flexible, enjoying the here and now and being happy to be dominated by immediate experiences; acting first and considering consequences later; seeking activities to be centred around themselves; **Reflectors (Review) -** standing back and observing; reviewing the experience; collecting and analysing data about experience and events, slow to reach conclusions; maintaining a global view using information from past, present and immediate observation; **Theorists**

(Conclude) – disciplined, aiming to fit things into rational order, adapting and integrating observations into coherent theories; thinking problems through in a vertical, step-by-step logical manner; attracted by systemic thinking, models, principles and theories; and **Pragmatists (Plan)** - searching and new ideas and planning the next experiments; keen to put ideas, theories and techniques into practice; impatient with endless discussions. The styles are not exclusive. A student can show different learning styles, but one is usually predominant. Learning styles as a description of the behaviours and attitudes, determine the preferred way to the students to learn. Analysing teaching practices and students' needs, Felder and Silverman of North Carolina State University have built a model of learning styles for use by college instructors and students in engineering and sciences, a model that has subsequently been applied in a broad range of disciplines. Though designed for students in engineering, we found that is less adequate for our students than the Honey and Mumford model.

There are 75 students from the first grade in computer science (18-19 years old) that participate in the design and evaluation of the software. Through questionnaires and discussions several students' profiles have been built.

Here are the results concerning the learning method they prefer: For the sample of 75 students the situation concerning predominant learning styles is as follows: 15 – activists (20%), 30 – reflectors (40%), 10 – theorists (13.3 %) and 20 – pragmatist (26.7%). Only 12% (9) prefer to learn online; 16% (12) voted for traditional face 2 face methods; the majority – 66.7% (50) is in favor of blended learning, and 4(5.3%) students were undecided.

Students that participated in the design and evaluation process were more concerned by the cognitive content of the lessons and less by the attractiveness of the interface. More than 60% had as main objective to obtain a good score at the exams (more than 80%) with a minimum effort and they wanted the system to give them all needed information, including models for the projects and tests. Though 66.7% of the students declare that they prefer blended learning only 35% of the sample worked with the system and combined online training with offline readings and discussions. It seams that habit is important and as they are in the first academic year they are using the same learning style they used in high school. They were creative in their work and had a high degree of attendance of face 2 face courses; they emphasized that human to human communication is important for them and that they feel that they learn better if they can discuss topics of interest.

At present, DANTE is implemented on a MOODLE platform, with a simple interface (figure 4).

Figure 4: DANTE Interface

ELearning general architecture (figure 5) is an architecture with three levels (user, mediators, provider – educational environment). To each level corresponds heterogen families of human and software agents (fig. 5, 6, 7, 8).

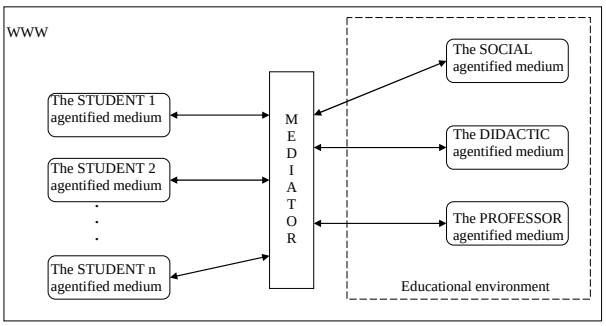

Figure 5: The three-level rchitecture of the eLearning system.

The professor (teacher, human agent) benefits from the services of two types of software agents: personal assistant (common interface agent) and didactic assistant (fig. 6). The personal assistant plays the role of a secretary, mediates communication with other human and artificial agents, edits new student activities and sends them to the latter, supervises student activities and the schedules oh the activities which take place in the real time. The didactic assistant plays the role of the assistant in the classical leaning system. He assists the professor in creating and distributing the didactic material and activities, manages the professor's personal database supervising access to it, and, on request, sends the personal assistant message for the

students or for other agent teachers. The didactic agent communicates with agents from the social environment (to obtain group profiles) and from didactic environment to obtain documentary information or data for creating didactic activities. The professor has access to the whole educational universe.

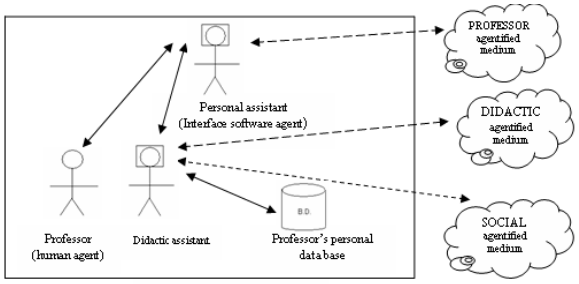

Figure 6: The professor agentified medium

The student (human agent) evolves in an agentified medium (fig. 7) with three types of agents. He also has a personal assistant (interface software agent) which monitors all student actions and communicates with all the other agents, with agentified media of other students and with professor agentified media. The students also benefits from two other agents: the tutor assistant and the mediation agent. The tutor assistant evaluates the student's educational objectives and proposes certain activities. The decisions are based on knowing the student's cognitive profiles (which takes into consideration the social component). The tutor agent interacts with the student's personal assistant, with de mediation agent and with the social agentified medium. The mediation agent chooses a mechanism of evaluating the solution given by the student to a test or exercises, analyses the student's solution, produces feed-back. The mediation agent may communicate with other agent's personal assistant. The system is designed to **stress** on shared activities between the students, which imply knowledge exchange, creating common projects, task negotiations, sharing resources, mutual effort in understanding a subject, group problem solving.

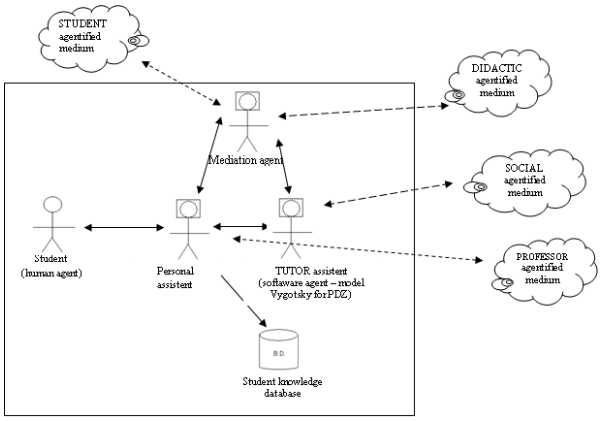

Figure 7: Student agentified medium

The social agentified medium (figure 8) is made up of asocial agent and a group profiles (social behavior profiles) database. The social agent has for main purpose creating models for groups of students which socialize in the virtual education environment. It seeks groups that may collaborate under good circumstances, that is their level of knowledge and personalities are alike. In collaborational learning model every groups is considered to be an active entity and the system must recognize it as such. One way of putting together group models would be for the tutor agent (from the student agentified) supplies the individual model. Individual models are compared, those alike are put together and the general model of a group having a certain number of axes (for example, common opinion, agreements, conflicts).

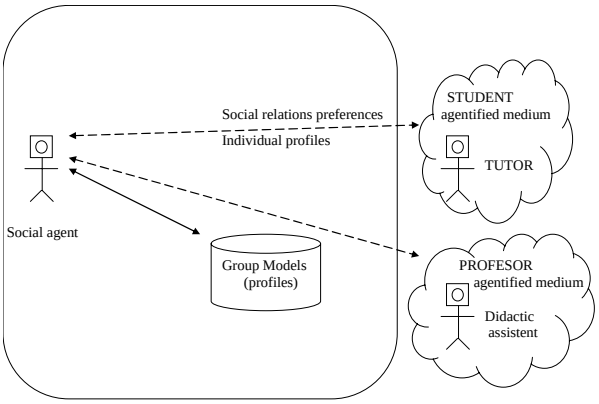

Figure 8: Social agentified medium

The didactic agentified medium (figure 9) must assist the students and/or teacher cognitive activities. In this environment evolves a web search agent and a semiotic agent, which stimulates the student mediations agent, sending stimuli such as icons,

texts and numbers. The medium has at its disposal a range of instruments and signs recorded in a database.

The artificial and the human agents interact. We thus distinguish software agents – software agent interactions, human agent – software agent interactions and human agent – human agent interaction. The system will provide instruments for synchronized and asyncronized learning. In a first stage there will be a supervisor agent (typical for the eLearning platform chosen, such as Agent Message Router for the JAT Lite platform – Java Agent Template Lite [11]) at the web server level, which will make the connection of different agents, further on, more advanced solutions are to be used.

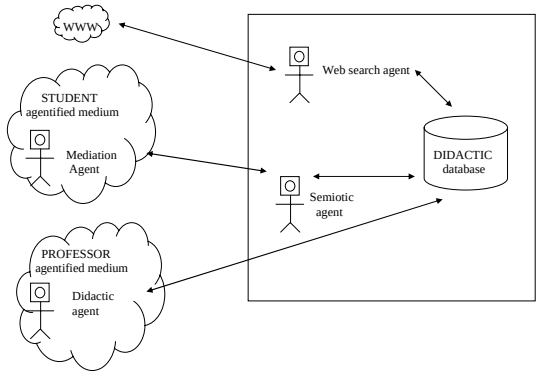

Figure 9: Didactic agentified medium

Such as it was conceived, the system falls into the category of advanced system through its client (student) orientation and value added educational services offer, obtained through the possibility of collaborational learning. The model proposes an original architecture by combining the artificial intelligence components (multi-agent system) with collaborational learning socio-cultural theory elements.

6. Conclusions

The broad terminology describing possible learning ways and approaches that use various technologies in the learning process has appeared together with rapid growth of information and communication technologies. This terminology should be ordered and precisely defined. This article presents the most widespread terms (such as computer-based learning, distance learning, e-learning, Internet based learning, online learning, resource-based learning, technology-based learning, Web-based learning). In addition the meaning of some terms coming from pedagogy (education, instruction, learning, teaching, training, and tutoring) and used as obligatory constituent part of other terms is clarified.

The proposed model aims to constitute a professional group which will facilitate the adaptation of all actors in an educational scenario (teachers, students) to work in virtual environment. The model permits virtual mobility of the researches (it implies network work, each team developing system models, to be put together I n a further stage) and virtual mobility of didactic staff.

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