Modeling Agents and their Interaction within SHIECC: A Computer Supported Cooperative Learning Framework

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1- Introduction

Cooperation is one of the most important human activities. However, it is still not a primary focus in a classroom, where interaction between students may be viewed as cheating. Students are typically in competition for best grades, teacher approval, etc. As a result students don't encourage and may discourage one another [1]. The essential feature of cooperative learning is that the success of one student helps other students to be successful. This is opposite to traditional classroom, in which the competition for rewards implies that student's success may reduce the chance of another's success. In cooperative learning students work together to accomplish a shared or common goal is This goal is reached through interdenpence among all group members rather than working alone. Each member is responsible for the outcome of the shared goal. Cooperative learning is very important because it produces greater student achievement than traditional learning methodologies [2] [3]. Beyond the academic benefits (less time and material are needed), etc.

Cooperative learning has been around for a long time [4]. However the use of computer to support such activity is fairly new. From the seventies, several intelligent tutoring system (ITS) have been developed. Nonetheless, all of these are bases on the tutor-tutee model (or one-to-one). This model has been criticized since the end of the eighties: the computer should cooperate with the learner and then facilitate the knowledge acquisition by the learner rather than only playing the role of an authorized teacher [5]. This introduces a new paradigm of cooperative learning [3]. In the nineties many alternatives for using the computer to support cooperative learning was proposed [6][7][8]. Computer Supported Cooperative Learning (CSCL) is a new emerging paradigm that extends classical Intelligent Tutoring Systems by introducing the concept of cooperation. In this sense, [9] presented the learning with companion approach, which simulates a second learner who learns together with the student.

Another alternative was proposed in [7]. The authors presented the learning by teaching model where the learner could teach the learning companion by giving explanation , etc

As it is shown education is fundamentally a cooperative process. An important issue is then to study how such cooperation could be supported? In [6] the author proposes that this cooperation could be supported using Electronic Documents. All the interact by sending documents which could be considered as mediating tools that support exchanges of viewpoints and concepts between the learners. An example of such CSCL system is ACTIDOC (ACTIve DOCuments) developed in hyperCard. The cooperation via electronic documents is a new activity which is involving new information-intensive tools. These are called Software agents. For example, the University of Michigan has developed an artificial agent-based architecture made by use-interface agents, supporting query-processing agents, etc [10]. Another work [11] proposed an example of the electronic classroom paradigm. The author used the name of filer-based teaching material. etc.

The SHIECC[2] Project is a contribution in the field wants to implement an effective cooperative learning paradigm. SHIECC presents an environment in which students learn by interacting with system, between them within their teams, with the teacher and with other collaborating student teams.
We present first the SHIECC environment and its conceptual model (sections 2 and 3). Then the section 4 proposes our agent based approach for modeling SHIECC. A study of the agent's interactions is given in section 6, and finally we detail how cooperative learning is implimented in SHIECC (section7) before concluding.

2. SHIECC Framwork

The SHIECC framwork presents the feature of integrating an tutoring system winthin a computer networking with aim of defining cooperative intelligent tutoring environnement.
Beyond the tutoring functionality, the SHIECC enables control of the interaction between the actors of a cooperative learning session i.e the artificial tutor represented by the students and the teacher.
The SHIECC environment is organized as represented in figure 1. The students are divided in distributed groups acting as separated teams. Each team is made of two or three students interacting between them and with a terminal. The student team and their terminal within a physical space constitute what are calling cooperative area. The teacher with its terminal constitutes a specific cooperative area. We define then a learning session as the interaction of serveral copperative areas linked withina network and which could be distant physically (cf. Section6).

Figure1. SHIECC framework

The network is made of a server and serval PCs' clients. These microcomputers are related using an Intranet [12]. The students within a team work together at the same terminal. They collaborate with each other on the course topics using the computer as an active tutor areas. This interaction is done using communication windows (i.e. CHAT) enabled by the Intranet ressources. So the srtdents can ask for advice, make comments, send suggestion…about the course.

3. Concetual model

The proposed cooperative intelligent tutoring system within SHIECC is made of the main concepts of tutor, pedagogical agent, domain model and the studen-team model (cf. Fig.2). We note the definition in SHIECC of two different kinds of interface and the interface. This is justified by the distinction between the functions and access rights of students and the teacher. The control between all these concepts could be considered as important comportant component of the system. The figure illustrates the basics kinds of interaction within the system.

[2] We note that depending framwork.

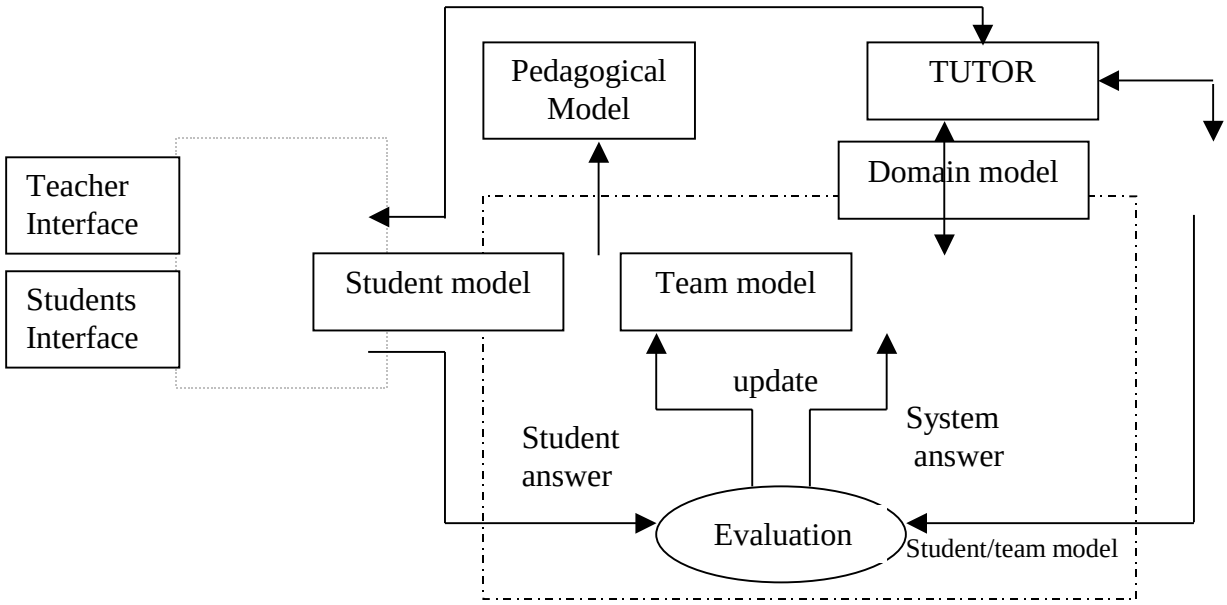

Figure2. SHIECC Conceptual model

The tutor, interacting with the domain model, transmits the lesson to the teams of students. The system evaluates constantly the syudents during the course progress (for example by comparing their answers to the correct knowledge within the domain) . The student team model is updated regarding to the result of this comparison. We note that in that in the case of individual evaluation only the student model is updated and not team model. The tutor cooperate with the pedagogical model to decide the new cooperative learning strategy to be adopted afterward. This is depending on the behavior of the learners (represented within the studen/team model). We the lesson contents are stored within the domain model.

4. Multi-agents architecture of SHIECC

As illustrated in figure 3, the whole system is modeled as the interaction of several heterogeneous (human and artificial) agents. We have identified: the ***System agent***: as a compound agent made of the tutor and pedagogical agent; the ***Learner agent***: made students; and the ***Teacher agent***: is a human agent.

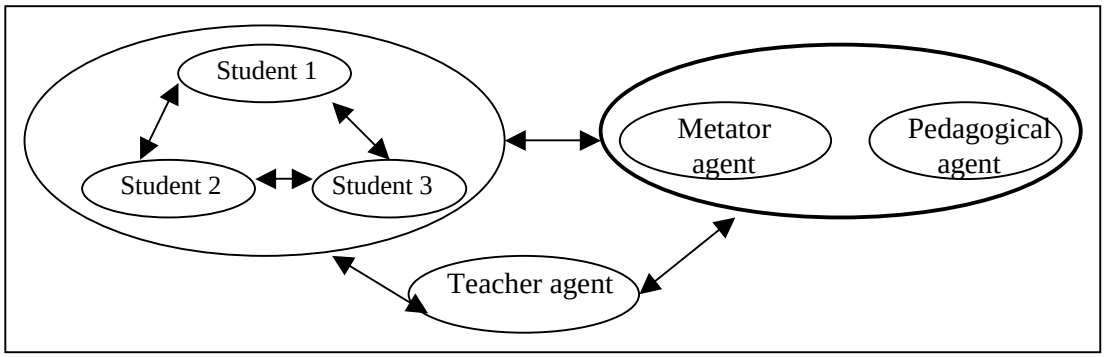

Figure 3. Multi-Agent architecture

Tutor agent. The tutor has the role of presenting the knowledge to the different students in the different cooperative areas. He's also responsible for controlling the interaction of the teams

of students with the system during the progress of the courseware. The tutor acts depending on the behaviour of the team. He interacts with the pedagogical agent for selecting the adequate cooperative teaching strategy to be applied. This agent determines what to teach (i.e. to present), when and how to it?

Pedagogical agent. It defines and proposes the pedagogical strategies to be applied. This is a very important feature in intelligent tutoring systems. The cooperative pedagogical agent defines basically the cooperative leaning strategies.

Teacher agent. As we mentioned earlier, we think that the role of teacher is still primordial even when using intelligent systems for tutoring . In cooperative learning , the teacher has to prepare the team of students to do such activity . He/She watches over the group work in each of the stages of learning session . The teacher could interact with a specific group or with all the groups . This could be done by sending messages through the system or directly when it is possible . The teacher has the full authority within the system .He/She has the right to access in real time the display of any students teams in the different cooperative areas to supervise their progress . He/ She could ask a group to do a specific work , give them advise ,etc .
Student agent : A group of two or three students interacts with the system in order to understand the course . They have to do some cooperative work acoording to a cooperative learning strategy determined by the pedagogical and tutor agents .

In previous works we defined an agent model applide to the problem of modeling multi-expertise (13) We are using here an extension of this model to show some examples of instantiation of SHIECC agents . We have identified five agent viewpoints . W e define an agent as organizational, specialist ,rational ,cooperative and communicative entity.
For instance , we are giving here the system agent by application of our agent modeling language.

Agent
Intrinsic-Characteristics
Name : System agent (SHIECC)
Type : artificial-agent
Status : Nil
Organizational Entity
Super agent : Nil
Structure : compound
Organization : Hierarchy
Sub-agent :Tutor, pedagogical agent
Organizational-structure :
Type :NIL
Leader: tutor
Organizational-representation: (Tutor (pedagogical Agent)
Specialist-Entity
Specialty : presenting and supervising the whole process of cooperative tutoring
Cooperative-Entity
< Cooperation-Model >
Communication-Entity
<Communication-Model >
end-agent

We note that we didn't consider the interface as agent. We think it is that really an important facility but according to the characteristics of the concept of recognized within the Multi-Agent System (MAS) community this component couldn't be considered as agent.

5. Interaction levels

Several kinds of interaction between the related agents can be thought out: between the system and the student team, between the system and the teacher, within a student team, between different student teams, and between the teacher and each student team.

System-Student Team interaction. The students interact with the system during the lesson presentation. They could ask the tutor to re-present a specific part of the lesson ask for help, etc. We note the importance of temporal aspect in SHIECC: The system allocates a determined duration for a team to explore each part of the lesson.

Teacher-System interaction. This is done the tutor and the pedagogical agent .The teacher could introduce new pedagogical, influence the progression of the lesson . He/She could allow a new lesson to be learnt by a specific team, or whether more exercises are needed upon the same lesson , or even to decide a backtrack to a previous lesson.

IntraGroup interaction. The learners within a cooperative area share the same goal . They collaborate to the realization of their activities of attending the course, assimilating it and putting their acquired knowledge in practice . All of them have the same responsibility for goal achievement students attend the course and then try together to assimilate it applying some cooperative strategies (cf. Section 6)

InterGroup interaction. Cooperation between groups is well encouraged .Groups could check their progress by inter acting with each other. One group could assist another for assimilating some parts of the course or resolving some problems. They can exchange ideas check their solutions, etc. This option is of course discarded when groups are defined to be competitive.

Student Teams6Teacher Cooperation. The teacher is responsible for a cooperative learning session. He/She has access to all the displays of the different cooperative areas and could, thanks to its observations, decide to interact with a specific student team or all of them. The teacher could ask the group to apply a new cooperative learning strategy, changes the parameters of the problems to be resolved, etc. He/She could also intervene when needed to reinforce cooperative skills within the team. These of interaction could also arise when a team has a problem for which neither the system nor the other teams provide a solution. The students can ask the teacher to deepen some concepts, etc.

However an important issue in SHIECC is that a learning session could be already done even in the absence of the teacher. In this specific case the interaction is differed. The students have the possibility to send their questions, uncertain knowledge, etc. to the teacher using the proposed primitives of communication or storing them in a specific Database, which is consulted, later by the teacher.

6. Cooperative Pedagogical Activities

The cooperative learning activities in SHIECC are composed of six principle phases (cf. Fig. 4): (1) preparation of the student groups,(2) preparation of the new knowledge,(3) course assimilation, (4) application of the acquired knowledge,(5) teams evaluation, and (6) individual evaluation. Each phase has its specific functions and is contemplated with some appropriate pedagogical strategy to be chosen in agreement with the students team model.

We defined the phases of knowledge *assimilation,* knowledge *application* and student team evaluation as the three cooperative phases. We present in the following each of the six phases. We propose especially our approach for modeling cooperative learning activities in the SHIECC framework.

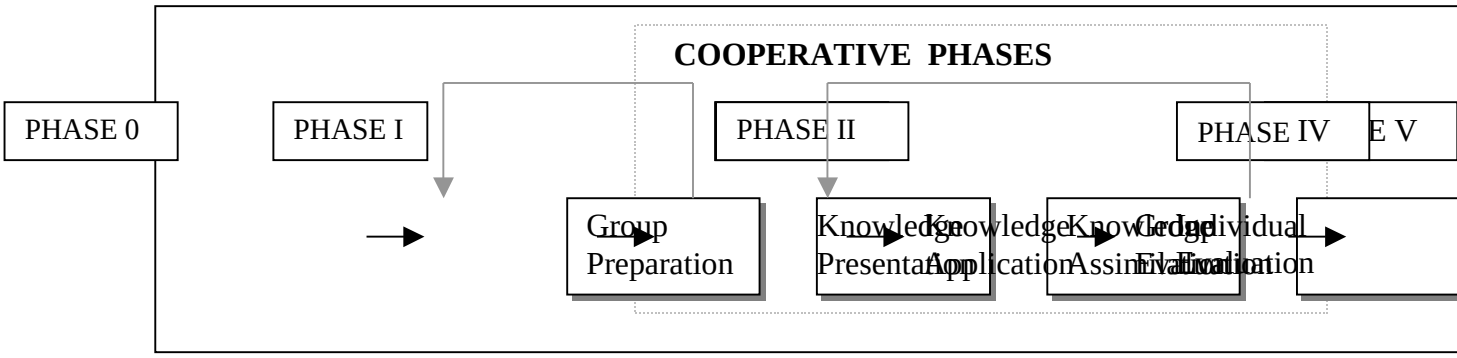

Figure 4. Cooperative pedagogical learning activities in SHIECC

6.1 Student Team Preparation

It is essential to explain the coopearative learning paradigm and the different step to be followed before a cooperative leaning session with SHIECC in order to ensure reliability and effectiveness of cooperative learning. In fact collaboration is most effective when the learners have the prerequisite knowledge to collaborate.

In addition identifying student teams and verifying their suitability for collaboration is yet an important task. Their suitability for collaboration with respect to the characteristics of other learners and the system should be verified. This is important to eliminate some of the shortcoming of cooperative learning. Finally, students may like to have a short training session on which the teacher will explain how to use the equipment.

6.2 Knowledge presentation

This phase corresponds to the presentation of the course on the terminals of the network in the different cooperative areas. A student leader is identified for each team who has the responsibility to interact with the system i.e. the tutor into account the specificity of the courses in engineering, especially in Total Quality Control, we are applying in SHIECC some specific pedagogical strategies like the argumentation and the analogy [14]. These kinds of techniques facilitate the knowledge elicitation of new concepts like histogram, diagrams, etc., as they are frequently used in Total Quality Control, [15].

6.3 Knowledge assimilation

This is the first really cooperative phase. After attending the course, the students try to assimilate it by exchanging ideas about the presented knowledge. They can discuss the contents of the lesson (e. g. to sum up the introduced concepts, to check whether they have a common understanding of these concepts, to confront different ways to solve a problem, ets) .A lot of models of cooperative learning are proposed in the literature such as Jigsaw,

Johnson's method, Student Team learning (which has multiple variation), etc . However. These methods are defined for classical cooperative learning. We retrain and modify adequately ,for our needs, some of our these cooperative strategies which are meaningful in our context:

Jigsaw model. In this method (16), students work on the academic material (presented in the first step) which has been broken down into sections. Next, members from the different teams who have studied the same sections meet (in the network or may be face-to-face) in " expert groups" to discuss their section s. Then they return to their teams and take turns teaching their teammates about their section. Students are motivated to support and show interest in each other.

Jigsaw II .Jigsaw II is a modification of Jigsaw developed at the Johns Hopkins University (17). Instead of being assigned unique sections, students with the same topic met in expert groups to discuss them, after which they return their teams to teach the whole material.

Student Team Learning. Little bit different from the Jigsaw model, this method involves use of student teams in which students teach each other. A number of approaches to students team learning exist: Student-Achievement Division (STAD), Teams-Gams-Tournaments (TGT),etc.

6.4 **Cooperative Knowledge application** This is the second cooperative stage in the learning session. In this step students are given work to do as a mean to apply the knowledge they acquired. Several cooperative modes are possible. In previous work (18), we defined modeling cooperation as at first the adoption of a cooperative behavior shared between the group while performing their activity. We identified several cooperative behaviors. We propose here the negotiation, the competition, the co-action, the assistance, the complement, and the indifference. The selected cooperative behavior is chosen regarding to the student team model. This is usually done by the tutor and the pedagogical agents. The teacher is already able to change the selected method.

Negotiation. The students could perform a work together. They negotiate with each other's during all the steps of problem solving (conflicts resolution, etc).If a consensus isn't reached the actual leader has the responsibility to define the group answer for example regarding local consensus,etc.

Competition The same work is allocated to all the member of the group. Each one tries to perform it separately before or at the place of the others. This mode of work does not implicate necessarily the discomfort between the learners and rather a bad use of the resources.

Co-action. As in the last mode, students resolve the work separately but without competition. There are no conflict resources problems.

Assistance. The work is allocated to only one student when needed. This mode of work is important to help student team homogenize their knowledge, especially when it is observed a distortion between the student levels.

Complement. The work allocated to student team would be divided in small works. Each one is done by one student member. The realization of the work is depending on the performance of all the sub-works: each completes a part of the work.

Indifference. The student are assigned different works that are performed independently from each other.

6.5 Student team evaluation. This is the last cooperative step. The same cooperative modes seen in the knowledge application phase could be adopted here for the problem solving. The cooperative mode could be defined in advance by the system (or by the teacher), or freely adopted by the group of students.

Three concepts are essential for a realistic group evaluation [17]: team rewards, individual accountability, and equal opportunities for success. The team aren't usually in competition to earn rewards. The team members are evaluated individually but they are rewarded as a group. Equal opportunity for success means that students contribute to their teams by improving their own past performance. This feature ensures that the contribution of all team members will be valued.

6.6Individual evaluation . Students take individual quizzes to be evaluated. This could be done in different ways. The paradigm of cooperative learning is important to accelerate and facilitate the knowledge elicitation process. However, the individual student is still the main objective of SHIECC. This step provides an indicator to measure the degree of success of the system.

7. Implementation. The SHIECC system is implemented in C++ Builder (a Visual Object Oriented Programming language). The Knowledge domain (the course) is implemented using the Toolbook 4.0 Development Kit. The implementation of the communication services is based on the TCP/ IP protocols.

Figure 5: Student Interface

Figure 4 shows the SHIECC student interface. This interface enables the student group, within their cooperative area, to access to the system functionalities. They could have an online help about the SHIECC environment: how to work ? What is the significance of the different proposed cooperative learning strategies ? etc. They could start a learning session (running the knowledge domain implemented inToolbook). The student interface offers all the resources for the inter-group and students-teacher interactions (Chats, Multimedia, and email).

Another important resource available in SHIECC is the Requests Base. This is a specific Database, playing the role of a blackboard that permits students to save their

questions, uncertainties, etc. Students, from all the groups, have access to this base ; they could answer (within the same base) to some requests, look for some answered requests, etc. This is a good factor of group integration that helps the learning process and enforces the collaborative learning paradigm.

8. Conclusion

As Piaget [19] pointed out, cooperative learning has a major role in constructive cognitive development .How to understand is individual, but it is more benefic or even necessary for us to understand things with people who have different viewpoints on the domain.

The system SHIECC proposed here is one of the few software pakages that implement effective cooperative learning paradigm. It offers new opportunities in education by integrating cooperative learning with computer, multimedia, and network technologies in a manner that we believe will challenge traditional methods of pedagogy and benefit the learning process in a fundamental way. It presents an environment in which students learn by interacting with the system, between them within their team, with the teacher and with others collaborating. A big efforts is done fore studying the different kinds of cooperative within the different stages in the learning session and new cooperative learning strategies are proposed. We presented in this work the SHIECC project as a new alternative for effective cooperative intelligent instruction. We proposed principally an agent-based modeling approach for SHIECC and addressed the problem of cooperative modeling. New cooperative learning strategies are proposed for each phase within our pedagogical learning model.

We are addressing now the problem of specification and operationalization of the different kinds of interaction studied here. The artificial agents interaction is specified using the KQML Agent-communication language.

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