Synchronous computer mediated collaborative activities among collocated students: Conditions that make them valuable in every day educational practice

George Fessakis, Argyroula Petrou, Angelique Dimitracopoulou

Fessakis, G., Petrou A., Dimitracopoulou A. (2004). Synchronous computer-mediated collaborative activities among collocated students: Conditions that make them valuable in every day educational practice. , In (Ed) P. Dillenbourg, Computer Supported Collaborative Learning SIG European Symposium,Lausanne, 7-9 October, 2004

SYNCHRONOUS COMPUTER-MEDIATED COLLABORATIVE ACTIVITIES AMONG COLLOCATED STUDENTS:

Conditions that make them valuable in every-day educational practice

George Fessakis, Argiro Petrou, & Angelique Dimitracopoulou

Learning Technology and Educational Engineering Laboratory,
University of the Aegean
{ gfesakis; petrou; adimitr}@rhodes.aegean.gr

ABSTRACT: Synchronous collaborative activities are usually studied in conditions where teachers and students are physically separated. Is there any possibility to apply these activities when all participants are collocated? Does this collocated collaboration setting seems meaningful and for what reasons? Is the quality of learning and teaching process satisfactory high? Under what conditions? The present research explores the previous questions. More specifically, it explores synchronous computer mediated collaborative activities with collocated students in realistic secondary school context. The proposed approach determines some significant application conditions: (a) The selection of critical instances of this setting application related to every day courses (e.g. conceptual understanding, strategies for inquiry or modelling), (b) The application of appropriate structured script that involves: individual work, synchronous computer mediated activity, face to face activity, and social activity with the whole class, (c) The existence of appropriate interactions' analysis tools, that support students in a metacognitive level, (d) The existence of interactions' analysis tools appropriate to support teachers in a diagnosis level as well as in a teaching strategies self-regulation level. Research results are based on analysis of students' actions & computer mediated dialogues, as well as on students' and teachers' points of view, in order to justify the meaningfulness of the activity. The quality of learning process and collaboration are analyzed mainly via a mixed analysis approach of students' computer-mediated dialogues.

KEYWORDS: Synchronous collaborative activities, secondary education, collaborative activity script, collocated students, teachers, sciences education, mathematics education, interaction analysis tools, diagnosis, motivation, dialogue analysis

1. INTRODUCTION

Synchronous collaborative activities are usually studied in conditions where teachers and students are located in different rooms, buildings, towns or even countries. A number of researchers have studied learning quality and value when there are appropriate cognitive tools (for action or dialogue) to work with, appropriate activities and settings [Baker et all. 2001; Constantino-Gonzalez et all, 2001; Wu et all. 2002]. In parallel, we know that computer mediated communication may increase the motivation for explicit expression and argumentation [Pilkington & Walker, 2003, Warschauer, 1996]. Students have to share their understanding and to 'speak' on what they do, in order to coordinate their work in the shared space. These simple operations, seems to be very valuable for sciences or mathematics learning, especially for students in process of conceptualisation (e.g. 13-16 years old), where they develop scientific concepts and reasoning, while they still have misconceptions. Furthermore, in a technological learning environment it is possible to log traces of the interaction (actions & messages). This information gives teachers unique opportunities to understand & diagnose students' difficulties and reasoning modes.

Synchronous collaborative activities among students that locate in different building or towns are very difficult to be organized in typical school conditions due to usually inflexible time-schedule. How these learning opportunities that may be offered by computer mediated Synchronous collaborative activities could be exploited? Is there any possibility to apply these activities when all participants are collocated? Does this collaborative setting seem meaningful and for what reasons? Is the quality of learning and teaching processes satisfactory? Under what conditions?

The present research explores the previous questions. More specifically, it explores Synchronous Computer Mediated Collaborative Activities [SCMCA] with collocated students in realistic secondary school context.

2. THEORETICAL FRAMEWORK & RESULTING APPROPRIATE CONDITIONS

The theoretical framework is mainly based on issues from:

(A) Cognitive psychology, science and mathematics education, where: (i) science learning is characterised by misconceptions [Driver, 1978; DiSessa, 1982; Viennot, 1979] (ii) a first step of conceptual change is the emergence of these misconceptions from the part of the students and the diagnosis of them by the teacher [Vosniadou, 2001] (iii) the role of explanation in conceptual learning is significant [Chi et all 1979], (iv) the social confrontation of the (pre)scientific' knowledge is claimed by epistemology, (v) there is a need to facilitate 'metaconceptual awareness, & metacognitive support [Vosniadou, 1994; 2000].

(B) CSCL field research, which give indices that under appropriate conditions synchronous computer mediated collaboration could incite explicitation, argumentation and explanation triggering, comparing to the typical class situations of school problem solving (where, students solve problems alone, expressing only the final product, e.g. a series of equations and a series of algebraic manipulations).

(C) The consideration of the school community, their practices, their rules and their conditions: school program, needs of teachers, typical course topics, etc.

The Design Rationale of the computer mediated collaborative setting among collocated students, is related to student and teachers expectations:

-*Regarding students*: To increase the possibilities of *explicitation, argumentation* and *explanation* triggering, in comparison to individual activity or collaborative side-by-side activity, that is usually applied in class.

-*Regarding teachers*: To provide tools and means for a detailed diagnosis of students' conceptual understanding and difficulties on specific activities processes (e.g. modelling, exploration).

The application of the proposed collaborative setting is intended to support learning through three complementary approaches: (a) Structuring the collaborative activity process in order to favour the emergence of productive interactions, (b) Supporting students to self-regulate their activity, (c) Monitoring students' interactions, by the teacher (on the fly, or afterwards.)

In order to apply the proposed approach, some significant conditions must be fulfilled:

(a) The selection of *critical instances* of this setting application related to every day courses (e.g. conceptual understanding, strategies for inquiry or modelling),

(b) The application of *appropriate structured script* that involves: individual work, synchronous computer mediated activity, face to face activity, and social activity with the whole class,

(c) The existence of appropriate *interactions' analysis tools*, that support *students* in a metacognitive level,

(d) The existence of *interactions' analysis tools* appropriate to *support teachers* in a diagnosis level as well as in a teaching strategies self-regulation level.

3. A GENERAL SCRIPT FOR COLLABORATIVE LEARNING ACTIVITIES AMONG COLLOCATED STUDENTS

The script incites groups of two students to work: *Phase 1:* individually for a while; *Phase 2*: an 'SCMCA' setting; *Phase 3*: side by side in order to reflect on their own previous activity using meta-analysis tools; *Phase 4*: in the wider social level of the class (see Table 1). The whole process is under the supervision (closed or not) of the classroom teacher.

COLLOCATED STUDENTS SYNCHRONOUS COLLABORATION SCRIPTPhase 1INITIAL INDIVIDUAL PROBLEM UNDERSTANDING.
Students solve individually specific instances of the problem using paper and pencil [via students printed activity'sheets].

⇨ Individual, with paper & pencilPhase 2SYNCHRONOUS COMPUTER MEDIATED COLLABORATION

⇨ collocated synchronous computer supported collaborative activity [students that are collocated in the same classroom, working on different PCstations, not near each other]

⇨ with possible supervision, by teacher (computer mediated or not)*Phase 2.1.Phase 2.2. Phase 2.3.*Phase 3GLOBAL GROUP REPORT
Students have to edit a report in order to present the process and the results of their collaborative activity process
During this phase, students must be supported, by using interactions analysis tools, that provides a readable 'history' of their collaborative activity process.

⇨ side-by side synchronous collaboration in front of the same PC

⇨ without supervision by teacherPhase 4REPORT PRESENTATION IN THE CLASSROOM.
During the next lesson, some group of students present their activity report in the classroom and answer other students' and teacher questions.
⇨ collective activity in the social level of the class, moderated by the teacher.

Teacher Role: Additionally, teacher intervenes to the whole class, or to specific groups after having study the 'history of collaborative process' of each group (using and studying information provided by interaction analysis tools).

Table 1. Phases of a general script for synchronous collaborative activities among collocated students

This general script could be applied in various learning activities: problem solving, exploratory activities (simulation exploration), expressive activities (modelling), etc, related to sciences & mathematics. The learning objectives may deal with specific conceptual understanding, reasoning modes, and strategies (for experimentation, modelling, or exploration). Additionally, the script use aims to the teachers provision with rich diagnostic information for students learning in critical time points during the teaching process of a subject'.

4. RESEARCH RESULTS: THE VALUE OF SYNCHRONOUS COLLABORATIVE ACTIVITIES AMONG COLLOCATED STUDENTS

4.1. Experimental conditions

The participants: The participants of the research were four teachers and eight students from K9 grade and eight students from K12 grade from three public schools. Neither teacher had any previous experience with computer supported collaborative learning. The teachers were not provided any initial instructions on collaborative learning and best practices. Teachers placed students into mixed ability groups. The members of each group worked on their own computers, which were not located in the immediate vicinity of the class. The modes of use were: i)**OME:** A group of two students and one teacher collaborating using three pcs, ii) **OXE:** A group of two students without the presence of any adult collaborating using two pcs.
The technology based learning environment: (a) an environment supporting synchronous collaborative learning activities: MODELLINGSPACE (it can be used in either stand-alone and synchronous or asynchronous collaborative mode), (b) tools supporting students: e.g. annotated Playback, (c) tools supporting teachers: (e.g. Quantitative Overview, CAF, Process Reproduction Tool).
The content: For the needs of the study a special series of learning activities has been designed with central theme the basic linear system: y=ax+b, framed with the authentic problem of mobile phone usage's cost, according to the general script (Table 1).
The available time: Each class had 8 sessions of 2x45 minutes (maximum) available for the full set of learning activities implementation. The whole approach lasted about two months.
The data collection: log files, final computer based collaborative products (models & texts), paper based-activity sheets of students, video & audio recordings of collaborations, students & teacher questionnaires, panel videos.

4.2. Main Research questions

The corresponding data of the four case studies were analysed regarding to the following issues:

Q1: Are these activities meaningful according to students and teachers?

Q1.a. Were students motivated to work through collaborative modelling activities?

Q1.b. What are the students and teachers point of view on the learning value of collocated collaborative activity?

Q2: The quality of synchronous collaborative activity (related to the content of the activity and the collaboration itself)

4.3. Research results

4.3.1. The meaningfulness of the activities

Pedagogical validation of the meaningfulness of the SCMCA is supported by research evidence estimating the motivation of students and records the participants' point of view. As far as the motivation estimation is concerned the research evidence has the following forms:

1. The level of active participation of students using a special designed collaboration analysis tool called Collaborative Activity Function (CAF) (Fesakis et al, 2004).
2. The percentage of the off-task dialogue messages wich is rather low.
3. The teachers' opinion about the motivation of students.

For the point of view of the participants is outlined by their answers to relevant questions. In the following both forms of research evidence is presented for the SCMCA meaningfulness support.

4.3.1.1. Are Students motivated to be implicated into these settings?

Students' motivation is documented by:

(a) ***Collaborative action diagrams of each group of collaborators*** (in phase 2).

Students were actively engaged in collaborative problem solving using MS. The following CAF (Fesakis et al, 2004) diagrams (figures 1-4) give evidence for this argument. The diagrams are constructed using data from the log file of MS. In any of the following diagrams the following three curves appear:

1. The **interaction curve** counts any action in the log file for the given agent for a specific time quantum. (240 seconds in our case). The more the actions of an agent the higher the interaction curve.
2. The **chat_msg curve** counts for each quantum the number of "chat" messages posted by the specific agent. If chat curve is equal to the interaction curve students are just posting chat messages.
3. The **run curve** counts the number of "run" button presses produced by the specified agent in each quantum. The run button press is a very significant event during modeling development because it signals that students probably try the first version of their model.

The diagrams are from typical cases of CSMCA from groups collaborating with (case OME) and without (case OXE) the participation of teacher. The results are presented seperately and then they are discussed.

Collaborative activity diagrams for typical instances of OME mode of use.

At the following collaborative activity diagrams (Figure 1 & 2) students are active from the first to the last quantum. Furthermore students are taking the initiate in turn from each other. Agents in the first case have comparable contribution while in the second the first student seems to hold the mouse for longer periods. Students seem to reflect for a long time interval after the quantum 11 in order to exploit the model in problem solving. In that period students are engaged most in social negotiation through chat. In traditional classes it is a rather unusual phenomenon for students to be active for so long (60 minutes minimum). Teachers have a rather discreet role in order for the group to keep collaborating.

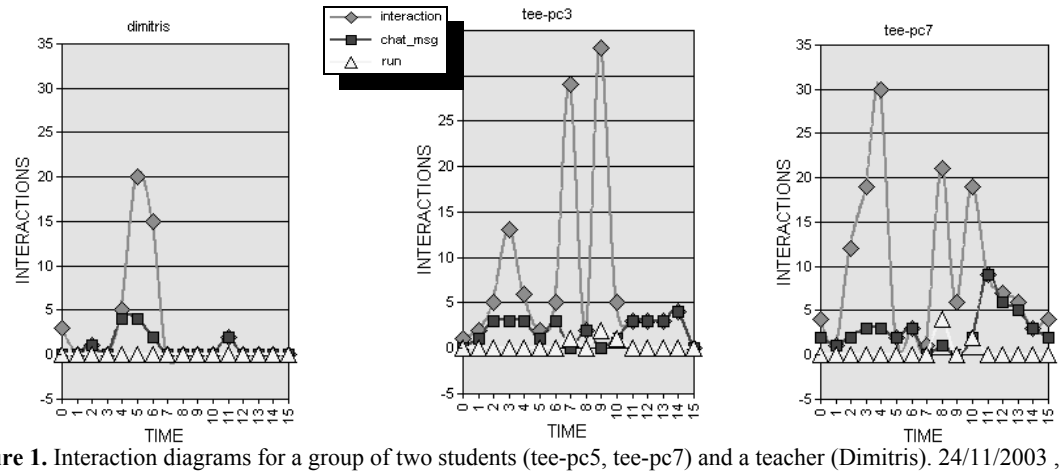


Figure 1. Interaction diagrams for a group of two students (tee-pc5, tee-pc7) and a teacher (Dimitris). 24/11/2003 , Activity 1.

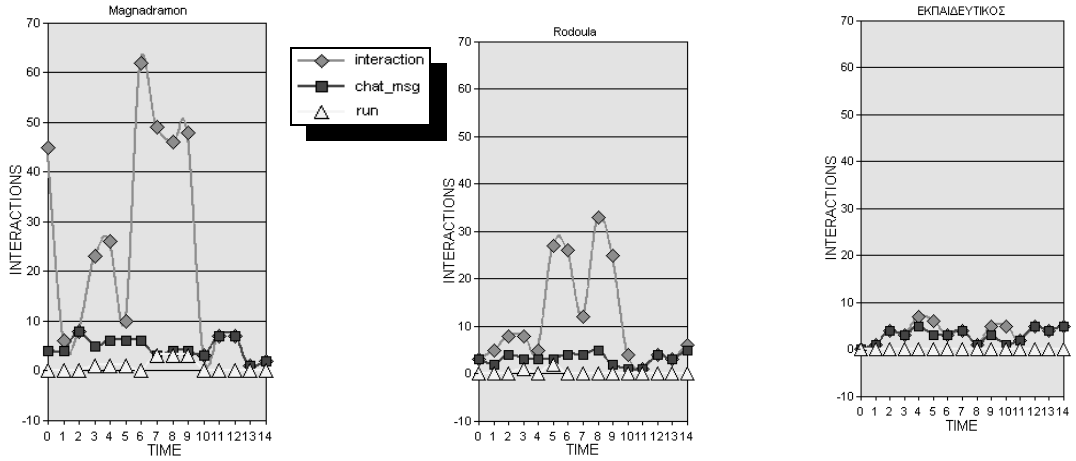


Figure 2. Interaction diagrams for a group of two students (Magnadramon and Rodoula) and their teacher. 19/01/2004, Activity 3.

Collaborative activity diagrams for typical instances of OXE mode of use.

At the following collaborative activity diagrams (Figure 3 & 4) we can see that even without the presence of a teacher students are actively engaged in the problem solving using MS. Students are taking initiative in turn from each other to modify the model in the common workspace while they constantly chat in order to negotiate, exchange and construct knowledge. Students are working for more than 60 minutes.

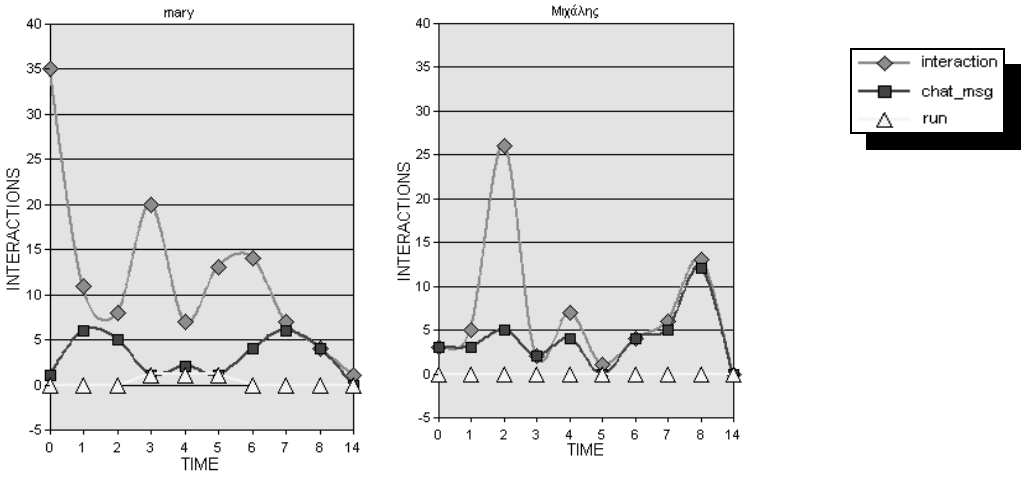


Figure 3. Interaction diagrams for a group of two students (Mary and Michael) without the participation of a teacher. 17/01/2004, 5G, Activity 2.

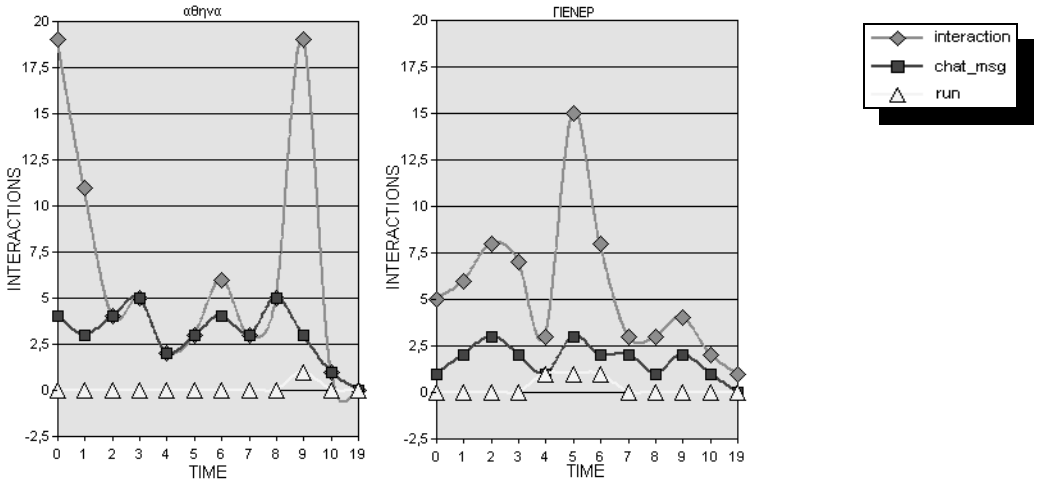


Figure 4. Interaction diagram of two students (Athina, Giener), without the participation of a teacher. 12/12/2003, Activity 2.

Discussion of the students' motivation from their active participation

Using the above information about the meaning of the curves that appear on the previous diagrams it seems that: (1) Students are actively participating to the learning activity using MS through out the duration of the activity in both modes of use (with or without teacher). (2) Usually students first collaborate in order to develop the model and after the model development they are mainly chatting reflecting on the model in order to answer the questions in the activity sheet. For example in figure 1 students are developing the model until about the 11th quantum (44 minutes) while they are chatting for the rest of the time for the answer of questions exploiting the model execution. (3) Agents are active not only in chatting but to modeling using MS representation system. In most cases all agents have significant contribution through out the activity duration.

The above observations show that students can successfully use the MS software environment to implement high motivated collaborative modeling learning activities.

(b) The analyses of the dialogs and especially by the estimation of the irrelevant to the task percentage of messages.

Strong evidence for the motivation of students can be formulated by the qualitative analysis of the agents' dialog. The percentage off-ask dialogue messages is usually (5-10)% which is characterised rather small in comparision to face to face collaboration where the oral dialogue is much more easier to get far from the problem solving.

(c) Teachers' opinion on students' motivation

According to teachers' questionnaires at the end of the session all teachers agree that the students that participate using MS are motivated.

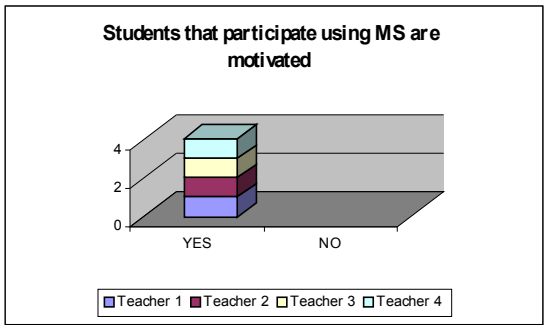


Figure 5. Teachers' answers to the question: Are the students that participate using MS motivated?

4.3.1.2. Participants' points of view on the value of these activities

(a) Students' points of view related to *the possible advantages of SCMCA* in comparison to face-to face collaboration, as well as to whether *they want to work again in this mode and why.*

According to students' questionnaires at the end of the session we have the following:

***Question 1*: Do you want to participate again and why?**

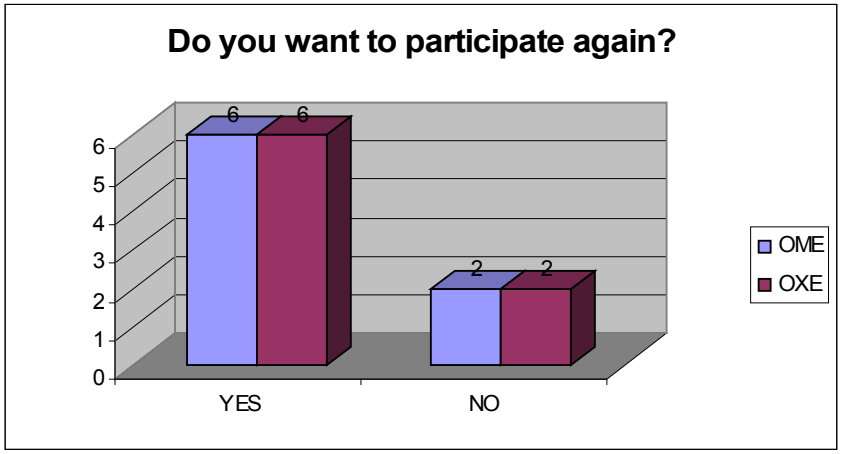


Figure 6. Students' answers to the question: Do you want to participate again using this kind of collaboration?

We can see that most of the students (75%) want to participate again. The reasons they gave are the following: "*We learned to collaborate and to communicate", " We learned things collaborating in this way"*, *"Collaborating in this way we learned what collaboration means"* ,*"It was interesting because we were discovering our knowledge"*, *It will be useful for the future"* ,*"Creative activity"* ,*"I prefer to be helped by my classmates"* ,*"I liked this kind of collaboration"* ,*"Very nice experience"*,*"Students are motivated*" ,*"Familiarization with computers"*.

From the above students' answers there are very interesting points concerning justifications based on collaboration (e.g. "*We learned to collaborate and to communicate")*, and on metacognition (e.g. "*It was interesting because we were discovering our knowledge"*) .

The students that don't want to participate again (25%) gave the following reasons: *"I didn't like it very much, "It was boring"*, *"I am not used to writing using computers"*, "*I don't like collaboration, I prefer solving problems alone"*. As we can see, one student expresses the possible difficulties of students on writing, as a more cognitive demanding activity. Another one prefers to work alone.

***Question 2*: Are there advantages between computer supported collaborative problem solving and face-to face collaboration, and if yes what are these according to your opinion?**

In computer supported collaborative learning unlike face to face collaboration participants communicate through written messages, something that according to most students' opinion students learn to express their thoughts, minimize off-task messages, students are more concrete and attend other participants' actions. Some find this way more attractive, out of the usual. Some other noticed the possibility of collaboration by distance while other think that it is just an opportunity to be familiarized with computers.

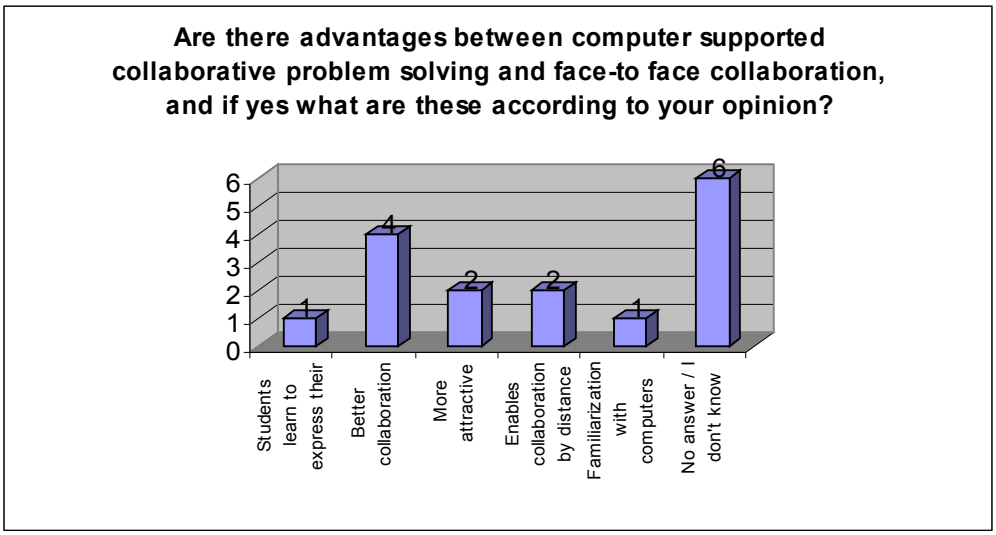
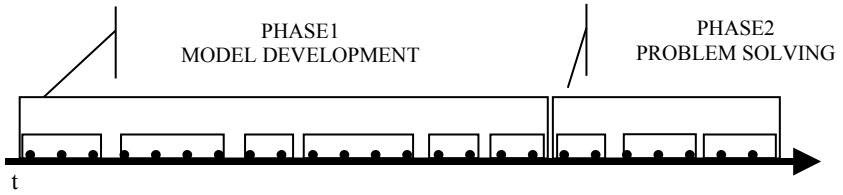


Figure 7. Students' answers to the question: "Are there advantages between computer supported collaborative problem solving and face-to face collaboration, and if yes what are these according to your opinion?".

(b) Teachers' point of view related to advantages, drawbacks, and conditions of SCMCA's implementation.
According to teachers' questionnaires at the end of the session we have the following:
***Question 1*: When during the teaching process do you consider that computer supported collaborative problem solving is appropriate be to applied?**
Teacher 1 wrote: *"If you want to use this approach you must design the appropriate activities that will urge students to argument".*
Teacher 2 wrote: "*I can use it from time to time as an alternative way of teaching, with activities suitable for collaborative learning".*
Teacher 3 wrote: *"Of course I can't use it every day because it is time consuming. I can use it to check students' thoughts on basic concepts and procedures".*
Teacher 4 wrote: "*I think this approach is valuable especially in cases you need to check students' concepts, what they haven't understood, what they have misunderstood. Of course you need the appropriate activities".*
Teachers notice that this approach can be applied:
(a) If the teacher designs the appropriate activities.
(b) As an alternative way of teaching.
(c) For checking students' concepts and misunderstandings.
***Question 2*: Are there advantages between computer supported collaborative problem solving and face-to face collaboration, and if yes what are these according to your opinion?**
Teacher 1 wrote*: "…with this approach students' thoughts and concepts are registrant".*
Teacher 2 wrote: *"I think that the biggest advantage of this approach are the collaboration's analysis tools that are available to teachers and the positive students' attitude towards this approach".*
Teacher 3 wrote*: "…teachers can attend students' collaboration and problem solving so he can intervene more effectively".*
Teacher 4 wrote: "Firstly *students' thoughts and concepts are registrant and secondly off-task messages are inexistent".*
So, according to teachers' opinion, the advantages of this approach are:
(a) Students' dialogues and actions availability.
(b) Positive students' attitude
(c) Inexistence of off-task messages.

4.3.2. The quality of learning activity and collaboration among students

Dialogues' analysis method: Different analysis dialogues methods are applied for different purposes, Baker and Lund (1996), McManus and Aiken (1995), related to the quality of the collaboration. Most of them use dialogue sentences as unit of analysis. We define a three layer framework approach (figure 9) in order to explore the quality of the collaboration and the quality, the process and the content of the activty: 1st layer: messages-single phrases, 2nd layer: detection of atomic episodes in the dialogues (sub phases), 3rd layer: main phases during activity (such as, problem analysis, modelling, and problem solving using the model).



Symbol	Meaning
•	Message. (Messages can be further color coded to depict information like the way a social negotiation begins, ends etc)
▭	Social conversation (irrelevant to the project)
▭	'Project' management (Planning, scheduling, assignment, auditing)
▭	User interface issues
▭	Social negotiation – collaboration for model development
▭	Social negotiation – collaboration during model exploitation for problem solving

Figure 8. The dialogue structure as theorized for the general script implementation (in case of modelling)

1.	**SOCIAL CONVERSATION (IRRELEVANT TO THE PROJECT).** e.g. [Sir you are a thief], [Wait! Do you consider me, a wizard?]
2.	**COLLABORATION DURING MODEL DEVELOPMENT (*PROJECT MANAGEMENT)***
2.1	**PLANNING.** e.g. [I will construct the model just like the previous activity, you watch me to detect any error.]
2.2	**SCHEDULING.** e.g. [Now I am going to construct the second company and after we are going to produce the diagram]
2.3	**ASSIGNMENT.** e.g. [set the values for the axes.]
2.4	**AUDITING.** e.g. [check if you have done all the steps you should.]
2.5	**UI AND/OR HCI ISSUES.** e.g. [Kiriakos, move the second model more to the left.]
3	**SOCIAL NEGOTIATION DURING MODEL DEVELOPMENT**
3.1	**SN REQUEST BY QUESTION.** e.g. [What max and min value I should set? They are not given. Should I use random values?]
3.2	**SN REQUEST BY DISAGREEMENT.** e.g. [You didn't set the right quantities to the axes]
3.3	**STATEMENT/DECLARATION.** e.g. [13E for the standard monthly cost and 0.03E for the cost per second]
3.10	**VERIFICATION CLARIFICATION** e.g. [I believe this because…]
3.11	**COMPROMISE** e.g. [we will set randomly.]
3.12	**AGREEMENT.** e.g. [Very good, Kiriakos. Let's proceed with the second company. Define again the entities.]
3.13	**REQUEST FOR CALL OF THIRD NEGOTIATOR.** e.g. [Neither do I. SOS, SOS!!! Sir, we do not know what values to set] [When you define it call Mrs Argiro to tell you what to do with axes ok?]
4	**MOTIVATION.** e.g. [quick.] [at last!]
5	**COORDINATION.** e.g. [Rodoula still has the key.] [Did you answer questions No 1 and 2?]
6	**COLLABORATION DURING MODEL EXPLOITATION**
6.01	**HYPOTHESIS STATEMENT-PROPOSITION.** e.g. [It is preferable the grater constant monthly cost with cheaper cost per second while if we speak much it not preferable the expensive cost per second, what do you think?]
6.02	**REQUEST FOR HYPOTHESIS VERIFICATION.** e.g. [Why is preferable the second company, rodoula?]
6.03	**REQUEST FOR HYPOTHESIS-STATEMENT CLARIFICATION.** e.g. [What value do you mean?]
6.10	**COMPROMISE.** e.g. [Ok, we finished with question no 3, company B is preferable. Let's go to No 4. Think about it and then we talk about it.]
6.11	**AGREEMENT.** e.g. [Nice!] [ok]
6.12	**REQUEST FOR CALL OF THIRD NEGOTIATOR.** e.g. [Ask Mrs Argiro!!]
7	**UNCLASSIFIED.** e.g. [????][!!!!]

Table 2. The hierarchical dialog analysis system.

The structure, the needs, and the quality of the dialogue are different among the main phases and the sub-sessions, and it is purposeful to be analyzed appropriately. More specifically:

a. The structure of the dialog during phase 1 (model development).

During the first phase agents dialogue episodes are basically of the following kinds:

1. *Project management*

Agents are in charge to manage the project in hand so they often exchange messages in the following categories: *Planning, Scheduling, Assignment, Auditing.* These categories follow the usual process model of the project management and permit the estimation of the administrative role of each agent and the style of administration of the project (democratic or centralised).

2. Social Negotiation (SN) during model development

In some cases agents stop the progress of the project implementation in order to face several issues using social negotiation. Since negotiation is a basic learning mechanism in a social constructivistic environment it is interesting to analyse the social negotiation episodes in order to estimate the learning quality of the involvement of agents. Special interest appears to the beginning and the ending modes of the SN episodes. SN analysis permits the estimation of the involvement style of each agent in terms of collaboration or competitive character.

4. *User Interface and Human Computer Interaction themes*

Despite the small frequency of these kind of episodes we consider them as a separate category because this infrequent appearance it is valuable software usability information in the context of MS evaluation.

b. The structure of the dialog during phase 2 (model exploitation).

During the phase 2 agents are mainly involved in social negotiations for the answer of activity sheet questions using the model. In these negotiations it is interesting to analyse the hypothesis formulation and verification by agents.

For the analysis of the dialogue a hierarchical system of messages categories has been defined (Table 2) and then each of the messages that has been logged by the system is categorized in order to produce the corresponding frequency distributions.

4.3.2.1 CASE 1. Two students and one teacher collaborating through their own pc's (mode: OME).

A. Distribution of chat messages to the main categories

Observing the activity curves in figure 2 we see that agents are constantly chatting during collaboration. The distribution of these messages to the main categories of the analysis system of the Table 2 can give as idea about the quality of the learning experience of agents.

In figure 9 we can see that over 60% of the messages were about project management (22%), or negotiations for model exploitation (20%) or model development (20%). Another 30% percentage of messages concern the coordination between the agents. Coordination messages aim to construct and share knowledge common for all the agents about the state of the group. Only a small percentage (6%) of the messages was irrelevant to the problem solving activity. In other words agents in case 1 have been involved in a rather beneficial collaborative problem solving with many opportunities of social negotiation and high order thinking activation.

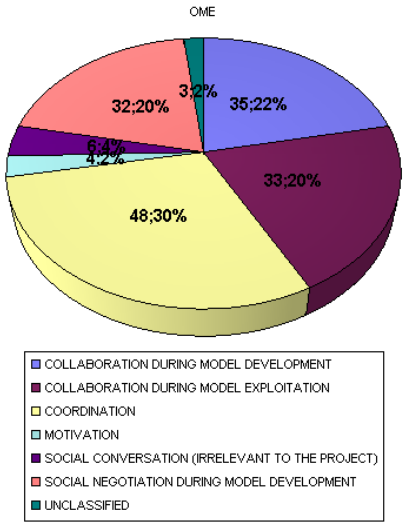


Figure 9. Chat message distribution to the main categories for case 1.

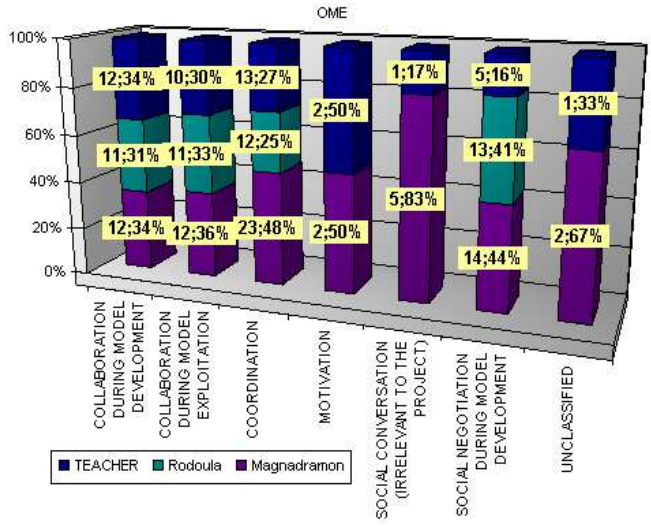


Figure 10. Distribution of messages to the main categories and agent for case 1.

B. Distribution of chat messages to the main categories and agent.

After the previous figure observation, questions about each agent's contributions appear very interesting. In Figure 10 we can see the distribution of messages kinds to the agents. Agents appear to have an evenly distributed contribution to the categories of messages except the motivation and unclassified where students Rodoula did not contribute at all.

C. Distribution of category 2 (COLLABORATION DURING MODEL DEVELOPMENT) messages to subcategories

In figure 11 there is the distribution of category 2 messages to the corresponding subcategories. Category 2 subcategories give as information about the kind of project management that we had in the activity. As we can see we had a high percentage of auditing messages which as is going to be clear in the next section are from teacher.

D. Distribution of category 2 (COLLABORATION DURING MODEL DEVELOPMENT) messages to subcategories and agent

The distribution of category 2 messages to the agents gives as an idea about the management role of each agent and the management style for the whole activity. As it can bee seen to Figure 12, teacher had an auditing and planning responsibility in the activity while student with nickname: "magnadramon" was

mainly responsible for assignments and student "rodoula" for planning. This fact in combination to the high percentage of the time that magnadramon was holding the key inform us that magnadramon was more or less competitive during the collabaration.
Despite the fact Magnadramon adopted a rather managerial role in this case since decides the most of the assignments Rodoula has a significant contribution because she is evenly responsible for the planning. Teacher is a clear auditor in this case.

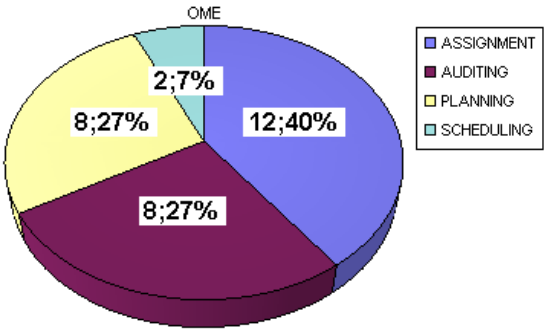


Figure 11. Distribution of category 2 messages. for case 1.

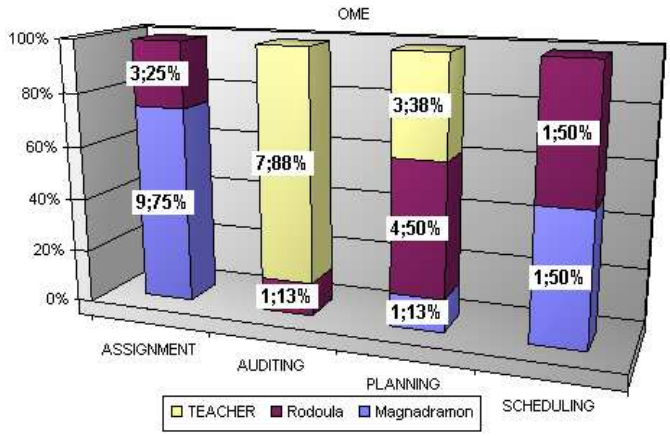


Figure 12. Distribution of category 2 messages to subcategories and agent for case 1.

E. MCA of the beginning and ending modes of social negotiations episodes and agents-TEACHERS & STUDENTS, during model development and model exploitation.

We choose to apply multiple correspondence analysis to the table of frequencies distribution of messages categories in order to find possible relationships between the way of beginning and termination of social negotiations. For example it is interesting to see how teachers usually begin a social negotiation and not only how often.

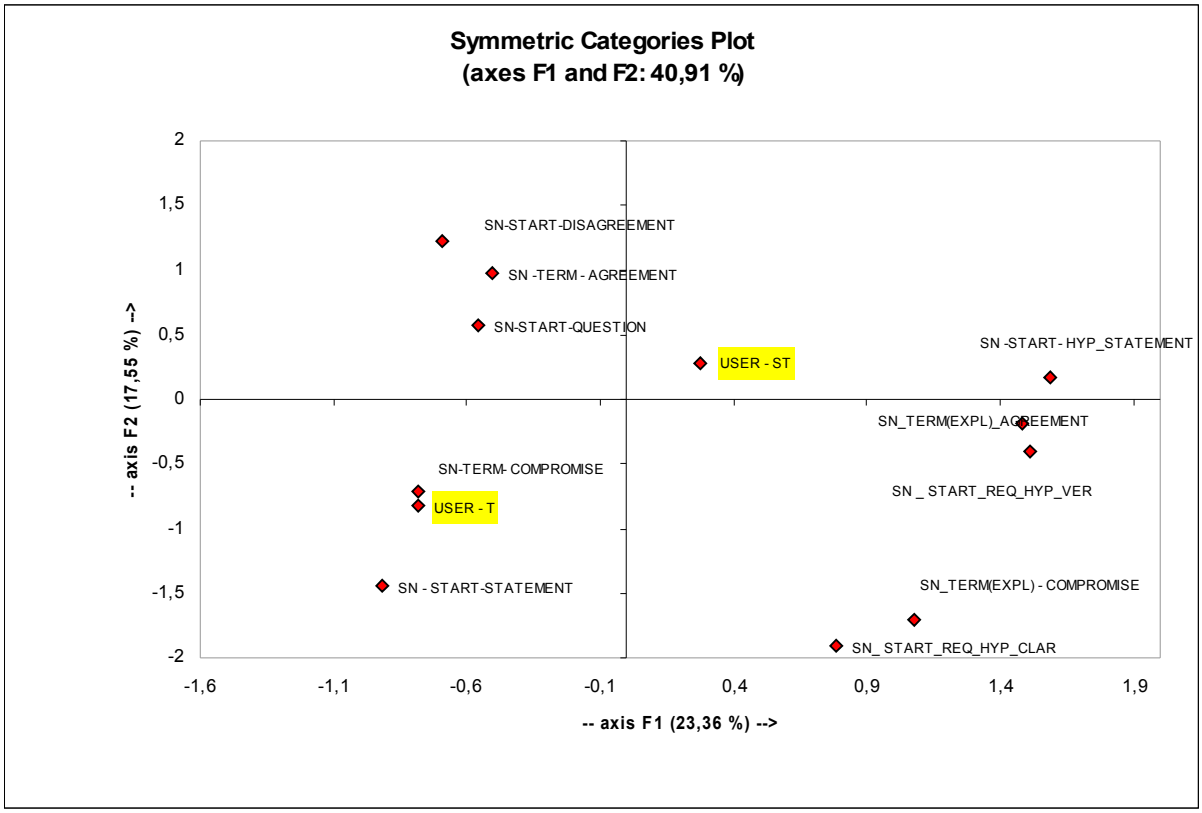


Figure 13. Factorial analysis of the beginning and ending modes of Social Negotiations (SN) episodes and agents-teachers&students that trigger the SN, during model development and model exploitation.

Observing Figure 13 we can conclude that students trigger most of the social negotiations (SN), since USER-ST is closer to (0,0) than USER-T (teachers).
During model development: Most of the Social Negotiation (SN) start with a question, and less often with a statement or a disagreement. When a SN starts with a question or a disagreement, and is mostly students that start their negotiations in this way, usually ends with agreement between the participants. Most of SNs that are triggered by a teacher start with a statement-declaration. This kind of beginning usually terminates with compromising between the participants. This is a natural result since teachers are authenties and their opinion is adopted by students.
During model exploitation: Most of SNs start with hypothesis statement-declaration or with a request for a hypothesis verification, and less often with a request for an hypothesis clarification. Additionally, most of SN terminates with agreement, while compromising is associated with the request for hypothesis clarification. The fact that during this phase most of SNs terminate with agreement can be explained because students have their model available so they can test their ideas.
We can notice that as far as teachers' strategies are concerned, they are more active during model development, while during model exploitation they leave students "alone". According to their sayings, during the last interview, students must do certain things during the day and they don't have unlimited time, so they were helping them with model construction, in order to have time to answer some questions exploiting the model.

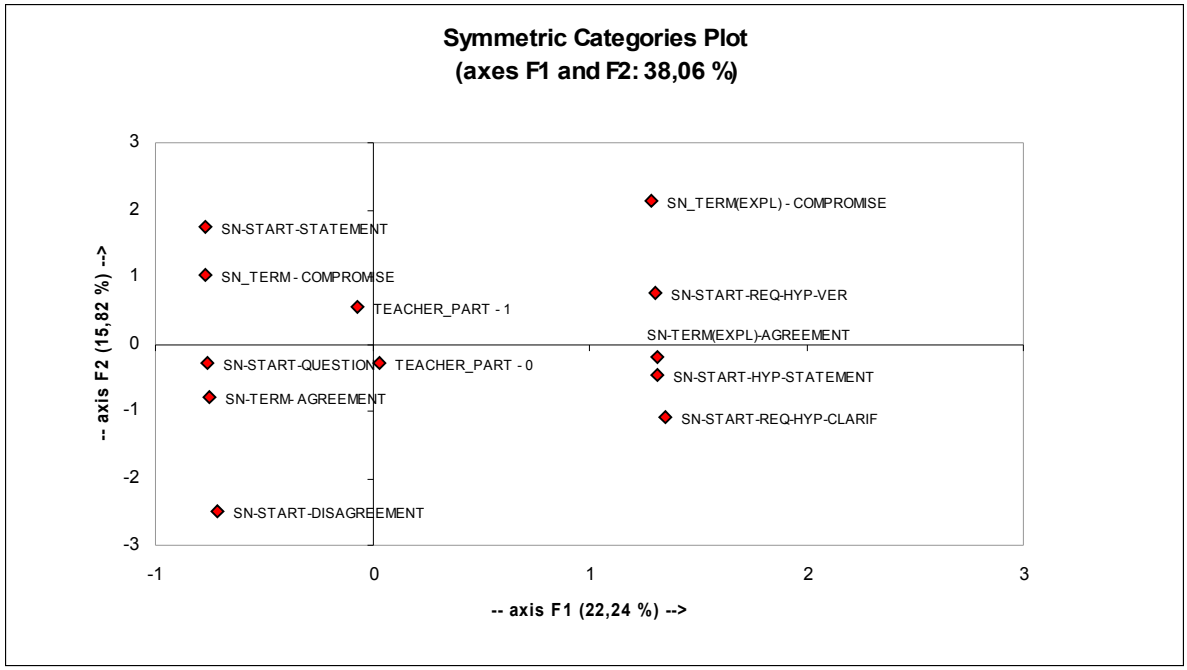


Figure 14. Factorial analysis of the beginning and ending modes of Social Negotiations (SN) episodes that were triggered by students during model development and model exploitation and teacher's participation to these episodes.

Additionally we did factorial analysis, Figure 14, of beginning and ending modes of SNs episodes that were triggered by students and teachers' participation or not to these episodes, in order to study the influence that teachers' involvement might had. As we can see, teachers did not intervene at most of SN triggered by students, TEACHER_PART-0 is closer to (0,0) than TEACHER_PART-1 is. Teacher participation is associated with compromising as termination mode of SNs. This can be explained since students tent to adopt teachers' opinion, either it is expressed explicitly or implicitly. Also, it seems that during model exploitation teachers tent not to intervene into students' negotiation.

4.3.2.2 CASE 2. Two students collaborating through their own pc's without teacher participation (mode: OXE).

A. Distribution of chat messages to the main categories

The distribution of these messages to the main categories of the analysis system of the Table 2 can give as idea about the quality of the learning experience of agents.

At Figure 15, we can see that as in the previous case a big percentage (58%) of the messages were about project management (17%), or negotiations for model exploitation (26%) or model development (15%). Messages about coordination (20%) are quit less than in the previous case (30%) where we had 3 agents. Coordination messages aim to construct and share knowledge common for all the agents about the state of the group. A small percentage (3%) of the messages was irrelevant to the problem solving activity. The increased percentage (15%) of unclassified messages is due to repeated posting of question marks by the one agent when the other could not respond quickly enough. In general agents in case 2 have been involved in a high quality collaborative learning activity as in the case of OME despite the absence of adults' supervision. This fact is a stronger evidence for the motivation of students.

B. Distribution of chat messages to the main categories and agent.

At Figure 16 we can see the distribution of messages kinds to the agents so it is possible to estimate the agent contribution to the dialogue.

In this case we have significant contributions from both the agents but mary adopted a rather managerial role as will be more clear in the followings (73% in contribution in collaboration during model development messages).

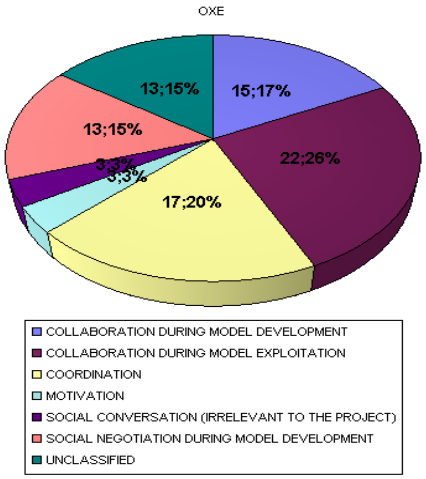


Figure 15. Chat message distribution to the main categories for case 2.

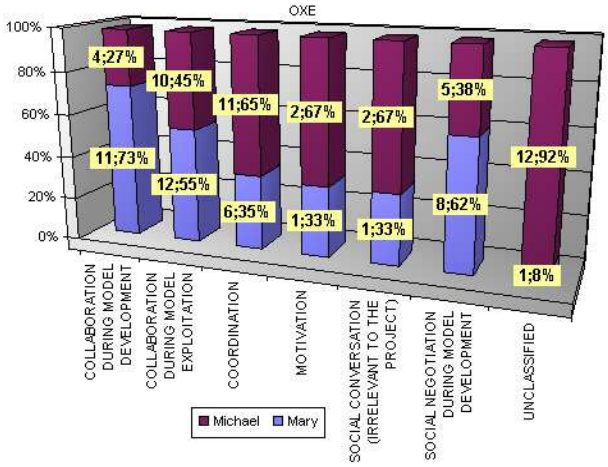


Figure 16. Distribution of messages to the main categories and agent for case 2.

C. Distribution of category 2 (COLLABORATION DURING MODEL DEVELOPMENT) messages to subcategories

At Figure 17 there is the distribution of category 2 messages to the corresponding subcategories. Category 2 subcategories give as information about the kind of project management that we had in the activity. In contrast to the case 1 we have very low percentages of auditing and planning. Planning is indirectly implemented through assignment but auditing is rather a function that nobody is responsible or conscious of.

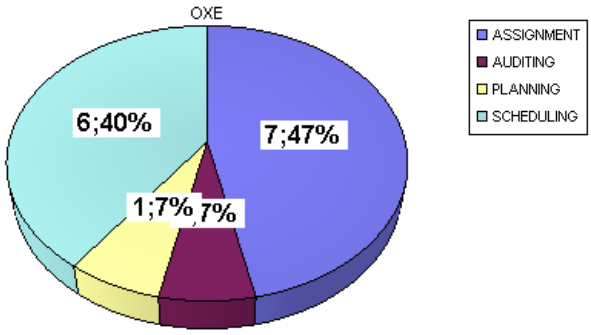


Figure 17. Distribution of category 2 messaged for case 2.

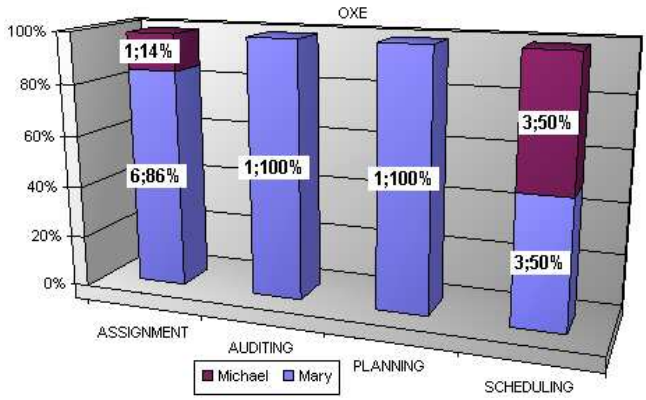


Figure 18. Distribution of category 2 messages to subcategories and agent for case 2.

D. Distribution of category 2 (COLLABORATION DURING MODEL DEVELOPMENT) messages to subcategories and agent

Observing Figure 18 with the distribution of the category 2 messages to the agents we can estimate the managerial role and style of them. Mary's dominance is obvious. Mary is the main manager but Michael contributes in scheduling. There is not auditor and the planning is implemented through assignment.

E. MCA of the beginning and ending modes of social negotiations episodes and agents-STUDENTS, during model development and model exploitation.

We can see, observing Figure 19, that when students are collaborating without teachers' presence, most of the characteristics of their SNs are the same. Most of the social negotiations during model development start with a question and less often with a statement or a disagreement. It worth to notice that if a social negotiation starts with a disagreement then it usually terminates by calling a third negotiator, in our case the teacher. Also, when a SN start with a statement it usually ends up with a compromising.

During model exploitation SN start with a request for hypothesis verification or with a hypothesis statement-declaration and terminates with agreement. During this phase we have also the situation that a social negotiation terminates by calling the teacher (negotiator) and is associated with hypothesis statement.

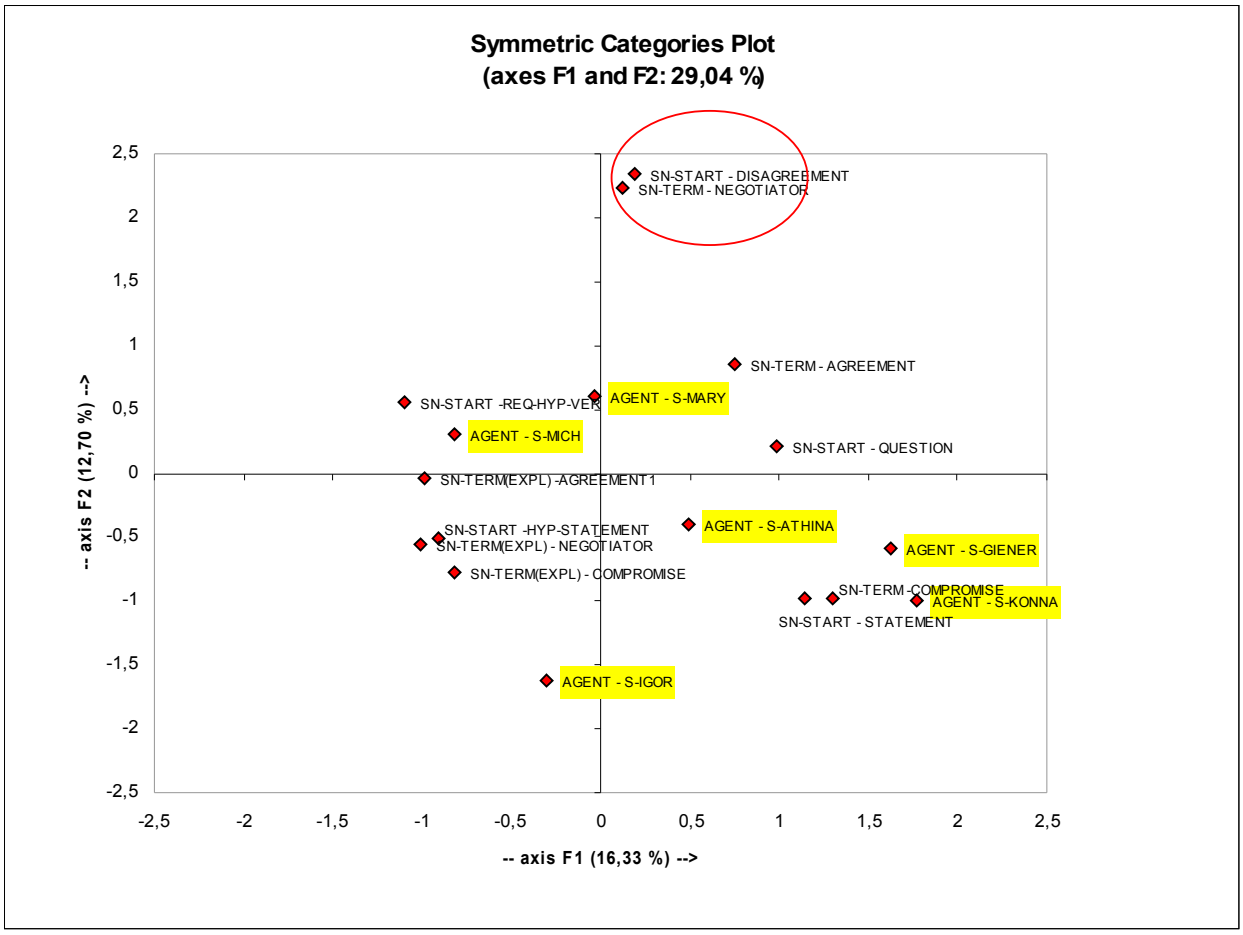


Figure 19. Factorial analysis of the beginning and ending modes of Social Negotiations (SN) episodes and agents-students that trigger the SNs, during model development and model exploitation.

5. CONCLUSIONS

[A] The previous research results showed that the implementation of SCMCA appeared meaningful to the participants, given that:

(a) Students were highly motivated:

- Students participated actively during the whole sessions (actions based analysis over time)

- Students out of task messages were less of 5%, in all the cases
- Teachers affirm that almost all of their students were highly concentrated during the sessions, situation difficult to be achieved during traditional courses.

(b) Participants' opinion were positive: As far as the students opinion is concerned, they believe that this approach valuable since it gives possibilities for better collaboration and communication, find this mode of working attractive and believe that computer supported collaborative learning is appropriate to be applied at school lessons. Teachers' point of view about collaboration among collocated students is positive since: (a) students are motivated, something that is proved according to their opinion by the inexistence of off-task messages and students' positive attitude, (b) unlike to face-to-face collaboration students' dialogues and actions are available.

[B] Concerning the quality of collaboration and activity process:

- Students in synchronous collaborative modelling, (via MODELLINGSPACE) produce rich expressions, as well as argumentative actions.
- Students trigger social negotiation situations during model development as well as during problem solving phase in both modes.
- When teacher participates in the collaboration it more possible a social negotiation to terminate with compromise.
- When students collaborate without teacher it is possible to call teacher as an external negotiator in case of disagreement.
- Different students and teachers can vary significantly according their style in social negotiation participation.

6. DISCUSSION

In this paper we have explored Synchronous Computer Supported Mediated Collaborative Activities with collocated participants. We have argued that this setting is possible to be implemented in selected time points of the course evolution; students are highly motivated and have the opportunity to engage in high learning quality social negotiation; teachers appreciate the diagnostic opportunities that are raised by the collaboration analysis tools available.

The analysis of the current research will be continued in order to exploit the significant new aspects of teachers' role that have been revealed. The analysis will be reported when completed. Additionally, the exploitation of mobile technologies could be further examined in SCMCA in order to permit a more convenient and integrated approach in the typical classroom.

7. REFERENCES

Baker, M., Erica de Vries, Lund, K., Quignard, M. (2001). Interactions épistémiques médiatisées par ordinateur pour l'apprentissage des sciences : bilan de recherches. *Sciences et Techniques Educatives - EIAO'01, 8*, 21-32.

Baker, M. J. & Lund, K. (1996). Flexibly structuring the interaction in a CSCL environment. In P. Brna, A. Paiva & J. Self (editors), *Proceedings of the European Conference on Artificial Intelligence in Education* (pages 401-407). Lisbon, Portugal.

Chi M., T., H, Glaser R., and Rees E. (1982). Expertise in problem solving. In R.J. Sternberg (Ed). *Advances in psychology of human intelligence* (Vol 1) Hillsdale N.J. Erlbaum.

Constantino-Gonzalez, M., Suthers, D.d., Icaza I.J. (2001). Coaching Web-based Collaborative Learning based on Problem Solution Differences and Participation, In *Artificial Intelligence in Education: AI-ED in the Wired and Wireless Future (Proc. AI&ED 2001),* J.D. Moore, C.L. Redfield, & W. Lewis Johnson, Eds., IOS Press, 2001, pp 176-187.

DiSessa, A. (1988). Knowledge in pieces. In G.Forman, & P.Pufall, (Eds). *Constructivism in the Computer age.* Hillsdale N., J., Lawrence Erlbaum.

Driver, R. (1989) Students' conceptions and the learning of science. *Int. J. Sci. Educ* Vol.11, Special Issue, 481-490.

Fesakis, G., Petrou, A., Dimitracopoulou, A. (2004). *Collaboration Activity Function : An Interaction Analysis Tool for Computer Supported Collaborative Learning Activities*. In Kinshuk, et all (eds). 4th IEEE International Conference on Advanced Learning Technologies (ICALT 2004), August 30 - Sept 1, 2004, Joensuu, Finland, pp. 196-201.

McManus, M.M. and Aiken, R.M. (1995). Monitoring Computer Based Collaborative Problem Solving, *International Journal of Artificial Intelligence in Education*, 6(4): 308-336.

Viennot, L. (1985). Analysing students' reasoning in science : a pragmatic view of theoretical problems. *European Journal of Science Education*. Vol. 7 (2). 151-162.

Vosniadou S. (1994a). Capturing and modelling conceptual change. *Learning and Instruction*. Vol.4, pp. 45-69.

Vosniadou S. (1994b). From cognitive theory to educational technology. In S. Vosniadou, E. De Corte, H. Mandl (Eds.), *Technology-Based Learning Environments: Psychological and Educational Foundations,* NATO ASI Serie F : Computer and Systems Sciences, Vol. 137, pp.11-18. (Springer Verlag).

Wu A., Farrell, R., Singley M. (2002). Scaffolding group learning in a Collaborative Networked Environment. In G. Stahl (ed). *Proceedings of Computer Support for Collaborative Learning, CSCL 2002,* congress, Colorado, January 7-11 2002., pp. 245-255., LEA, NJ,, USA.