

# **COMPUTING IN EDUCATION: NEW TECHNOLOGIES APPLIED TO THE SENIOR HIGH TEACHING**

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## **ABSTRACT**

The present paper proposes a modeling for a Support Tool to the Cooperative Teaching (STCT) applied to the senior high school teaching. Such a modeling has been developed based on the result of researches with students, teachers and educators of the senior high at CEFET-MA. The above-mentioned tool takes part of a pilot project aimed at developing a cooperative learning environment at this Teaching Center. Pedagogical strategies have been selected that best fit the new approach used at the institution: the teaching/learning by competence (Leis de Diretrizes e Bases 9394/96 [Brazilian Law for Education] and the National Curricular Parameters) aimed at developing not only the student's academic abilities but the social as well. As a practice we have chosen Mathematics, Physics, Chemistry, etc. because they observe the difficulties of the cooperative strategies use concerning the content related to it.

## **KEY WORDS**

Computing applied to education, educational software, tutoring tools, CSCL, pedagogical strategies, cooperative learning, and learning environment

## **INTRODUCTION**

With the globalization advent as well as the revolution at the information and communication technologies, it is important to rethink the pedagogical practices in order to face new challenges, aggregate social values to the teaching/learning process as they are related to several factors and not only to the exchange of material between teacher and student.

The traditional education has given place to an effective participation of all the integrants of the learning process. This was also distinguished by the inclusion of computing at this context. The use of computers in education has brought advantages such as: more class availability, content's repetition flexibility, more autonomy for the student, diversity of knowledge transfer tools besides mediating the building of knowledge and the concretion of the teaching/learning process.

With the joint of Computing and Education fields we have the cooperative learning paradigm that enables the student to build his knowledge through strategies that enhance the individual learning through co-operation amongst the components of study groups. Thus, the collaboration idea aims at stimulating every student so that he/she can dynamically involve himself/herself in all the assimilation phases of the content presented to the group (Ellis et al., 90). Even though the cooperative learning paradigm has been used for some time, the use of computers as an auxiliary tool for such an end has been facing several challenges such as the difficulties of properly compose a cooperative teaching/learning process and computerized systems without hampering the quality related to the pedagogical criteria whose main focus is given to the group, not to the student individually. Researches in this area have contributed a lot to raise a paradigm called Computer Supported Cooperative Learning – CSCL (Greif 1988). Such approach gives several options for research aimed at favoring the conception of strategies that optimize communication between the basic elements involved at this

scenario: the teacher, the student and the computer. Such technology, on the other hand, should be conceived based on methods and pedagogical techniques that help the teacher to transmit relevant information in a dynamic and gradatory fashion that allow the students to build up the knowledge that is necessary to form specific competences.

Facing the challenge of contributing with methods and techniques that favor the pedagogical practice for the teaching/learning process by teacher's competence at the CEFET-MA senior high, the Educational Technology team of this Center proposes the development of a tool that integrates appropriately computing and the cooperative learning to the teaching by competence. The main focus of this article is the modeling of the mentioned tool.

The presentation of this article is as follows: section 1 brings a brief scenario of the senior high school teaching and its need to adapt to the paradigm of the cooperative teaching as to the new teaching/learning curriculum by competence (Leis das Diretrizes e Bases 9394/96 [Brazilian Law for Education] and the National Curricular Parameters) used at CEFET-MA, Brazil. Section 2 shows an updated study of the students, teachers and educator's expectations at CEFET-MA as well as a result's analysis of this study. The main focus of this article is on Section 3 that is our proposal for modeling a Support Tool to the Cooperative Teaching based on the study mentioned on Section 2 aimed at favoring senior high teacher's pedagogical practice at CEFET-MA. Finally, Section 4 brings our conclusion and perspective of future works.

## **SENIOR HIGH VS. COOPERATIVE LEARNING**

The curricular guidelines on the basis of the law nr. 5692/94 divided the traditional education in several teaching levels: Education for Children (Educação Infantil), Fundamental Teaching (Ensino Fundamental), Senior High School (Ensino Médio) and Graduation. With the new Lei de Diretrizes e Bases (Brazilian Law for Education nr. 9394/96) it was a need to reform the organization of Senior High that now is centered at the teaching by competence. At this very new model of Education students' knowledge, abilities and attitudes have to be developed (Perrenoud, 1999). At this context, traditional education has been given place to new educational practices due to the necessity of adapting to the new way of teaching, having the National Curricular Parameters as a reference in order to guide the teachers in their educational practice.

In order to have a good development of that educational practice, at the teaching by competence, the teacher needs strategies that allow the building of knowledge as well as measure it, implement abilities and guide attitudes. This can be reached through an activity inherent to men that is the co-operation ability that can be considered as a crucial factor to overcome daily difficulties (Aronson et al, 1978). However, group works do not necessarily imply that the group is cooperative. The interaction amongst group members is necessary in order to reach its pre-established goals.

This context is also valid for the educational context in order to assure some basic elements in the cooperative learning process such as a positive interdependency, individual responsibility, social abilities and group processing (Johnson et al., 1994) or the real co-operation sense will not be totally reached. The cooperative learning is important to allow the student to have a better and wider productivity concerning the methodologies of the traditional learning (Sherman et al., 1991).

Since one of the conceptual landmarks of the Brazilian teaching indicates the expansion of the education meaning to beyond school (Law nr. 9394/96), e.g., to life, the above mentioned concepts could be reached with the use of strategies based on the cooperative learning that enables the teachers to develop their educational practice, enriched by the different situations that arise within a group of cooperative work.

With the advent of computing at the educational context, some works have been developed to support co-operation. A clear example is system proposed through electronic documents where all the participants of the group interact sending documents that can be considered as tools that allow the

exchange of students' opinions and experiences (Boy, 1997). Thus, we thought of co-operation as an essential factor for the educational process, mainly concerning the teaching/learning process by competence. So, it is necessary to subsidize it through studies of how to model and implement educational tools to support the cooperative teaching.

In the two following sections we present our point of view concerning the support to the cooperative learning that has been developed at CEFET-MA. We give emphasis to the modeling phase of the Support Tool to the Cooperative Teaching (STCT) directed to Mathematics, Physics, Chemistry, etc..

## **RESULTS ANALYSIS: PRESENT ANALYSIS OF STUDENTS, TEACHERS AND EDUCATORS' EXPECTATIONS AT CEFET-MA**

After the study with the senior high students, teachers and educators at CEFET-MA about the pedagogical methods that comprise the new curriculum adopted by the institution, we have discussed problems concerning the difficulty of adaptation to the new curriculum based on the teaching/learning process by competence. According to the opinions of around 80% of the interviewed teachers, this is a much more complex process, either concerning the knowledge transfer process or (mainly) the evaluation process. The reason lies on the fact that the traditional teaching process preserves a supposed facility of teaching due to a much lesser number of variables. We have also noted that around 50% attribute the problems to the big number of students per class-room, lack of qualification and real application of theoretical methods, the amount of indicators that should be taken into consideration during the content given, the few time (in classroom and out of it) to register the referred indicators, low remuneration that does not stimulate the quality of teaching, etc. Most of the students, on the other hand, believe that the new process has much more advantages than disadvantages and that benefits will come at a medium time. However, the students are not ready yet for the new forms of evaluations that are much more demanding than the traditional ones.

The educators evaluate both teachers and students. The conclusion is closer to the exposed. Thus, the objective of the proposed tool to all the people involved at the senior high educational process at CEFET-MA is to provide alternatives to apply cooperative strategies in a satisfactory fashion aimed at favoring this new approach of the learning/teaching process.

## **CONCEPTUAL MODEL OF THE SUPPORT TOOL TO THE COOPERATIVE TEACHING (STCT)**

The STCT proposed at this work has been modeled with six components: *the educator*, *the virtual library*, *the composed student* (Labidi et al., 1998a), *the student's interface*, *the teacher's interface* and the *interaction and control component* that allow the exchange with all the others. This way, the Unified Modeling Language (UML) has been used. Next we present a brief summary of the role of each one of these elements in the system.

*The educator* helps the teacher in defining more adequate strategies to the group of students during the course of the class and activities.

*The virtual library* stores the content to be passed on by the teacher, including the necessary activities to the retention of the content.

*The composed student* allows the follow-up of students and groups' present situation, respectively, concerning each phase of the learning process.

*The existing interaction and control component* between the system's modules is represented in the form of arrows and allows, as the name suggests, coordinate the other components of the system.

Finally, *the student/group's interfaces and the teacher's interface* allow the system's users a friendly interaction with it. Figure 1.

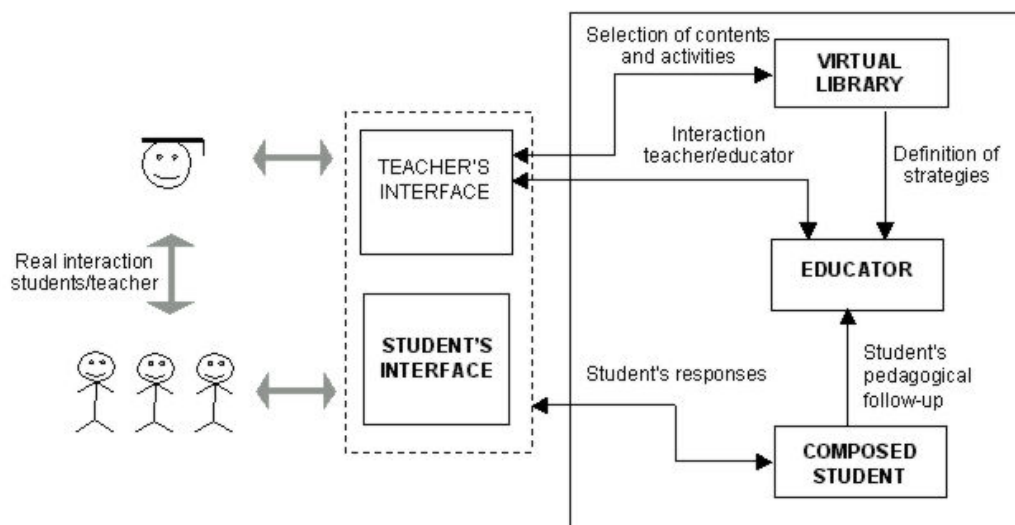


Figure 1. Advantages of the STCT

## DESCRIPTION OF ADVANTAGES

**Educator:** this module indicates to the teacher the pedagogical strategies that best fit a specific content. Amongst the pedagogical strategies we can find argumentation, analogy, expository class and guided study whose application is suggested in the knowledge's presentation phase; and the Curricular Cooperative Package (STAD, TGT, TAI and CIRC), *Jigsaw and Jigsaw II* and MURDER (Kagan, 1988) (Slavin et al., 1987) (Johnson et al., 1994), for the content's assimilation phase. It is important to emphasize that the mentioned strategies have been defined for the classical collaborative learning and not to computerized tools. Thus, as in (Ferreira, 1998), these strategies should be adapted to the needs of the proposed model. That adaptation relates, among other aspects, number of students in the group, material used, interaction between groups and the teacher, content assimilation time, evaluation, etc. In order to guide each phase of the cooperative learning/teaching process we have used a *sequence of cooperative pedagogical activities* defined at (Labidi et al., 1998c), as shown in Figure 2. Such sequence integrates all the necessary phases to a better utilization of strategies either traditional or cooperative that favor the group learning and, consequently, individual.

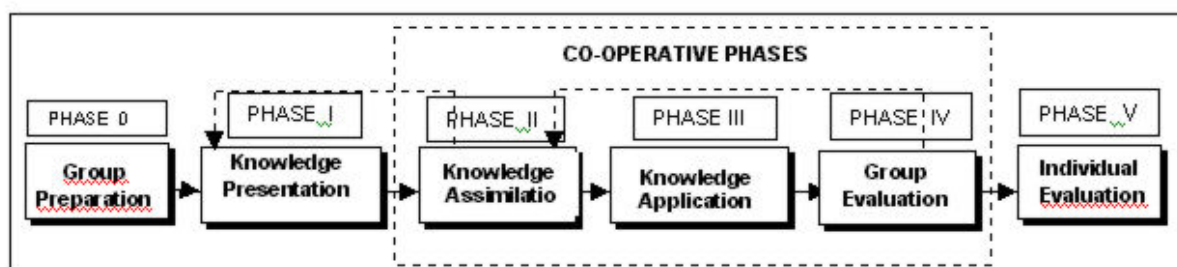


Figure 2. Cooperative pedagogical learning activities

At STCT modeling, we have considered the co-operation/communication between all the actors involved in the scenario as a determinant factor to reach the final objective: the individual learning. The highlighted interactions are: student/student (intra and inter groups), students/teacher, students/STCT and teacher/ STCT. Such interactions are relevant as they allow working with indicators that are fundamental for the development of important competences to qualify the student as a citizen and future

professional. Next we present the connection between the phases presented in Figure 2 and the above mentioned interactions.

*Phase 0 – Group preparation:* allows the teacher to specify the objectives of the class, the academic objective and the social objective. The academic objective concerns to the content that the student is to learn. The social objective details which interpersonal abilities will be emphasized during the class. All the lessons in the cooperative teaching have both objectives. The objective of the group preparation is to assure more interaction and effectiveness during the cooperative phases. Indeed, collaboration flows better when the group components are properly prepared to exert it. At this phase the most important is the interaction students/teacher.

*Phase I – Knowledge Presentation:* Allows the teacher to work the class content via STCT according to the strategies pointed out by the educator. At this phase there is the concern of presenting the content that consists with the students’ level (basic, intermediate, advanced). Such level could be determined through interactions students/ STCT, where the *educator* levels the content; or through students/teacher interactions, where the teacher himself/herself, based on the previous phase, determines the difficulty level of the presented class. Table 1 presents some strategies to the referred phase.

Table 1. Strategies for the class presentation phase

<b>Presentation Strategies</b>	<b>Student’s level</b>	<b>Justification</b>
Argumentation	Basic Intermediate Advanced	Allows a better establishment of new concepts; Establishes a faster learning. Allows content’s review by the student.
Analogy	Basic Intermediate Advanced	Allows a faster and objective assimilation of contents belonging to more abstract domains.
Expositive Class	Intermediate	Allows the follow-up of the class in a traditional fashion.
Guided Study	Basic Intermediate Advanced	Develops the capacity for researches.

*Cooperative phases:* Allow the integration of three phases of the class. 1. Content assimilation, 2. Content application, 3. Group evaluation. The cooperative phase is also *interactive*. According to the evaluation of the student’s group by the teacher or *educator*, there may be a need of returning to the previous phases. We can note that such phases, despite being analyzed separately, can be included in only one task according to the strategy adopted by the teacher. The interactions for the cooperative phases involve all the actors in the scenario. They are: student/student, students/teacher, students/ STCT and teacher/ STCT.

*Phase II – Assimilation:* this is the first phase effectively cooperative. As the students follow the classes they try to assimilate it, exchanging ideas on the studied subject. After this interaction they have to give a positive or negative feedback to the system showing whether the assimilation was well succeeded or not. The strategies for this phase are on table 2.

Table 2. Cooperative Pedagogical Strategies

<b>Cooperative Strategy</b>	<b>Justification</b>
Cooperative Curricular Package: STAD, TGT, TAI e CIRC	Stimulates self-instructional learning. Students try to assimilate the content individually checking his colleagues' answers.
<i>Jigsaw</i> and <i>Jigsaw II</i>	The use of these strategies is very interesting in the case of inter-group interaction and it can also be adapted to the group's internal work.
MURDER	Stimulates face-to-face interaction within the group because of pair work.

*Phase III – Knowledge Application:* this phase represents the second cooperative stage at the learning section (Ferreira, 1998). The objective of this phase is to propose tasks through which knowledge will be applied. The strategies used here are: *negotiation, competition, co-action, assistance, complement* and *independence*, based on the cooperative modes defined in (Labidi, 1996). Table 3 presents a synthesis of the mentioned cooperative modes with its respective objectives.

Table 3. Cooperative Modes

<b>Cooperative mode</b>	<b>Synthesis</b>
<i>Negotiation</i>	Students <i>negotiate</i> among them in all the phases of the problem and seek for the best solution.
<i>Competition</i>	The same activity is allocated to all the students in the group. The students try to solve it separately. This activity is aimed at stimulating production with quality concerning the reaching of goals for the activity.
<i>Co-action</i>	Students solve the task separately but with no competition.
<i>Assistance</i>	The work is allocated to only one student. The other peers help whenever necessary. It aimed at making the group more homogeneous concerning the level of knowledge of each one.
<i>Complement</i>	Each student perform part of the task. The allocated activity represents a small part of a bigger task. The accomplishment of the task depends on the performance of each and every in the group.
<i>Independence</i>	Students work on their tasks without the need of participating in the other's tasks. Although this does not seem to stimulate co-operation, when properly combined with others, allows a good performance of individual abilities for the student within the group.

*Phase IV – Group Evaluation:* at this phase there are three important concepts: group reward, individual responsibility and equal opportunities for the success (Slavin, 1987). Some of the cooperative modes seen in the knowledge application phase could also be adopted here. The group's cooperative behavior can be determined by the STCT, based on the results of the previous phases and also in records done by the teacher. Still, there is the possibility that the teacher, regardless of the tool, evaluates the group and then updates the system. The students themselves can participate with group's self-evaluation phases, against teacher's authorization. Thus, the interactions at this phase can be restricted to or expand through all possibilities, depending on the selected strategy.

*Phase V – Individual Evaluation:* at this phase the students undergo evaluations to check their learning with no involvement with the group. The STCT through the *educator* would suggest the return to the previous phases in case the evaluation does not present the satisfactory feedback. After all the idea is to

use the group work to develop the individual potential of each student. The evaluation phases will better detailed in the section “Composed Student”

**Virtual Library:** It is to store all the content and activities related to a specific domain. The teacher, as the manager of the process, will be able to insert new content or activities at the STCT’s virtual library. The teacher can also alter or exclude specific contents of his/her field of action. The *virtual library* is hierarchically organized, as shown in figure 3, at the levels *specific domain*, *curriculum*, *units*, *themes*, *content* and *activities cycle* (Ferreira, 1998).

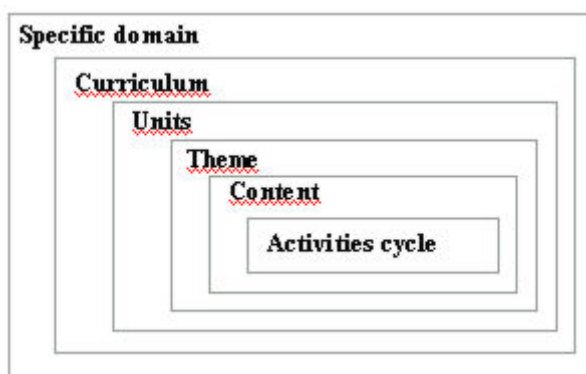


Figure 3. Virtual Library Levels

Next we have a brief description of each level of the Virtual Library: The *specific domain* is related to the general context to be studied. The *curriculum* concerns to what domain’s knowledge will be seen along the course, subject, etc. The *unit* is the name given to each module where a curriculum is divided. The *theme* corresponds to each topic where the units are subdivided. The *content* represents the class itself, that is, the subject that will be transferred to the students about a specific theme. Last but not least, the *activities cycle* is a set of tasks related to each content that the tutor repasses on to the students/group after the class.

**Composed students:** The STCT’s composed student is aimed at allowing the follow-up of the student’s progress, individually as well as of the group’s. As such, the answers given by the students to the STCT will be compared to the ones filed at the *virtual library*. The results are submitted to the *educator*. If the results are good (reach a pre-established average) the *educator* suggests that the teacher go to a new phase of activities or to a new phase of cooperative pedagogical sequence. On the contrary, the teacher suggests a group’s self-evaluation as well as returning to the previous phases of the process pointing out alternative strategies to the teacher. Figure 4 represents the STCT’s *composed student*. The records of students’ individual profile are usually done during the individual evaluation phase or when there is the need due to the strategies selection or cooperative modes that comprise this function. However, the group’s records are updated in all the cooperative phases.

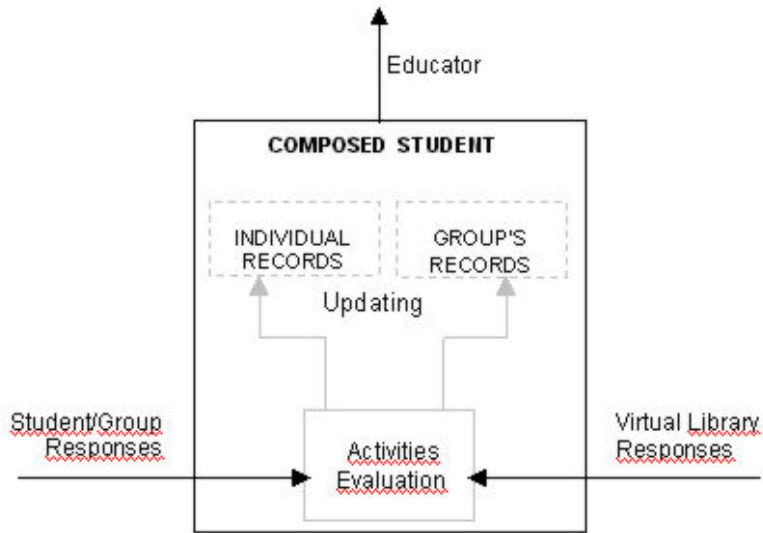
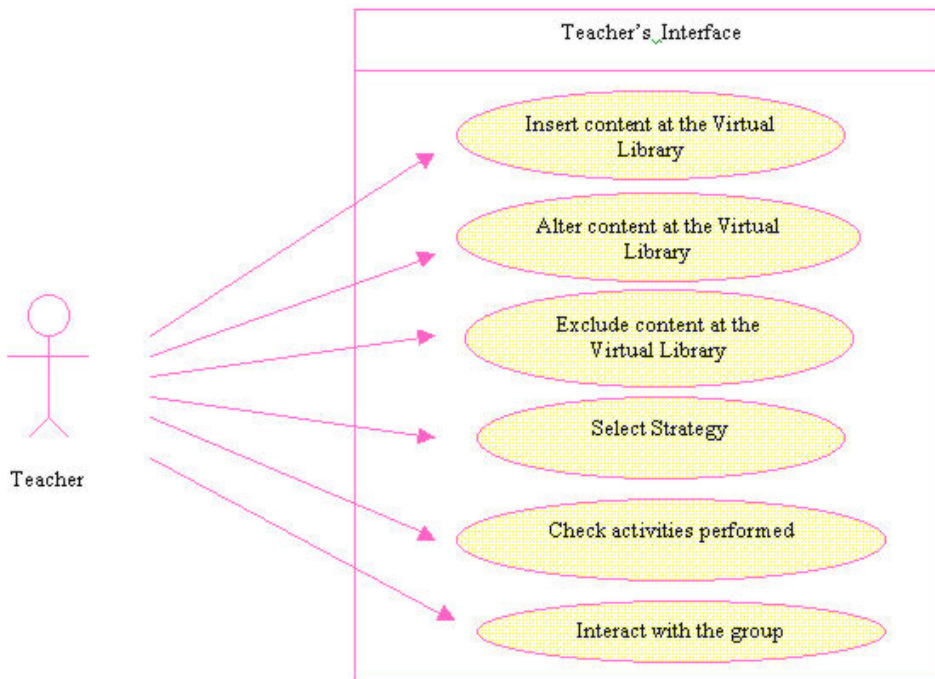


Figure 4. STCT's Composed Student

### STCT'S MODELING IN UML

Next we present some of the STCT's diagrams (figures 5, 6, 7 and 8), developed using UML that provides a macro view of the advantages of this tool.

#### Diagram of Cases in Use





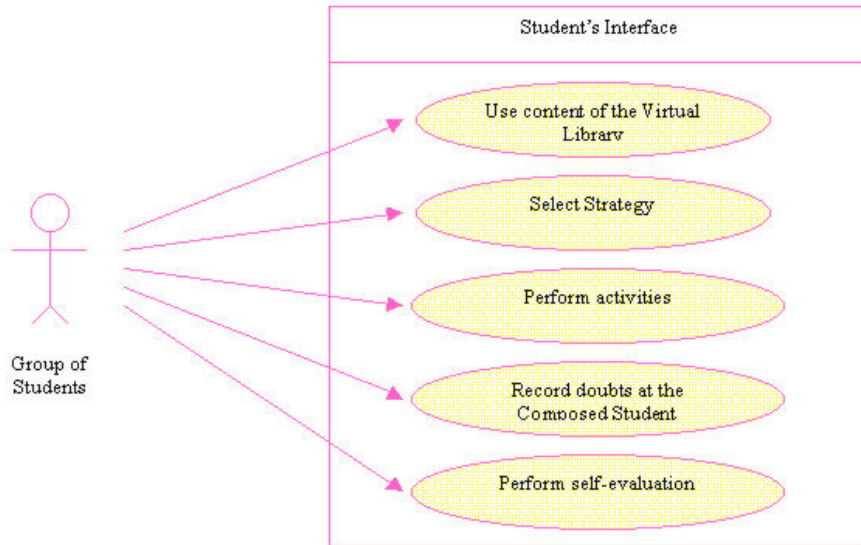


Figure 5. Diagram of cases in use of some functions of the interfaces teacher and student

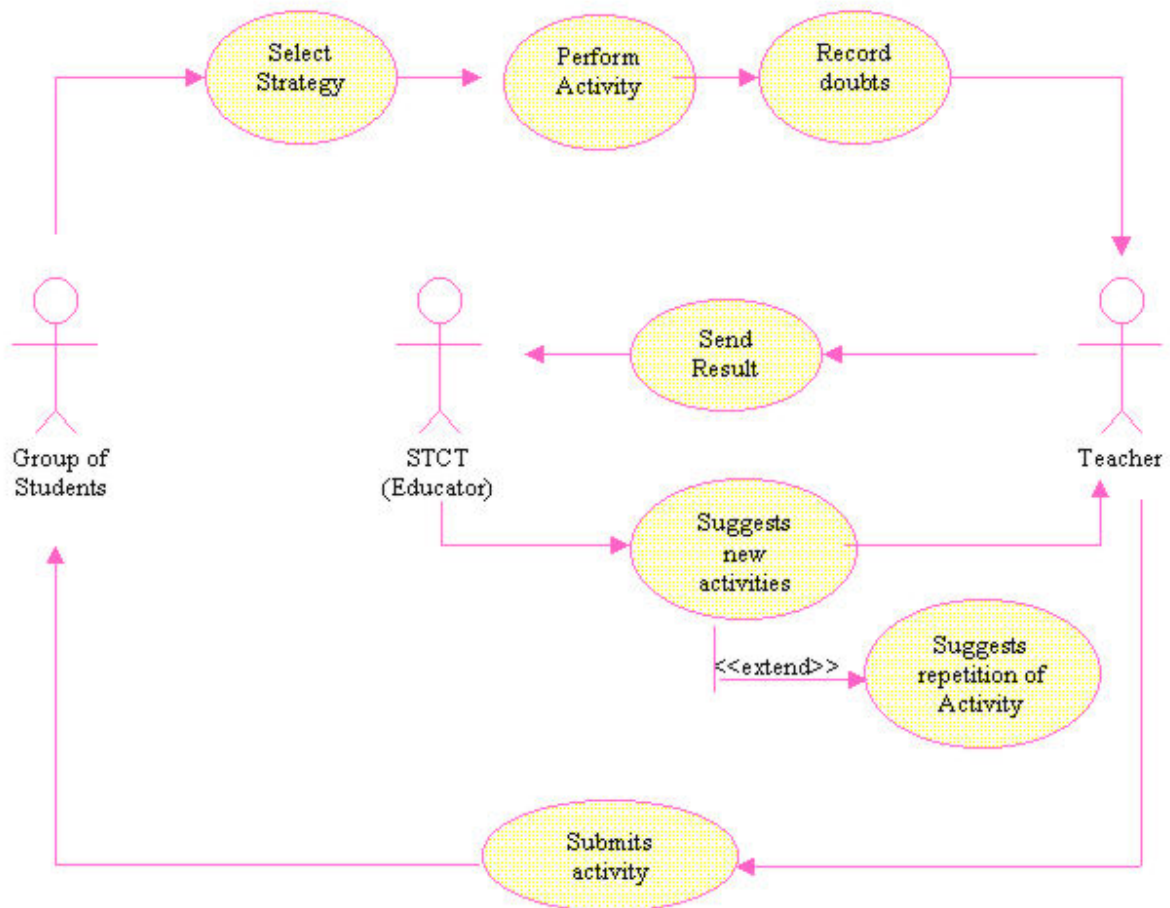


Figure 6. Diagram of cases in use representing interactions between a group of students, teacher and the STCT

## Status Diagrams

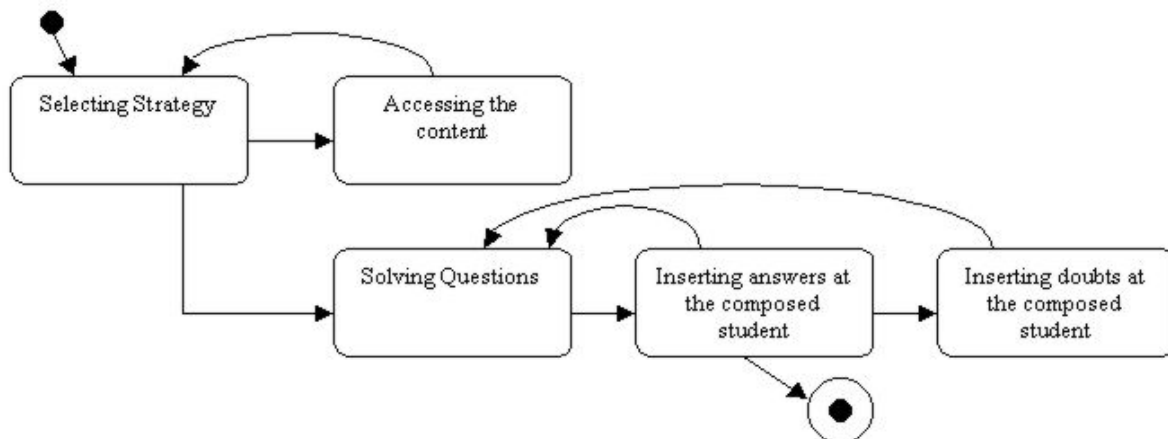


Figure 7. Status diagram representing a group of students who study the content and perform activities

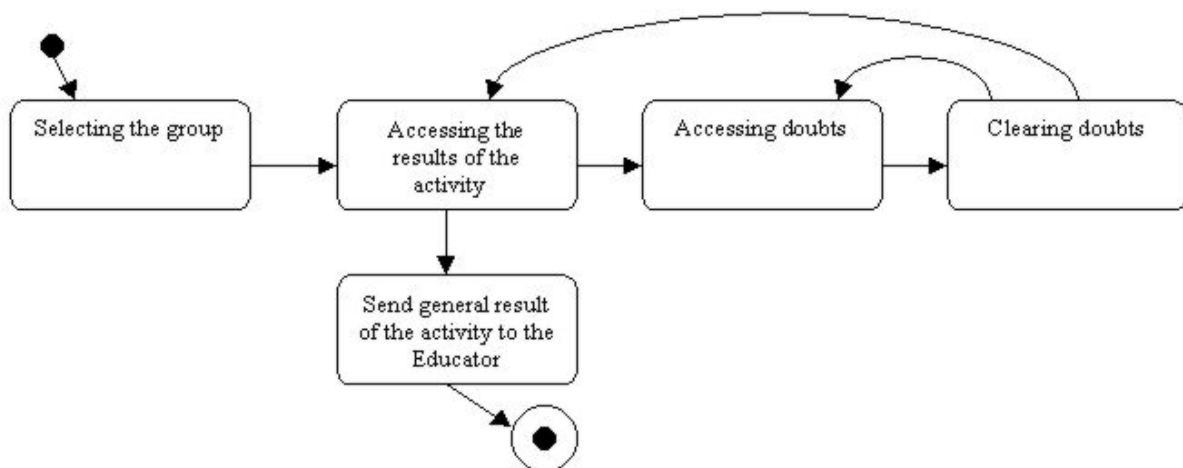


Figure 8. Status diagram representing the follow-up of the group's activities by the teacher

## CONCLUSION AND FUTURE PERSPECTIVES

At this article we presented the modeling of a Support Tool to the Cooperative Teaching (STCT) to be used at the senior high school. The mentioned tool has been developed based on the results of researches with students, teachers and educators of the senior high school teaching at CEFET-MA. We have selected pedagogical strategies that better comprise the new approach adopted at the institution that is the teaching/learning by competence (Leis de Diretrizes e Bases 9394/96 [Brazilian Law for Education] and the National Curricular Parameters) aimed at developing not only student's technical abilities but social as well. It has been noted that the cooperative learning paradigm has several strategies that favor the inter and intra group interactions, valuing co-operation as a crucial factor to student's leveling, having the final objective in mind: the individual learning.

The next steps of this project are: conclude STCT's prototype; implement the proposed tool in the Java/JavaScript language using the SGBD SQL Server 2000 and the Platform Windows NT 2000 Server and/or Windows XP; develop the interface with multimedia kit Tool book II Instructor 6.0; test the tool with content of the Mathematics, Physics, Chemistry, etc. area; make the tool available to teachers and students of the senior high. Follows with future perspectives that STCT include the intelligent agent's technology (Ferreira, 1998), adjusting its functions to the ones of a Cooperative Intelligent Tutoring System (CITS).

STCT's development work is in the intermediate phase and has been approved by the *Fundo de Amparo à Pesquisa do Estado do Maranhão – FAPEM* (State agency that coordinates Researches). It integrates a pilot project of the Educational Technology Group at CEFET-MA, whose objective is to develop an intelligent cooperative learning environment at the referred institution. The project aims at helping senior high teacher's pedagogical practice at this Center as well as favoring the learning process by the target public: the students.

The above-mentioned intelligent environment has been conceived based on the Computerized Cooperative Teaching of Intelligent Hypermedia System – CCTIHS – (Labidi et al., 2002). The referred system presents the feature of integrating an intelligent tutoring system within a computer net thus generating a Cooperative Intelligent Tutoring System (CITS). Besides the tutoring functions the CCTIHS activates the interactions between the integrants of a cooperative learning section: *the artificial tutor, the group of students* and the *teacher*, Figure 9 illustrates the organization of a CCTIHS environment.

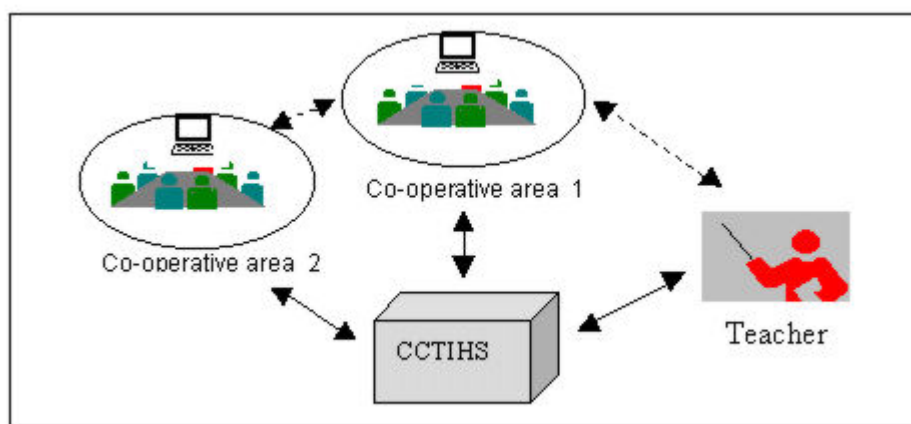


Figure 9. CCTIHS environment

With the STCT's integration in a cooperative learning intelligent environment it will also be possible to expand it to a long distance teaching.

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