Design of Virtual co-Learner for asynchronous Collaborative e-Learning.

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Abstract

Cooperative co-learner agents can achieve an almost natural human-computer interaction. Agents are life-like computer characters that can interact with learners. They do so by picking up phrases from a database, according to predefined set of rules so as to achieve effective communication. We introduce the design of a software agent capable to collaborate with a learner in asynchronous e-learning environment. It offers new opportunities in e-learning as it integrates collaborative learning in a manner that challenges traditional methods of pedagogy and benefits the learning process.

1. Introduction

Among many different pedagogical approaches cooperative learning is considered to be an essential element of learning. Since collaboration develops a base of social communicative interactions, which sequentially formulate a dialogue, a limited number of attempts to introduce cooperative learning techniques in Educational Technologies have been done so far. For example, the Computer-Supported Collaborative Learning features include highlighting the importance of social interactions as an essential element of learning, as well as the role of participatory analysis and design of the whole community when creating new technological environments [2]. Learning methods based on collaborative techniques such as dialogues analysis and workspace information have also appeared in literacy [2]. Hadjileontiadou et al [4] establish a new way of tracking peers' role exchange during collaboration.

Because of the social interactions significance and the crucial role of conversation in collaborative learning very little have been done to imply elements of such learning methods in asynchronous e-learning. Using simulated student the system monitors real learners' progress in learning. In fact, simulated student can be simultaneously an expert and a co-learner, scaffolding and guiding the humans learning in subtle ways [8]. To the best of authors' knowledge there is an even bigger lack of published results concerning the area of collaborative learning applications in asynchronous Adaptive Educational Hypermedia Systems (AEHS). In asynchronous systems one may not expect to fulfill the effective collaboration requirement for adaptive pairing of collaborative peers on real time. In learner's human-computer interface actions and in combination with the question of problem solving plan recognition techniques have been used as input material, without any dialogue analysis [3].

This paper aims to present a virtual co learner's design which is capable to participate in a short of collaborative learning via asynchronous e-learning. We focus on asynchronous collaborative problem-solving technique where participants are both humans and virtual learners. We intend to design and develop an intelligent agent based on the learner profile and using the mobile agents' technology. The agent will be able to adjust flexibly to the cognitive level and schemata of the learner he interacts with. He will take in consideration the knowledge and cognitive level capabilities of the learner and adjust so as to become a co-learner with about the same capabilities so as to be able to converse and cooperate with the learner. During the cooperation the agent will provide information and help in the form of suggestions, like hints/motives that will activate the learner's thought so as to help its further development. The agent will help the learner develop his thought so as to advance "cooperatively" – but in fact alone – to the solution of the problem. (Problem solving situations). Thus the learner will feel that he has a synchronous co-learner,

while, in reality, he will work in an asynchronous learning environment. Thus is achieved a natural human-computer interaction, while the learner has all the advantages and benefits of cooperative learning, only with a virtual agent as co-learner. The learner profile will be used for the selection of the right agent. The issue is focused in the number of answers that will be integrated in the agent's database, which, should be appropriately modified so as to fit to the relevant cognitive level of the learner and to his character.

The choice of the appropriate agent will be according to the answers each learner will provide in the beginning of the course so as to form his profile. The questions the learner will answer, will concern his general knowledge, special knowledge, personal data, elements of his character and some psychometric test questions. Thus the learner will have a personalized cooperative co-learner intelligent agent. The learner will be aware that his co-learner is not a human person, but still he will have the illusion that it is real, since the agent will be able to cooperate with him for the solution of a problem in synchronous learning situation. The advantage is that the learner can cooperate with the agent whenever he, himself, can, a fact that releases him from the time limitation.

With regard to believability, we shall take in consideration of the learner's schemata to support structured and coherent conversations, so as to ensure users' satisfaction and agent believability.

For the above needs, we propose the design of a collaboration tool, which fulfills the following requirements: (1) Has a friendly interface for the tutor so that experts can easily contribute problems and their solutions as well (2) Has a well designed interface to facilitate the communication of the co-learner agent with the learner (3) Has a scoring learner's work system (4) Provides adaptable information volume on demand (5) multi- real and virtual learner participation in the collaboration group, (6) role discrimination according to learners' style, behavior and learning material familiarity, (7) learners' rating system

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2. System definition

Collaboration in learning results in the co-construction of knowledge with the mutual engagement of participants [8]. Collaboration in problem-solving collaborative learning environments should, consequently, analyze collaboration and provide this information. In asynchronous e-learning systems learners usually find difficulties on real time seeking for another learner to collaborate with. Furthermore, it is even harder to match learners having the same style and profile, which results in the efficiency of the system. To overcome such limitations, we design the Virtual co-Learner (VcL) intelligent software mobile multi-agent which will be available on demand. As an agent VcL meets some requirements, like: (1) constant updating of knowledge on problem-solving, (2) accessing distributed problem-solving objects (PSO) databases over the network, (3) managing (filtering) huge amount of PSOs, (4) providing any time and anywhere problem-solving collaboration, (5) providing collaboration to learners of various learning behaviors, (6) taking into account learner's style, (7) diagnosing problems in problem solving system and (8) providing vocal expressions, (9) taking into account the learning material the user is already familiar with.

As mobile agent becomes the user interface of the AEHS replacing other web approaches [6] e.g. applets which are programs downloaded as the result of a user action, then executed from beginning to end on one host. As multi-agent has a distributed architecture over a loosely coupled network of communicating and cooperating entities situated on distributed machines [5].

3. Collaborative Problem-Solving issues

In order to support problem-solving efforts of a learner using cooperative procedures, a software system has to provide:

A step by step method: solving procedure should be split into discrete easy to follow steps. A complete list of steps should be available to the learner through the content as it appears on the system interface. The learners will be called to apply some of these steps with the collaboration of the VcL.

Turn-taking conventions govern dialogue to ensure that either the learner or the virtual co-learner communicates at a time until the completion of a turn.

An easy to handle interface for tutors: tutors who intend to supply the system with PSO need guidance in order to follow the pattern of solution on demand. Such material is both the exercise and its solutions based on complete

applications of the appropriate problem-solving step by step method.

PSO's databases: Distributed databases with content the PSO and their appropriate metadata. Metadata will comply with the IEEE LOM standards as they are.

Dynamic PSO content synthesis: As the problem-solving procedure depends on a sequence of learner's responses, the procedure is synthesized dynamically. In order to have such on real time synthesis of the PSO content, the possible scenario has been designed on a tree having as many levels as many steps the PSO procedure has. Therefore, the procedure follows a path according to the learner's responses at each step. Learners get an impression of collaborating with a co-learner.

The collaboration on PSO can be based on the analysis and understanding of the main terminology on Problem-Solving procedures like purpose, situation, problem, cause, solvable cause, issue and solution. Analysis of the problem makes clear to the learner the differences between issue and problem, or problems and causes. Moreover VcL assists the learner to analyze strategies and to apply a certain strategic thinking to solve the problem and to organize the solution in separate steps.

A first attempt to design a VcL agent

The VcL agent is separated into two subsystems: the tutor and the learner subsystem. Generally, the tutor subsystem provides a step-by-step procedure for creating or modifying a collaborative lesson and the learner subsystem applies this collaborative lesson to the learners' group. Although the number of group members must be defined by the tutor-creator of the lesson, the type of learners participating (real or virtual) is not required. As a result one, two or more real users can participate in a group and the rest will be "created" by the systems.

A login process is required (the user must already be registered as a tutor or learner) in order to initialize the tutor or the learner subsystem. A connection to one or more learning objects database must be established.

Tutors' subsystem

1. The tutor has to choose one of the available concepts or create a new one. The collaborative lesson that will be created applies only to this concept. (example: statistics → normal distribution)
2. The inspection of the concept's learning objects or the creation of new ones is required. (example: normal distribution (text), normal distribution (formulae) normal distribution (graphs), normal distribution (examples) e.t.c.)
3. Then the tutor must create a list of required steps that must be followed by the members of the group in order to complete the collaborative lesson. Every collaborative lesson's first step should be the collection of information about this concept (example: step 1 collection of information about this concept, step 2 find the definition of the normal distribution, step 3 find the dependent and independent variables, step 4 define the function between the dependent and independent variables, step 5 find a diagram that represents the normal distribution, step 6 find examples of applications of the normal distribution, step 7 exercises)
4. The tutor must search in this concept's learning objects and define, by highlighting certain words or phrases, mathematical symbols or equations, pictures, diagrams, each step's expected (right) outputs. Every learning object that contains highlighted parts (right outputs) is stored and they are marked as "relevant" learning objects.
5. The tutor also marks a number of "irrelevant" learning objects (highlighting possible wrong outputs), of the same or other concepts, and adds them to the previously stored ones. Both "relevant" and "irrelevant" learning objects introduce the "lesson's information storage" of this collaborative lesson. As the "information storage" grows, the identification of "relevant" learning objects for the learners becomes harder.
6. The tutor defines the minimum and maximum number of group members that can participate in this collaborative lesson.

Learners' subsystem

Throughout a course a learner is supposed to gather knowledge by learning concepts. Every concept consists of several learning objects which present parts of the concept's knowledge in different ways. The collaborative lesson is just one of the methods to teach the concept's knowledge. A learner, while attending a course, can be divided into four categories:

a. He has already been successfully taught this concept with the collaborative method and has advanced to another concept.

b. He has already been successfully taught this concept with another educational method and has advanced to another concept.
c. He is ready to be taught this concept or has been unsuccessfully taught this concept, no matter the educational method, and he is willing

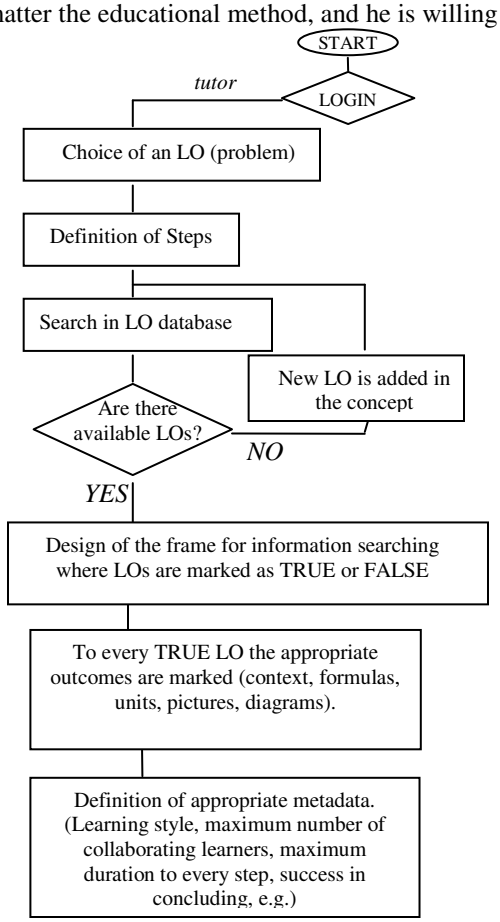

Figure 1: Tutor's subsystem

to participate in the collaborative lesson.
d. He is ready to be taught this concept or has been unsuccessfully taught this concept, no matter the educational method, and he is not willing to participate in the collaborative lesson.
The learners of the first category can be invited to play the role of the Group-Coordinator, as they are familiar both with the concept's knowledge and the collaboration methodology. The learners of the second category can be Outside-Group-Contributors, because they can answer specific questions on the concept in order to help the progress of the group, but still don' t know how to behave as members of the group. The learners of the third category will consist the main body of the group (Group-Members). Group-Members have to deal with each step's questions, search and study the "information storage" and find the outputs. The last category's learners can be invited as Group-Watchers. It must be stressed out that all these group roles can be played by real or virtual learners. A collaborative lesson could be conducted even with no real users participating, although that would be pointless. A Group-Coordinator and a certain number of Group-Members are required, but a collaborative lesson can still be held with no Outside-Group-Contributors or Group-Watchers.

Learner as Group-Coordinator

1. His role is to determine the order of the steps that the group will follow to complete the collaborative lesson.
2. Also he has to assign one or more Group Members to each step.
3. If asked by a Group Member he can contribute to the solution of a step.
4. If the group faces a problem that can not be solved he can reorganize the step order or reassign the Group-Members to the steps.

Learner as Outside-Group-Contributor

If asked he can contribute to the solution of a step.

Learner as Group-Watcher

He has no active role in the group. He just observes the group organization and progress. Apart from the knowledge he gains, he may be persuaded to participate in another group lesson in the future.

Learner as Group-Member

1. He is assigned to solve one or more steps of the collaborative lesson, as decided by the Group-Coordinator.
2. Every Group-Member has the right to contribute into step 1. Step's 1 output is the learning objects, sourced from the "lesson's information storage", that the Group-Members thought as "relevant".
3. As the collaborative lesson advances the Group-Members wait until the step they are assigned to is active (step 1 is always active).
4. When this happens they focus their attention in each "relevant" learning object, they chose before, and highlight the words, phrases, mathematical symbols, equations, diagrams, pictures, etc they believe as outputs of this step.
5. When this step's Group-Members have completed all the expected outputs, the lesson advances to the next step. If the Group-Members, assigned to this step, can not complete it, the Group-Coordinator or an Outside-Group-Contributor can be asked to complete it. The "information storage" is enriched by the outputs

of the completed steps, so that these outputs are available for the next steps.

Virtual Learner as Group-Coordinator

1. The Virtual Group-Coordinator determines the order of the steps that the tutor has chosen.
2. Group members can be assigned randomly to each step.
3. If asked by a Group Member the virtual user can contribute to the solution of a step by answering according to the tutors right outputs.
4. A problematic procedure in impossible to arise because the Virtual Group-Coordinator responses in accordance to tutors right step list and outputs.

Virtual Learner as Outside-Group-Contributor

5. If asked he can contribute to the solution of a step by answering according to the tutors right outputs.

Virtual Learner as Group-Watcher

1. Because of his inactive role virtual Group-Watcher can influence only physiologically the real learners of the group.

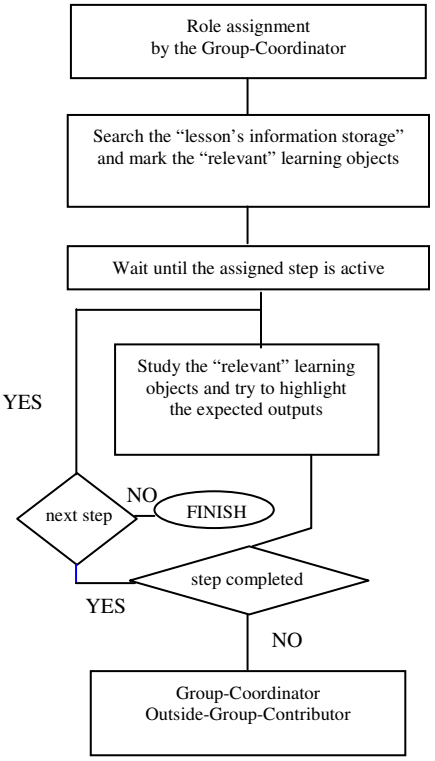

Figure 2: Role assignment by the Group-Coordinator

Virtual Learner as Group-Member

2. Virtual Group-Member is created and assigned to solve one or more steps of the collaborative lesson, as decided by the Group-Coordinator.
3. Virtual Group-Member can contribute into step 1. It can propose both "relevant" and "irrelevant" learning objects in the group.
4. Virtual Group-Member waits until the task assigned to is active.

When it is time to act it can propose both right and wrong outputs to the specific step.

Future Work

As further work we plan: (1) to enrich PSO databases, (2) to improve the design in order to introduce more sophisticated features in collaborative learning and (3) to have a summative evaluation of the system as soon as we have a considerably large PSO database.

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