A virtual cooperative learning environment using human companion

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ABSTRACT. This paper describes the architecture of an interactive learning environment (ILE) on 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 contents 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 llearner actor who represents the main actor of the system for whom is dedicated the teaching. And a learning companion actor whose role can be sometimes as an assistant, and other times, as a troublemaker.

RÉSUMÉ. Ce papier décrit l'architecture d'un environnement d'apprentissage interactif (ILE) sur Internet utilisant des compagnons dont un est humain et géographiquement distant du site de l'apprenant. Le système repose sur une architecture Client-Serveur à trois tiers (Client, Serveur web, Serveur de données et d'applications) où acteurs humains et logiciels peuvent communiquer via l'Internet et utilise la stratégie d'apprentissage DTL. Il comprend cinq principaux acteurs : un acteur *Tuteur* chargé de guider l'apprenant dans son apprentissage ; un acteur *Système* dont le rôle est de gérer et de contrôler les accès au système ; un acteur *Enseignant* chargé de la gestion et la mise à jour des différentes bases ; un acteur *Apprenant* qui représente le principal acteur du système pour qui est dédié l'enseignement. Enfin un acteur *Compagnon* d'apprentissage, qui peut être humain ou logiciel, dont le rôle peut être celui d'un assistant ou d'un perturbateur.

KEYWORDS : Interactive learning environment, LCS, DTL strategy, companion, distant learning, troublemaker.

MOTS-CLES : Environnement d'apprentissage Interactif, LCS, stratégie DTL, compagnon, apprentissage à distance, perturbateur.

1. Introduction

The distant teaching pedagogy defers of 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.

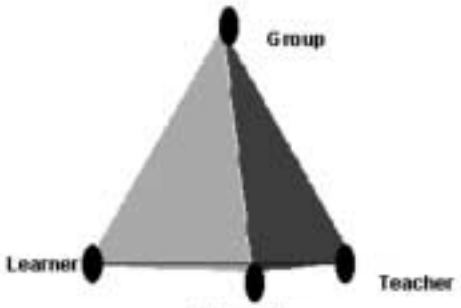

Figure 1. *The pedagogical triangle*

In a distant learning context, the pedagogical triangle [11][9] must take into account two elements that, in this case, take a particular importance: the group and the mediation context (Figure.1).

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 occurs the interactions.

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 tools, more powerful, as the electronic mailing, the forums, that have already been integrated in many distant-training framework as support for collective learning activities [1][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. 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 [4][8][2].

The structure of a LCS (Learning Companion System) described by Chan[4] 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. In several systems, this actor can be a troublemaker. A learner actor who is a committed and active person in an acquirement process or a knowledge perfection.

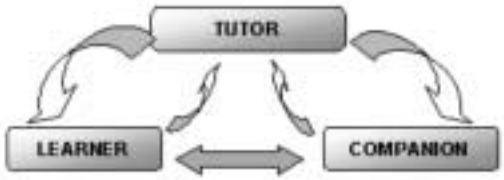

Figure 2. *General architecture of a LCS*

The approach adopted in the present work goes in the setting of the CSCL context (Computer Supported Collaborative Learning) 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. The DTL strategy

A typical learning session that uses the DTL strategy (Double Test Learning) [7][2] 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 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 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, finally, the tutor values his answers in order to attribute him a score and, determine his new profile.

4. The society of actors

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 has in charge to update 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 time.

- *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 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 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).

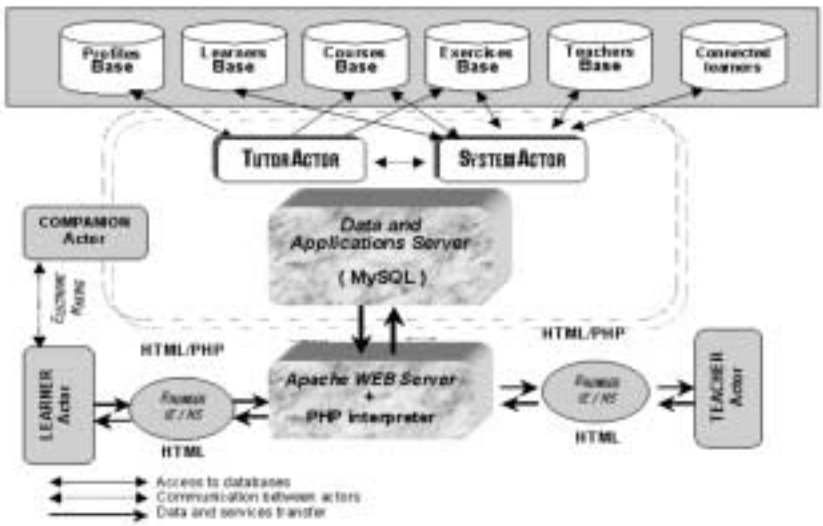

Figure.3 : General architecture of the system

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 on-line on the system.

6. The knowledge

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 the 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).

Level	Meta-concepts	Concepts
01	Basic concepts	1. Database definition 2. Database management system ..... 2.2 The abstraction levels .....
	.....	.....
02	The relational model	1. The relational model 1.1 Domain .....
...	.....	.....

Table 1. *Description of the contents of the levels*

7. The evaluation

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 (2) 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 (2) are attributed,
- If the proof is correct, the score will be increased of two (2) 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:

$$\mathbf{ScoreG}_{\text{phase i}} = \left(\sum_{k=1}^{n} \mathbf{tokensQ}_k \right) \quad (1)$$

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

$$\mathbf{ScoreM} = \left(\sum_{i=1}^{3} \mathbf{ScoreG}_{\text{phase i}} \right) / 2 \quad (2)$$

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

$$\mathbf{Score}_{\text{Final}} = \left(\sum_{i=1}^{3} \mathbf{Score}_{\text{phase i}} \right) \quad (3)$$

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

$$\mathbf{Score}_{\text{Final}} >= \mathbf{ScoreM} \quad (4)$$

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

$$\mathbf{ScoreG}_{\text{Pre-Test}} = \sum_{k=1}^{n} \mathbf{tokensQ}_k \quad (5)$$

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:

$$\mathbf{Score}_{\text{Pre-test}} >= \mathbf{ScoreM}_{\text{Pre-test}} \quad (6)$$

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

$$\mathbf{ScoreM}_{\text{Pre-test}} = (\mathbf{ScoreG}_{\text{Pre-test}}) / 2 \quad (7)$$

8. The 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 communication tools very powerful. DB-Tutor++' system has been achieved 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

We present a user's scenarios of the application for a learner user, a teacher user and for an administrator user. (Figure 4.).

9.1. A "learner" scenarios

- *Connection / Disconnection of a learner*
- *The learning*
- *Post-Test 1 Phase*
- *Post-Test 2 Phase*
- *Request for a companion*

9.2. A "teacher" scenarios

- *Connection / Disconnection of a teacher*
- *Courses/exercises updating*
- *Consultation of learner's profiles*

9.3. A "administrator" scenarios

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.

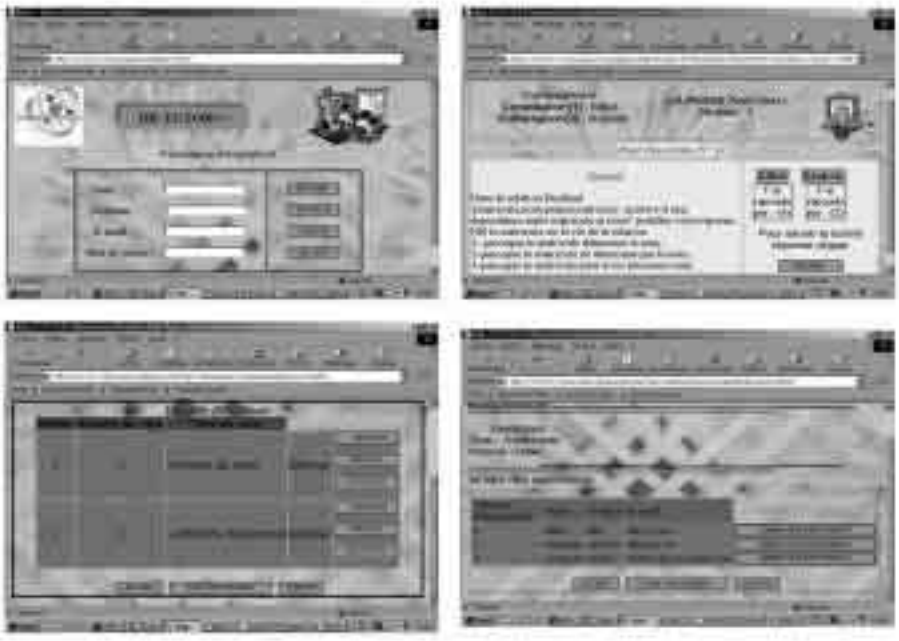

Figure 1. *Users scenario*

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 3-tier customer/server architecture, 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.

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