A Virtual Cooperative Learning Environment Using Human Companion

Tahar Bouhadada and Mohamed Tayeb Laskri
Research Group on Artificial Intelligence, University of Annaba, Algeria

Abstract: *This paper describes the architecture of an Interactive Learning Environment (ILE) on the internet using companions which one is a human and geographically distant of 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 uses 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, distant learning, troublemaker.*

Received July 20, 2004; accepted September 26, 2004

1. Introduction

The distant teaching pedagogy defers 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 [9, 11] must take into account two elements that, in this case, take a particular importance: the group and the mediation context (Figure 1).

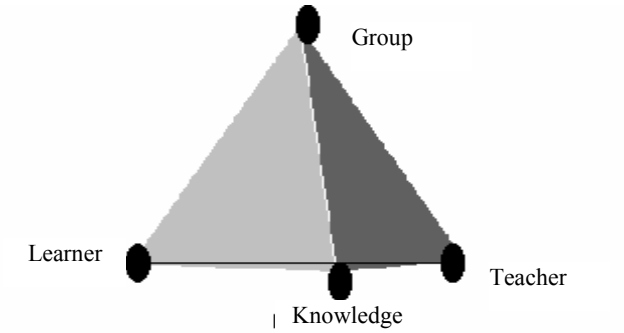


Figure 1. The pedagogical triangle.

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 [10]. Indeed, the group constitutes a psychological support factor [7]. The mediation context constitutes the material or virtual environment in which the interactions occur.

In the present work, we describe an interactive learning environment 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 relational databases learning whose customer/server architecture is based on multi-agents approach. For the communication between the learners, we used more powerful tools as the electronic mailing, the forums, that have already been integrated in many distant-training framework as support for collective learning activities [2, 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 cognitive form [5, 12].

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 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 centrage *ego-object* of the cognitive psychology a tripolar relation *ego-alter-object*. According to this approach, the interactions with others play an essential role into trainings. In particular, they are going to permit the discount in reason the initial conceptions and to create some favorable dissonances to the new knowledge construction. It is the socio-cognitive conflict mechanism [3].

2. 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 [1, 4, 8].

The structure of a Learning Companion System (LCS) described by Chan [4] implies three basic actors (Figure 2):

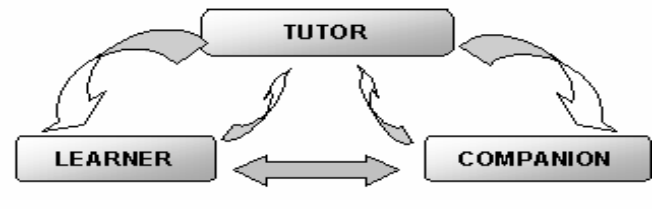


Figure 2. General architecture of a LCS.

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's 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 whom the learner can ask for help and assistance, sometimes as a competitor. In other systems, he can be a troublemaker. A learner actor 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 context Computer Supported Collaborative Learning (CSCL) that constitute an evolution from a distant interactive environment to environments supporting the collaboration to enrich the collective and social construction of the knowledge [13].

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

3. Double Test Learning Strategy

A typical learning session that uses the Double Test Learning (DTL) strategy [1, 8] 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 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 where 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. A anytime that the co-learners give the problem solution, the tutor values their answers. If their answers are incorrect and that the one 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 him a score and, determine his new profile.

4. 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 a user's suppression (learner 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 put 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 is in charge of updating courses and exercises. He is as 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 learning 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 introduce two software companions whose behaviours 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. Software Architecture

The system has been conceived according to the three levels customer/server architecture (Architecture 3-tier): 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).

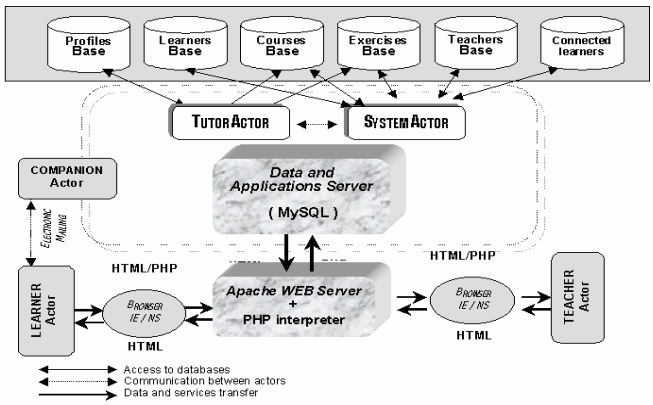


Figure 3. General architecture of DB-Tutor++.

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 behaviour 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 on-line on the system.

6. Knowledge

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 acquirement of 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 formed of a whole of meta-concept, and a whole of examples. The passage from a level to a superior level requires the acquirement 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).

Table 1. Description of the contents of the levels.

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 ……..
…	……	……

7. Evaluation

The evaluation is a process that consists in either determining or assigning 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 the simple questions, the learner must type the number of his answer. For this kind of question two tokens (02) are assigned for a correct answer, and 0 for an erroneous 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 tokens (02) are attributed.
- 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 his proof is correct).

7.1. Acquirement of a Level

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

$$ScoreG_{phase\ i} = (\sum_{k=1}^{n} tokensQ_k) \quad (1)$$

where:
n: is the number of questions.
i: phase Pre-Test, phase Post- Test1, phase, Post-Test2

The average score for a learner in a session is calculated as follows:

$$ScoreM = (\sum_{i=1}^{3} ScoreG_{phase\ i}) / 2 \quad (2)$$

The final score gotten by a learner is equal to the sum of acquired tokens during every phase:

$$Score_{Final} = (\sum_{i=1}^{3} Score_{phase\ i}) \quad (3)$$

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

$$Score_{Final} >= ScoreM \quad (4)$$

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

$$ScoreG_{Pre\text{-}Test} = \sum_{i=1}^{3} tokensQ_k \quad (5)$$

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:

$$Score_{Pre\text{-}test} >= ScoreM_{Pre\text{-}test} \quad (6)$$

Where $ScoreM_{Pre\text{-}test}$ is the requisite average score for this phase:

$$ScoreM_{Pre\text{-}test} = (ScoreG_{Pre\text{-}test}) / 2 \quad (7)$$

8. Implementation

The development of distant 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 very powerful communication tools. DB-Tutor++ has been achieved with a language customer oriented and a language server oriented.

The system has been developed on the basis of the APACHE server and uses its PHP interpreter for the different interactions interpretation. For the realization of the courses base, we used the HTML 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 face the working and the global dynamic of the system, and more particularly, the interactions between the different actors (human and artificial), we present a user's scenarios of the application for a learner user, a teacher user and for an administrator user (Figure 4).

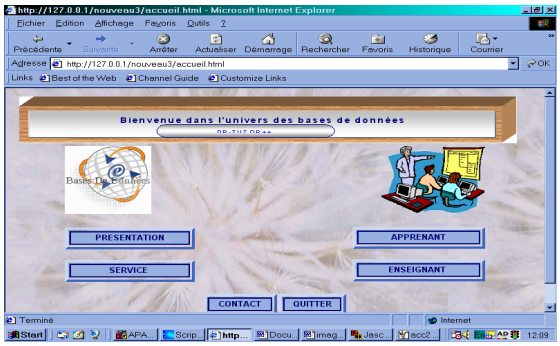


Figure 4. User's scenarios.

The learner, the teacher or the administrator types 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 troublemaker 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 starts the Pre-test phase, and possibly, according to the kind of learner, the other phases (the learning phase, the Post-Test1 phase, and in short, the Post-Test2 phase).

  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. 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 it exists a human companion connected on-line on the system, in the contrary case, he creates two software companions which one of both is a troublemaker (Figure 6).

Figure 6. 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 him courses corresponding to the determined level in the Pre-Test phase.
- *Post-Test 1 Phase*: As soon as the session of training is finished, the learner attends the phase Post-Test1 as an observer. He observes reactions of his companions during questions/answers sequence proposed by the tutor. He can also take notes and remarks on his notebook (Figure 7).

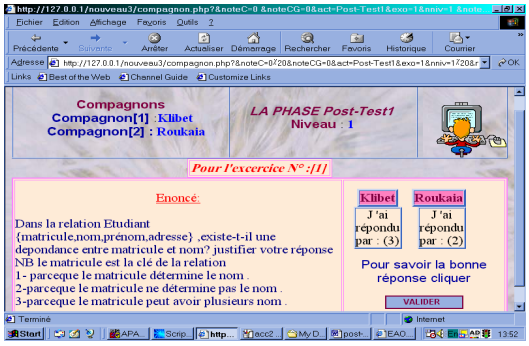


Figure 7. Post-Test 1 phase.

- *Post-Test 2 Phase*: In this phase, it is the human learner that is 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 stage, the tutor displays the final score of the learner.

9.2. A "Teacher" Scenario

- *Connection/disconnection of a teacher*: When a teacher connects himself to the system, the system actor asks 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 suppress 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, the teacher will select the number of the course or of the exercise then to add or to delete. In the case of a new exercise, the statement must be joined by its solution (Figure 8).

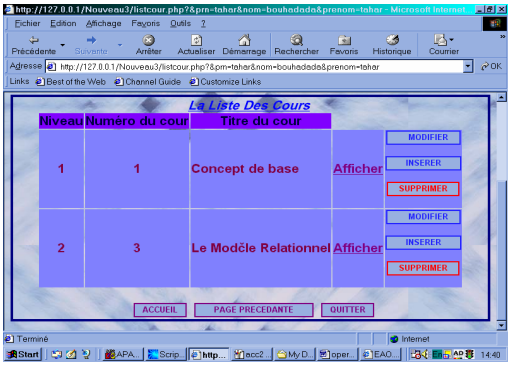


Figure 8. Courses / exercises updating.

- *Pedagogical strategies updating*: 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 to him the list of learners and their individual profiles as well as the historic of their behaviours in the different situations of the learning (Figure 9).

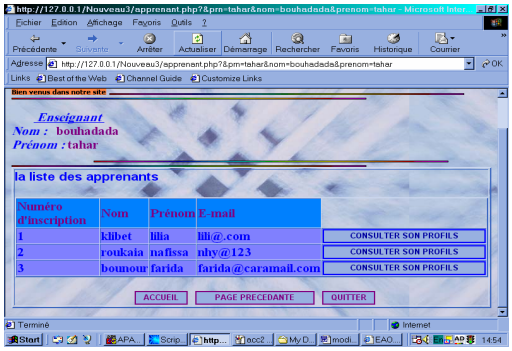


Figure 9. Consultation of learner's profiles.

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 profile base in the case of 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 pluri-disciplinary contributions.

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.

References

[1] Bouhadada T. and Laskri M. T., "DB-TUTOR: Un Système Tuteur Utilisant un Compagnon Perturbateur," *in Proceedings of 10th Colloque Africain sur la Recherche en Informatique,* CARI'02, aoundé, Cameroun, October 2002.

[2] Bouthry A., Chevalier P., and Shaff J. L., *Choisir une Solution de Téléformation,* France, 2000.

[3] Cerisier J. F., *Environnement d'apprentissage Collectif en Réseau. Enseignement et Apprentissage en Réseaux*, Stage CRDP, Poitou-Charente, Mars 1999.

[4] Chan T. W. and Baskin A. B., "Studying with Prince: The Computer as a Learning Companion," *in Proceedings of Intelligent Tutoring Systems* (ITS'88), Montréal, Canada, June 1988.

[5] Doise W. and Mugny G., "Social Interaction and the Development of Cognitive Operations," *European Journal of Social Psychology*, vol. 5, no. 3, pp.367-383, 1975.

[6] Ecoutin E., "*Etude Comparative Technique et Pédagogique des Plates-Formes pour la Formation Ouverte et à Distance,*" ORAVEP, Ministère de la Recherche (DT/SDTETIC), 2000.

[7] Faerber R., "Apprentissage Collaboratif à Distance: Outils, Méthodes, et Comportement Sociaux," *in Proceedings of 5th Biennale Internationale des Chercheurs et des Praticiens de l'éducation et de la Formation*, Paris, France, April 2000.

[8] Fahmi M. and Aimeur E., "RACSY: An Intelligent Tutoring System Based on the Double Test Learning Strategy;" *in Proceedings of the 5th Maghrebian Conference on Software Engineering and Artificial Intelligence* (MCSEAI'98), Tunisia, December 1998.

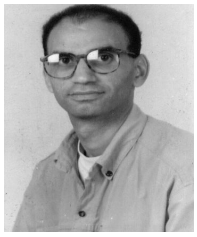
[9] Houssaye J., *La Pédagogie: Une Encyclopédie pour Aujourd'hui,* ESF, Paris, 1993.

[10] Jaillet A., *Apprentissage à Distance, une Révolution pour les Enseignants,* Université Louis-Pasteur, Strasbourg, 1999.

[11] Meirieu P., *Apprendre… Oui, Mais Comment?* Paris, ESF, 1989.

[12] Mugny G. and Doise W., "Socio-Cognitive Conflict and Structure of Individual and Collective Performances," *European Journal of Social Psychology*, vol. 8, pp. 181-192, 1978.

[13] Zidane A., Djoudi M., Zidat S., and Talhi S., "CHELIA: Un Environnement Coopératif pour l'apprentissage sur Internet," *in Proceedings of 10ème Colloque Africain sur la Recherche en Informatique (CARI'02)*, Yaoundé, Cameroun, October 2002.



Tahar Bouhadada has been a teacher-researcher in the Research Group on Artificial Intelligence (LRI/GRIA) since 1994. He obtained his MSc degree from the University of Annaba in 1994. He has been working on the learning environment architectures and Intelligent Tutoring Systems (ITS) since 1990. He presented many papers about the Interactive Learning Environments (ILE), the Learning Companion Systems (LCS), and the learner modelling. He supervises many graduate works on learning environments. He also teaches at the graduate level in computer science and data base systems.

Mohamed Tayeb Laskri is the president of the University of Annaba. He obtained his PhD degree in 1995 from the University of Annaba. He is the chairman of the Research Group on Artificial Intelligence (LRI/GRIA). He supervises many works on learning environment, automatic treatment of natural languages, the users-case, human-machine interfaces, and the coordination on multi-agents systems. He leads tasks at some national commissions on treatment of natural languages, the distant learning frameworks and information technologies. He supervises seven PhD students and several MSc students in knowledge management and distant learning environment. He also teaches modules at both graduate and MSc levels in computer science, expert systems, Intelligent Tutoring Systems (ITS), and artificial intelligence.

.