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An Interactive Web-based Environment using Human Companion

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Abstract

This paper describes the architecture of an Interactive Learning Environment (ILE) on internet using companions, one of which is a human and geographically distant from the learning site. The achieved system rests on a three-tier customer/server architecture (customer, web server, data and applications server) where human and software actors can communicate via the internet and use the DTL learning strategy. It contains five main actors: a tutor actor in charge to guide the learner; a system actor whose role is to manage and to control the accesses to the system; a teacher actor in charge of the management and the updating of the different bases; a learner actor who represents the main actor of the system for whom is dedicated the teaching. Also, a learning companion actor whose role can be sometimes as an assistant, and other times as a troublemaker.

Keywords: Interactive learning environment, LCS, DTL strategy, companion, distance learning, troublemaker.

1 Introduction

The distant teaching pedagogy differs from the teaching in a classroom. Indeed, the absence of the teacher influences the incentive and the concentration of the learner, what encourages the isolation feeling and so, moves him away of the stimulating context as in a real classroom.

In a distant learning context, the pedagogical triangle [1],[2] must take into account two elements that, in this case, take a particular importance: the group and the mediation context (Figure 1).

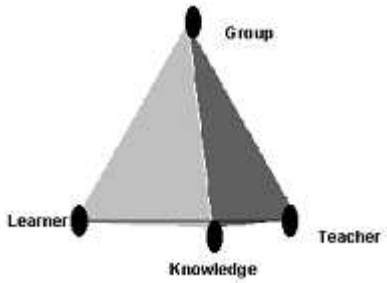

Figure 1. The pedagogical triangle

The group is an instituted set of learners and teachers in interaction, sharing some common objectives. The introduction of the group element puts in evidence the social character of the knowledge construction [3]. Indeed, the group constitutes a psychological support factor [4]. The mediation context constitutes the material or a virtual environment in which occurs the interactions.

In the present work, we describe an interactive learning environment (ILE) in a distant-teaching context with learning companions and using Internet as the environment of communication and interaction. The achieved system is a software framework dedicated to the learning of the relational databases whose customer/server architecture is based on multi-agents approach. For the communication between the learners, we used tools, more powerful, as the electronic mailing, the forums, that have already been integrated in many distant-training frameworks as support for collective learning activities [5],[6].

Several works showed that in a learning environment, the social interaction and the cooperative work in a community of learners has an influence on the intern structure of the learner's cognitive form [7], [8].

Our gait is based on the principle that the learning enriched also itself through the exchanges, the confrontations, the negotiations, the competition and the interactions between persons.

Indeed, in the learning psychosocial model, learner doesn't learn

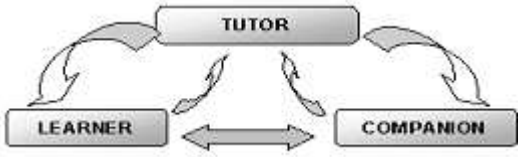

Figure 2. General architecture of an LCS

alone, but with confronting his thought and his actions to the material and social reality. The social psychology of the cognitive development opposes to epistemic individualism and substitutes to the bipolar centering *ego-object* of the cognitive psychology a tripolar relation *ego-alter-object*. According to this approach, the interactions with others play an essential role in trainings. In particular, they are going to permit to disapprove the initial conceptions and to create some favorable dissonances for the construction of a new knowledge. It is the socio-cognitive conflict mechanism [9],[10].

2 The Learning Systems Using Companions

The learning systems using companion rest on a software companion where the behavior and reactions are entirely simulated and often, follow a linear and recurrent structure. Several systems using software companions showed the recurrence in a learning situations of the behavior of the companion in a cooperative and collaborative environment [11],[12],[13],[14].

The structure of a Learning Companion System (LCS) described by Chan [12] implies three basic actors (Figure 2):

A tutor actor (software teacher) whose role consists fundamentally to provide matter to teach, to offer examples, indications, and commentaries to the learner and the companion. A learning companion actor whose objective is to stimulate the collaboration with the learner through the competition. This actor can have several roles; he can play the role of an assistant to whom the learner can ask for help and

assistance, sometimes as a competitor. In other systems, he can be a troublemaker. The third actor, a learner, who is a committed and active person in an acquirement process or a knowledge perfection.

The approach adopted in the present work goes in the setting of the CSCL context (Computer Supported Collaborative Learning) that constitutes an evolution from a distant interactive environment to environments supporting the collaboration to enrich the collective and social construction of the knowledge [15],[16],[17].

In our system, we introduce three learning companions: A human companion and two software companions.

- *The human companion:* He is a learner who follows his training in the same title and at the same time as the system learner and to whom he can bring assistance. This companion can be any other learner connected on-line on the network and that the learner can solicit him. In case of absence of a human companion, the learner can solicit the machine companion which is created for such situations.

- *The machine companion:* He takes the role of an assistant, and other time, the role of a troublemaker, giving some erroneous answers voluntarily to put the learner in a doubt situation and so, to test his confidence and his convictions.

3 The DTL Strategy

A typical learning session that uses the Double Test Learning (DTL) strategy [11], [13] starts with a Pre-Test phase in which an initial learner model is created. In the second phase (Learning phase), the system dispenses the teaching and the co-learners benefit of the same training that the human learner, so, at the end of this phase, the three learners have the same level of knowledge.

In the third phase (Post-Test1), the tutor tests the co-learners. The human learner will be in the place of an active observer. He will follow the questions/answers sequence between the tutor and the co-learners.

The learner has in his possession a notebook on which he can mention all useful observation. At anytime that the co-learners give the solution of the given problem, the tutor values their answers. If their answers are incorrect and that of the human learner is correct, this last must justify and explain his answer to the co-learners. When the co-learners finish the Post-Test1 phase, the tutor turns then toward the human learner and the last phase (Post-Test2) begins. Here the learner's notebook is withdrawn, and therefore, he has access to his memory only and to the knowledge that he has acquired lately through the co-learners answers. At the end of this phase, the tutor values his answers in order to attribute to him a score and, determine his new profile.

4 The Society of Actors

An actor represents a set of coherent roles played by an external entities (human user, device system), that interact directly with the studied system.

Our system includes five main actors, implying human actors and software actors:

- *The system actor:* It's a software actor whose role is the management of the accesses to the system and the control of the registration or the suppression of users (learners or teachers).

- *The tutor actor:* It's a software actor; its role is to assure the pedagogical progression of the learner during his training. It puts to his disposition the courses, explanatory examples and exercises with solutions and arguments. He has also the task of the evaluation during the test phases (Pre-Test, Post-Test1, Post-Test2).

- *The teacher actor:* He is a human actor who has in charge to update courses and exercises. He is responsible of the choice and the definition of the pedagogical strategy to be adopted. He can also consult any registered learner's profiles in the system.

- *The learner actor:* He is a human actor, he represents the main actor for whom the teaching is dedicated.
- *The companion actor:* It can be human or software :
  - *The human companion:* He is a learner connected on-line on the system whose learning is not the principal objective for the system. His role is essentially to assist the learner during the Post-Test1 phase. His presence is not certain. He can be solicited by the learner at any moment.
  - *The machine companion:* This companion is solicited in case of absence of a human companion on the network. Its role is to simulate the human behavior. The system introduces two software companions whose behaviors are simulated; one of them plays the role of an assistant and the other one a troublemaker by introducing disruptions during the Post-Test1 phase in the goal to test the insurance and the conviction of the learner. The answers provided by the troublemaker companion are, in most time, incorrect voluntarily.

5 The Software Architecture

The DB-Tutor++ system has been conceived according to the three levels customer/server architecture (Architecture 3-tiers): a customer level, a data and applications server level and a web server level (Figure 3).

- *Customer level:* It represents the different services asked by a customer, learner or teacher.
- *Web server level:* It constitutes the interface between the customer and the data server while transmitting the customer's request toward the data server, and the achieved service by this last toward the customer.
- *Data and applications level:* It represents the different services of data management offered to the customers (teachers, learners).

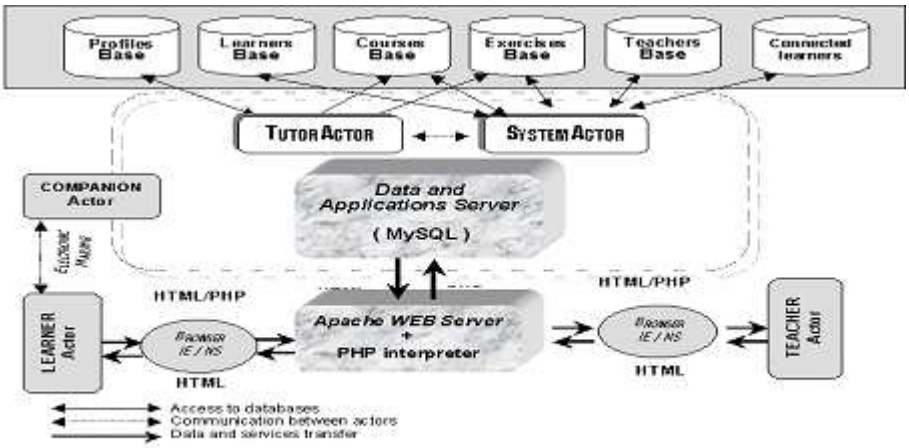

Figure 3. General architecture of DB-Tutor++

In our data server, we distinguish two main actors that achieve these services according to the customer's request: the system actor and the tutor actor. These two actors use a whole of databases for managing their services:

- A learners' base that contains the personal information about the learners.
- A teachers' base that contains information concerning the teachers.
- A profiles' base that contains the historic of the different learner's behavior during the different sessions.
- A courses' base whose structure is hypertextual that contains the whole of courses, structured in levels.
- An exercises' base that contains the list of exercises for every test phase and distributed in different levels.

- A connected learners' base that contains the list of learners online on the system.

6 Teaching material

Databases are dispensed in all training programs in computing science.

Particularly, the relational databases constitute the most merchandised database systems and the most used in the enterprise's computer systems. The courses base of the DB-Tutor++ system is organized in levels. A level represents a state of knowledge acquired by the learner. A level contents concepts and meta-concepts. A concept is a knowledge element. A meta-concept is composed of a whole of concepts. A course is constructed about meta-concept, and a whole of examples. The passage from a level to a superior level requires the acquisition of the concepts introduced in the lower levels. The courses are organized as a hypertextual form.

In its present version, the system's courses base includes 54 meta-concepts, and 218 concepts distributed in 5 levels, numbered from 1 to 5 (Table 1).

7 The Evaluation

The evaluation is a process that consists in determining or to assign a level to the learner in a learning session. For the learner evaluation, we defined two categories of Multiple Choices Questions (MCQ). The first category includes simple questions and the second, questions with proof.

For simple questions, the learner must introduce the number of his answer. For this kind of question two (02) tokens are assigned for a correct answer, and zero (00) for an incorrect answer.

For questions with proof, the learner must answer by *yes* or by *no*, and his answer must be justified by a proof.

- If the answer is correct, two (02) tokens are attributed.

Level	Meta-concepts	Concepts
01	Basic concepts	1. Database definition 2. Database management system 2.1. Instances and Schemes 2.1.1. The object type ... ... 2.2. The abstraction levels 2.2.1. The conceptual level ... ...
	The logical data models	1. The hierarchical model 2. The network model ... ...
02	The relational model	1. The relational model 1.1.Domain ... ... 2. The functional dependences ... ... 3. The normal forms ... ...
	The relational algebra	1. The relational algebra 1.1.The operations 1.1.1. Union ... ... 1.2.6. Projection ... ...
...	... ...	... ...

Table 1. Description of the contents of the levels

- If the proof is correct, the score will be increased of two (02) other tokens.
- In the case where the learner does give an incorrect answer, no token will be attributed (even if the proof is correct).

7.1 Acquisition of a Level

To every i phase a general score *(ScoreG)* equal to the sum of tokens attributed to the n Q questions of the phase is associated:

$$ScoreG_{phase_i} = (\sum_{k=1}^{n} tokensQ_k), \quad (1)$$

where:

n: is the number of questions.

i : Pre-Test phase, Post-Test1 phase, Post-Test2 phase.

The average score *(ScoreM)* for a learner in a session is calculated as follows:

$$ScoreM = (\sum_{i=1}^{n} ScoreG_{phase_i})/2. \tag{2}$$

The final score ($Score_{Final}$) gotten by a learner is equal to the sum of acquired tokens during every phase:

$$Score_{Final} = \sum_{i=1}^{3} Score_{phase_i}. \tag{3}$$

So, for a learner, to reach to the immediately superior level, it is necessary that:

$$Score_{Final} >= ScoreM. \tag{4}$$

For a new registered learner, the assigned level is determined by the score gotten during the Pre-Test phase:

$$ScoreG_{pre-Test} = \sum_{k=1}^{n} TokensQ_k. \tag{5}$$

Questions of the Pre-Test phase concern the immediately lower level.

So, for a learner, to be registered in a level L, it is necessary that:

$$Score_{Pre-Test} >= ScoreM_{Pre-Test}, \tag{6}$$

where $ScoreM_{Pre-Test}$ is the requisite average score for this phase:

$$ScoreM_{Pre-Test} = (ScoreG_{Pre-Test})/2. \tag{7}$$

8 The Implementation

The development of distance learning systems requires languages dedicated to the implementation of applications on Internet network. The realization of an environment according to 3-tier architecture requires navigation, interpretation and communication tools very powerful. DB-Tutor++ has been achieved with a language oriented to customer and a language oriented to server.

The system has been developed on the basis of the APACHE server and uses its PHP interpreter for the interpretation of the different interactions. For the realization of the courses base, we used the XML language, more adapted for the development of hypertext systems. Finally, for the management of the different bases, we opted for MySQL whose performances are especially indicated for this kind of application.

9 Users Scenarios

In order to fear the working and the global dynamic of the system, and more particularly, the interactions between the different actors (human and artificial), we present users scenarios of the application for a learner user, a teacher user and for an administrator user (Figure 4).

Figure 4. Screen "Home Page"

The learner, the teacher or the administrator introduces the username and the password that have been assigned to him at their account creation time. After verification of the identity by the system actor, the interface of the corresponding user (learner, teacher or administrator) is displayed.

9.1 A "Learner" Scenario

- **Connection / disconnection of a learner:** At the connection of a learner, two actors, the companion actor and the trouble-maker actor, are created and enter to the system.

  The tutor actor is informed about his connection, via the system actor, that goes to re-actualize the advancement state with taking into account the profiles base, then, to present the companions to the learner. After this, the learner lunchs the Pre-Test phase, and the other phases (the Learning phase, the Post-Test1 phase, and the Post-Test2 phase) according to the kind of learner.

  For the disconnection, the learner must inform the system actor about his exit so that it frees the occupied resources and companions (Figure 5).

Figure 5. Screen "Connection / disconnection of a learner"

- **Request for a companion:** At the connection, the learner

sends to the system actor a request for a learning companion. This one verifies if there exists a human companion connected on-line in the system, in the contrary case, he creates two software companions, which one of both is a troublemaker (Figure 6).

Figure 6. Screen "Request for a companion"

- **The learning:** The learning starts at the end of the Pre-Test phase. The learner signals to the tutor that he is ready to follow the training. The tutor transmits to him courses corresponding to the determined level in the Pre-Test phase

- **Post-Test1 Phase:** As soon as the training session is finished, the learner attends the Post-Test1 phase as an observer. He observes reactions of his companions during the questions/answers sequence proposed by the tutor. He can also take notes and remarks on his notebook (Figure 7).

- **Post-Test2 Phase:** In this phase, the human learner will be tested. At this level, the notebook is not on his possession. He is submitted to a set of questions and exercises to which he must give answers. The tutor recovers answers, value them and assign a score. At the end of this step, the tutor displays the final score of the learner.

Figure 7. Screen "Post-Test1 phase"

9.2 A "Teacher" Scenario

- **Connection/disconnection of a teacher:** When a teacher connects himself to the system, the system actor asks him for his identification in order to verify his access right. The disconnection is achieved by the teacher on his demand.

- **Courses/exercises updating:** When the teacher wants to add or to withdraw a course or an exercise that he judges useless, or to modify it, the system puts to his disposition a list of the available courses/exercises in the base, then the teacher will select the number of the course or of the exercise to be deleted or to be modified. In the case of a new exercise, the statement must be joined by its solution (Figure 8).

- **The updating of the pedagogical strategies:** The teacher can at any time define or modify the educational rules according to the learner's profile and the previous definite pedagogical objectives.

- **Consultation of learner's profiles:** At any moment, the teacher can consult learner's profiles by a demand to the system. This last displays the list of learners and their individual

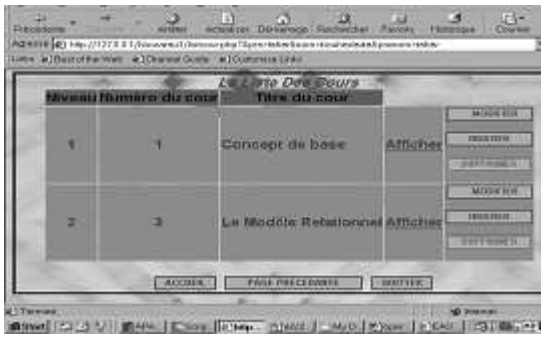

Figure 8. Screen "Courses / Exercises updating"

profiles as well as the historic of their behaviors in the different situations of the learning sessions (Figure 9).

Figure 9. Screen "Consultation of learner's profile"

9.3 An "Administrator" Scenario

We mean by administration, the insertion and the deletion of teacher account or learner account. The creation and the suppression of an account are system procedures that permit to introduce or to suppress

users from the system, as well as the updating of the base of the profiles in the case of an inscription of a new learner.

10 Conclusion

We described an interactive learning environment dedicated to teaching the relational databases on Internet. The system DB-Tutor++ that uses the DTL learning strategy, in its new version, implies a community of learners, and human and machine companions.

The system adopts a three-tier customer/server architecture (web server, data and applications server and customer), where human and software actors can communicate through the Internet network.

The system adopts a collaborative pedagogical method that permits a constant solicitation of the learner, a permanent evaluation, a multiplication of paths, and multimedia tools that encourages using a maximum of learning channels implying a community of human and machine actors.

The ambition of the present project is to offer a collaborative learning environment on Internet, what requires complementary pluridisciplinary contributions.

The gaits are undertaken currently to shelter the system on the university web site in order to be able to experiment it with students of the 3rd year of the engineers cycle.

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