Structuring time and task in online collaboration activities: A case study for teaching ER modeling using LAMS and Synergo

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Δομώντας το χρόνο και την εργασία σε πραγματικού χρόνου συνεργατικές δραστηριότητες: Μια μελέτη περίπτωσης για τη διδασκαλία Διαγραμμάτων Οντοτήτων-Συσχετίσεων χρησιμοποιώντας το LAMS και το Synergo

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Abstract
The majority of existing Learning Management Systems (LMS) support collaborative learning through unstructured, general purpose collaboration workspaces that provide educators with semantically poor low-level data about learners' interactions. Educators in turn, labour to process and interpret this kind of data, and consequently, are not able to intervene effectively in the collaboration process.
To overcome this limitation, we used Learning Activity Management System (LAMS), an activity-based LMS, integrating in it some activities to be implemented with Synergo, a collaborative concept mapping specific tool with a structured interface. A case study of using this compound learning environment is presented in this paper.
This case study is used to investigate what will be the benefit for educators and learners from such an approach. In this context we designed a particular collaboration script to also test the hypothesis that scripts support the acquisition of cognitive skills.
A pre-test for validity and reliability of the script has been performed in order to understand and experiment with the technical's aspects of the integration of the two e-learning collaborative systems and to investigate the students' opinions.

Περίληψη
Τα περισσότερα Συστήματα Διαχείρισης Μάθησης (ΣΔΜ) υποστηρίζουν τη δημιουργία δραστηριοτήτων για συνεργατική μάθηση κυρίως μέσω εργαλείων δραστηριοτήτων γενικού σκοπού (π.χ. chat, mind map) και αδόμητων σεναρίων μάθησης. Τα ΣΔΜ αυτά, αν και διευκολύνουν τη συνεργασία, δεν παρέχουν στους εκπαιδευτικούς τα εξειδικευμένα εργαλεία και πληροφορίες για την σημασιολογική ανάλυση των αλληλεπιδράσεων των εκπαιδευομένων, γεγονός που δυσχεραίνει αποτελεσματικότερη υποστήριξή τους.

Σε αυτή την εργασία παρουσιάζεται μια μελέτη περίπτωσης που έγινε για τον προ-έλεγχο της αξιοπιστίας και εγκυρότητας του σχεδιασμού ενός μαθήματος στο Σύστημα Διαχείρισης Μαθησιακών Δραστηριοτήτων (LAMS) με αξιοποίηση του εξειδικευμένου εργαλείου συνεργασίας Synergo. Σκοπός αυτής της προσπάθειας είναι να διερευνηθούν τα οφέλη και οι δυσκολίες από αυτή την προσέγγιση για τους μαθητές και τους εκπαιδευτικούς. Αν και απαιτείται σημαντικός χρόνος για την ανάλυση των δεδομένων συνεργασίας λόγω των δυσκολιών αυτοματοποιημένης επεξεργασίας και παροχής δεδομένων σε πραγματικό χρόνο, διαπιστώθηκε ότι με τον κατάλληλο σχεδιασμό, οι παρεχόμενες πληροφορίες και τα εργαλεία ανάλυσης που διαθέτει το Synergo διευκολύνουν σημαντικά το έργο του εκπαιδευτικού και τη συνεργασία των μαθητών. Η μελλοντική πιθανή ενσωμάτωση του Synergo στο LAMS ή η ανάπτυξη ανάλογων εργαλείων στο περιβάλλον του LAMS θα αποτελέσει ένα σημαντικό βήμα στην εξέλιξη αυτών των συστημάτων.

Key-words: *Scripted Collaborative Learning, LAMS, Synergo,*

Introduction

The research reported here refers to the wider area of *Technology-Enhanced Learning* (TEL) that studies how digital technology may be used for supporting learning.

Various technology learning approaches have been applied to support problem solving. *Scripted Collaboration Learning* appears as one promising instruction model in this area, as the scripts used are expected to be able to specify the cognitive activities that learners are motivated to engage in.

A key feature that distinguishes collaborative learning from individual and competitive learning is its social nature. Students interact and share their ideas to improve both their individual and mutual understanding, to solve problems cooperatively, and to complete their joint tasks. Dillenbourg and Schneider (1995) make a distinction between cooperative and collaborative learning. They indicate that cooperative learning is *"... a protocol in which the task is in advance split into subtasks that the partners solve independently"*, while collaborative learning describes situations *"... in which two or more subjects build together a joint solution to some problem"* (p. 110). So in effect, collaborative learning is a situation in which two or more people learn or attempt to learn something together (Dillenbourg, 1999). Unlike individual learning, people engaged in collaborative learning capitalize on one another's resources and skills (by asking one another for information, evaluating one another's ideas, monitoring one another's work, etc.) (Chiu, 2000; 2008). More specifically, collaborative learning is based on the assumption that knowledge can be created within a community where members actively interact by sharing experiences and take on asymmetrical roles (Mitnik etal, 2009). A learner needs to use specific methodologies and environments which engage them in a common task where each individual depends on and is accountable to each other. These include both face-to-face conversations and computer based discussions (online forums, chat rooms, etc.).

However unstructured interactions do not necessarily enforce learning. One way to enhance the effectiveness of collaborative learning is to structure interactions by engaging students in well-defined scripts of action. A script is a sequence of phases and each phase can be described by attributes (Dilllenbourg, 2002). *A collaboration script* is a set of instructions prescribing how students should form groups, how they should interact and collaborate and how they should solve the problem. The need for using scripts emerges from the fact that collaborative learning is a complex process where it is very difficult – if not impossible – for the instructor to consider all

interacting parameters in order to foster productive learning experiences (Dillenbourg etal, 1995). Instead, it is suggested that the instructor guides the learners' interactions within the group, by implementing an appropriate structure (O'Donnell etal, 1992). By this way the probability of productive student to student and student to teacher learning interactions are being increased. Scripting collaborative learning has commonly been reported to result in improved learning outcomes (Hertz-Lazarowitz & Miller, 1992; Rummel & Spada, 2007; Kollar etal, 2005; Weinberger etal, 2002).

There are various technologies that can be employed to support students and faculty members in deploying collaborative learning experiences. Online collaboration platforms are a general "catch all" term to describe a range of internet based tools that allow learners to do things together online. This may include online conversations in forums and email lists, co-creation of documents on wikis, file sharing and storing, etc. Several of these tools now are being available in the majority of Learning Management Systems (LMS) like Blackboard, Collage, LAMS, Moodle, Sakai, etc

Such tools provide a range of services for designing, managing and delivering online collaborative learning activities in addition to authoring environments for creating sequences of learning activities. Most of the LMS provide a lot of collaboration and communication tools to support information sharing and communication between learners in a course and by these enable collaborative learning. Some of them support unstructured collaboration spaces that group course participants and offer an open interface for communication and sharing of knowledge and experiences. (Talavera & Gaudioso, 2004).

LAMS in particular, as discussed in the next section, makes use of the so called *workflows* or *lesson plans* in order to help teachers to organize successful educational scenarios.

The Learning Activity Management System (LAMS)

LAMS (http://www.lamsfoundation.org/ is an e-learning system for authoring, managing and delivering online collaborative learning activities. It has the power to represent in a complete and functional way different activity structuring techniques. It provides the appropriate support to develop a collaboration approach through shared workspaces, wiki editing and other communication tools, such as forums and chats, where group members can exchange ideas and make progress in developing activities collaboratively (Dazliel, 2003).

However many of LAMS tools that support synchronous and asynchronous collaboration provide only quantitative characteristics and cannot offer to teachers the appropriate indicators to measure the quality of collaboration (Papadakis and Paschalis, 2010). There is consequently a need in LAMS, of a structured shared workspace for creating task-specific collaborative activities, with integrated drawing and communication tools for learners, and corresponding analysis and monitoring tools that would provide educators with high-level data about the collaboration process. Some of these features are being supported by Synergo, as it is presented next.

The Synergo

The Synergo environment (www.ee.upatras.gr/hci/synergo) is a client-server distributed application, which comprises a suite of interconnected tools to support collaborative drawing and sketching activities. It consists of the Synergo Client, a collaborative diagram building tool and an Analysis tool that aids students' reflection and helps the teacher to monitor the collaboration process.

Synergo client supports synchronous collaborative building of diagrammatic representations by small groups of students. Synergo supports building of different kinds of diagrams. It contains libraries for building flowcharts, entity-relationship diagrams, concept maps, data flow diagrams etc. On the other hand, the Synergo Analysis tool supports the analysis and supervision of the activity.

The main functionality of the Analysis tool is the presentation and processing of logfiles which have been produced during group activities. These logfiles contain actions and exchanged messages of group members, in sequential order. The logfile is based on the same format of the exchanged control and chat messages and is stored in XML form. This file can be viewed, commended and annotated by a researcher using an adequate analysis framework (Avouris etal, 2004). A related functionality of the analysis tool is its capability of post reproduction of the modeling activity, using the logfile, in a step by step or continuous way using the playback tool. Further annotation of activity logs through this playback tool can also be done, as discussed in more detail in (Avouris etal, 2003).

Combining LAMS and Synergo

From case studies during teaching in tertiary education in our country using LAMS (Paschalis & Papadakis, 2009; Papadakis & Paschalis, 2009), it was observed that synchronous collaboration tools of LAMS (chat, instant messaging, concept mapping) do not cover in a satisfactory way the requirements of students and teachers. So, it was observed that existing LAMS tools do not provide students with the capability to design specific symbolic representations like UML flowcharts, ERDs etc.

The Mindmap tool of LAMS is suitable for designing mind maps learning activities, through synchronous interactions of distant partners, but it lacks of a specific toolbox for designing other symbolic diagrams. On the other hand, LAMS provides an application for monitoring the learning process in a sequence of learning activities and a gradebook tool for evaluating the performance of the students. But, it does not provide teacher with high-level indicators for the evaluation of the process in collaborative activities. For example, the learner's dialogs in the Chat tool of LAMS are not associated with logfiles and their corresponding actions in MindMap tool. Consequently in LAMS does not exist a structured shared workspace for creating task-specific collaborative activities, with integral drawing and communication tools for learners, and corresponding analysis and monitoring tools that would provide educators with high-level data about the collaboration process.

Synergo on the other hand, is a tool that provides these capabilities, but it does not support scripted collaboration. More specifically, it allows learners to collaborate in the creation of UML of diagrams in a shared desktop using a specific toolbox and a chat tool only for concrete instance of collaboration. Moreover, Synergo incorporates an Analysis Tool, which logs and synchronizes data from student's actions and interactions in the workspace and in the chat. It also provides the supervisor with the capability to define suitable indicators for analyzing and evaluating the collaboration.

For these reasons, it was considered desirable to use these two tools as an intergraded learning environment, as it is discussed next.

Aim and Objectives

The aim of this effort is to investigate possible benefits for educators and learners of using Synergo as an external tool in LAMS for structuring, in terms of task and time, problem solving activities related to ER modeling. In this way, we intend to overcome the lack of such specific collaborative tool in LAMS and of analysis capabilities.

Our objective is to use this example as a mean for further understanding integrated learning technologies that support collaborative learning and in particular technologies that support scripted collaborative learning in student project work.

The results of collaboration analysis are proposed to be used as an aid for the supervisor in next stages of the activity by either helping him to send suitable feedback messages to the students or by supporting him in redesigning the activities in order to improve collaboration and the learning outcome.

A pre-test for validity and reliability of the script has been performed in order to understand and experiment with the technical's aspects of the integration of the two e-learning collaborative systems and to get a first feedback from the students.

A case study of LAMS and Synergo based collaborative activity: Development of a Collaborative Learning Model

In order to achieve the objectives discussed above, we conducted a pre-study that concerns with the development and testing of collaborative activities designed using Synergo, within a lesson for Database Design that will be implemented in LAMS. This study is conducted in a higher-education institution, as part of the undergraduate program. It involves four phases of computer-mediated collaborative problems-solving activities.

More specifically, the proposed script's collaborative activities are studied by involving the students of Computer Science Sector of the Department of Electrical and Computer Engineering of the University of Patras, Greece. The students are engaged in jointly building the diagrammatic representation of a given database design problem in a two-hour laboratory session. These activities have been taken place in a single laboratory room, equipped with one computer per student. The problem given is to make the Entity Relationship Diagram (ERD) of a database for the University, i.e. a diagrammatic representation of the basic entities and their relationships in the world of a University.

The laboratory sessions concerning ER-Modeling were waged in previous academic years by using Synergo as an environment for the students for implementing ER diagrams collaboratively. Analysis Tool has been used by the supervisors for the evaluation of the groups and their members. From our previous teaching experience of the course we verified the necessity for a more structured learning and collaborative process which could be aid to a better analysis and evaluation of the students.

For the needs of the study, the students are divided in two teams of 20 students each: a) the Experimental team, which is engaged in a collaborative learning process scripted in four phases in LAMS using Synergo as an external tool for collaboration and b) the Control team in which the teaching is also supported by LAMS and Synergo, but in a single phase. The effect of the integration of the two environments and using a more structured approach is studied this way.

The Activity Flow of the Course

The proposed learning flow for the course is based on a combination of different known *collaborative learning flow patterns (CLFPs)* and cooperative learning phases. As the underlying strategy is problem-based learning, the overall structure lead user activities to a global goal which consists of individual phases and subtasks that are carried out using several tools of LAMS and Synergo.

The sequence of learning activities is consists of the following phases: a) Pairs formation and group work proposal following to the structure of the "Peer-reviewing" CLFP, b) Individual subproblem proposal solution from each student, c) Return to the

original groups and reviewing the subsolutions, d) Group report for a unified solution. The last two phases are structured according to a CLFP which is a variation of the *Thinking Aloud Pair Problem Solving (TAPPS)* collaborative learning strategy.

An abstract overview of the learning flow is depicted in Figure 1, which shows the UML activity diagram of the activity flow.
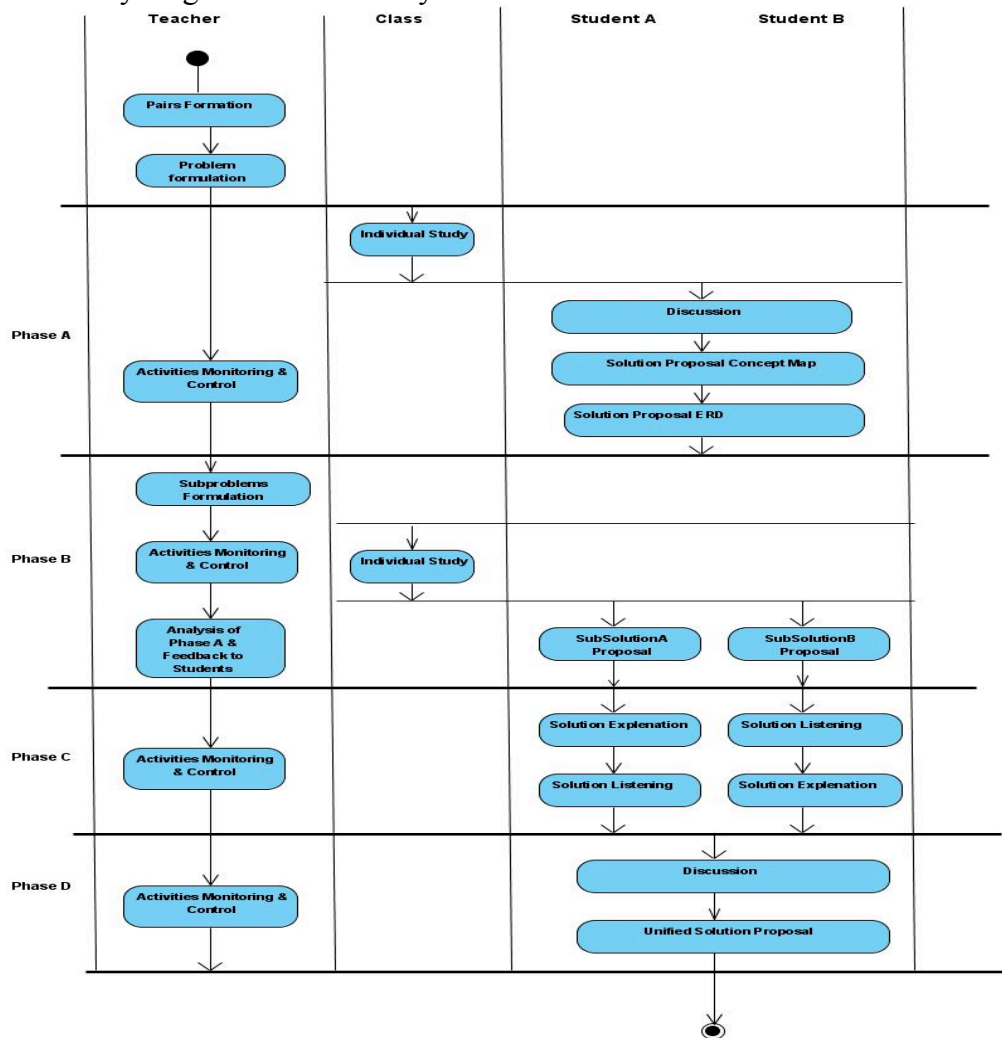

Figure 1: The diagram of the activity flow of the course

The phases, the tasks and the tools of the course

The learning design of the lesson, according to the structure introduced in the previous section, has been implemented in LAMS where we have defined the tasks, the scheduling and the grouping of the activity (Figure 2). In this case study, Synergo is used as external tool in LAMS in order to provide students with a shared desktop space for collaboratively designing the ERD of the given problem. The Analysis Tool of Synergo is also used in order to provide the instructor with the ability to monitor the collaboration through the actions and the discussions of the students. This tool provides visualization of various quantitative parameters, like density of interaction, symmetry of partners' activity, degree of collaboration etc, particularly useful for understanding the mechanics of collaboration. Using this tool, the instructor could evaluate the collaboration that has been contacted in the groups, and after that he could give future directions to the students through the *Instant Messaging* application of LAMS or reconfigure groups via the Live Edit facility of LAMS.

The students that participate in the experimental team, after the general directions given from the instructor, form pairs and they work (collaboratively or individually) in four phases, as discussed above. After each phase they are evaluated both for the way they collaborate and also for the quality of the solution they give. The learning design of the sequence implementation with LAMS is shown in figure 2.
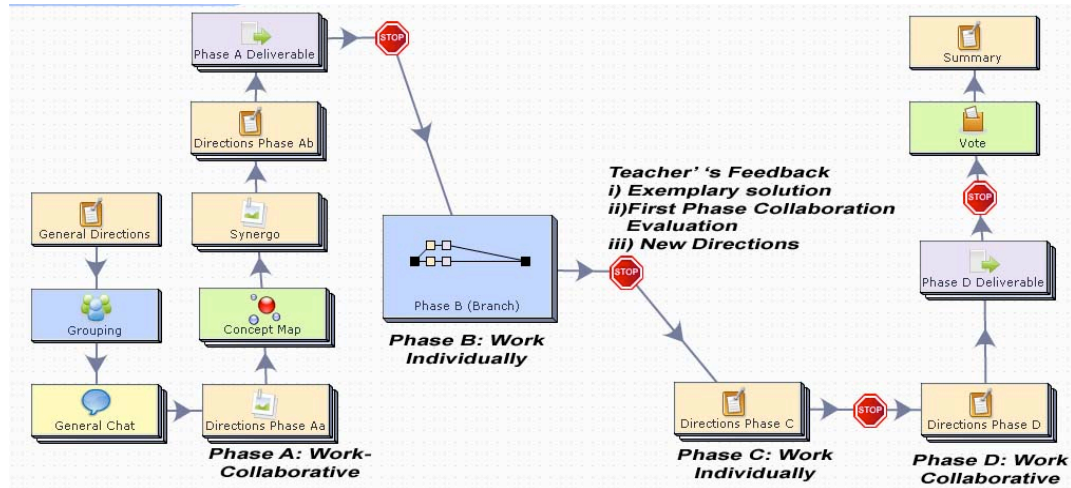

Figure 2: LAMS experimental team's sequence.

At the beginning the students have to read general directions about the way they have to work and collaborate, using Synergo. Next they are been assigned to pairs and start a collaborative session, in which they are asked to create the part of ERD according to the basic concepts that have been given to them in the real world problem description (phase A).

In this phase the students as members of a team have to collaborate for 40 minutes in order to recognize and design the entities that are related with the first part of the given problem, taking information from the description that has been given to them describing a real world situation. They use Concept Map and Chat tools of LAMS at this phase. In addition, they should be able to recognize the cross-relations between the entities and design using Synergo's shared desktop, creating with this way an Entity Relation Diagram (ERD) that corresponds to the given description. So, they use Synergo and its integrated chat tool.

Before the phase B, the supervisor logs all learners' activities using Synergo Analysis Tool in order to evaluate them. Based on its conclusion the instructor gave suitable directions for better and more efficient student's collaboration. More specifically, the instructor observed each team's work in order to evaluate collaboration in the learning environments of LAMS and in Synergo. He evaluated the quality of the final solution, and then he shared an exemplary solution to them.

In phase B (available time: 30 minutes), each learner works individually to solve a given sub-problem. Members have separate roles (figure 3) as they are asked to work on two different subtasks. The first member of the group is assigned to design individually one part of the ERD and the second member of the group another part. At the end of this phase the instructor will evaluate the quality of these individual solutions.
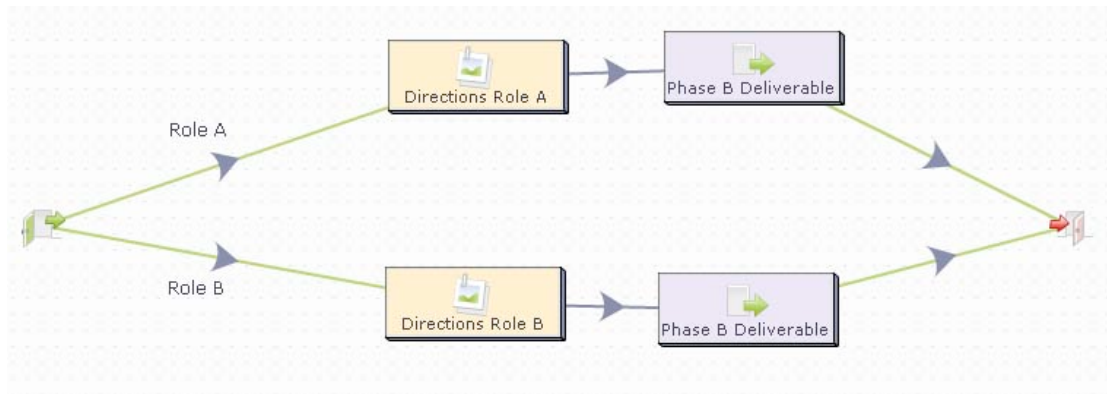
Figure 3: Phase B branch with different roles for each dyad member.

In phase C which lasts for 25 minutes, each member of the group is asked to inspect his or her partner's solution. They asked to explain their solution to each other and try to detect possible errors and propose corrections in the partner's diagram. The first half of the available time of this phase is dedicated for commenting the part that has created by the first partner and the other half by the other. At the end of this phase the instructor needs to evaluate the development of critical reflection and meta-cognitive student's skills.

In phase D (available time: 15 minutes), the group members are asked to converge and produce a single diagram unifying the diagram parts that were developed by the each group member separately at the previous phase, simplifying or increasing the individual diagram, getting rid of redundant entities or adding new entities or new relations.

On the other hand the students of the Control team work in pairs in order to create the same ERD for the same problem as Experimental team's members, however without the structure presented here. They also use Synergo, but they work in a single phase (figure 4).
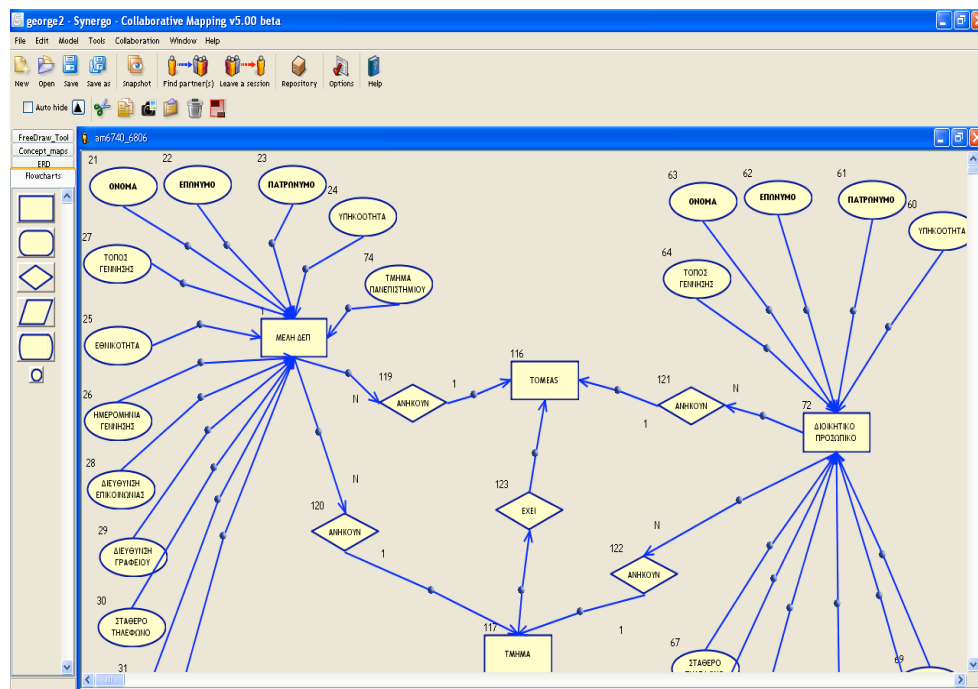

Figure 4: Control team's Synergo Instance.

Empirical Study
Methodology
Collaborative activities designed and studied in this article in the full scale experimental study are going to involve 40 to 50 undergraduate students. The course concerned has in total 8 two-hour laboratories sessions. The first two sessions deal with ER-Modeling. Before applying the collaborative learning script, presented here, in full scale, we liked to implement a trial session of the script to test in laboratory's practice the collaborative learning supported by the integration of two collaborative environments, LAMS and Synergo. The feedback will be used to design more effectively the activity flow of the laboratory session and also to detect possible technical problems.

We also tried to verify the previous assumption and to explore the participant's experience and their personal beliefs about collaborative learning in practice and also about their previous experience in databases and programming languages.

For this reason a questionnaire was distributed among the students, before the start of the trial session, which had been authored following a multifaceted approach, combining qualitative and quantitative data. The quantitative data were collected through a compiled questionnaire that was given to each participant at the beginning of first laboratory session. The questionnaire was constructed taking into consideration theoretical assumptions of multiple literature perspectives (Gillham, 2000; Oppenheim, 1992; Sapsford, 1999), in order to clarify certain goals. The questionnaire included two sections: One recording the attendees' profile, such as gender, age, previous experience in ER-modelling and programming languages and one which concerned participant's attitude about collaborative learning. Qualitative data were recorded through follow-up observation data during the whole procedure, and individual face-to-face conversations with some attendees who were randomly selected.

From 43 total students 38 replied to our questionnaire. 34 were male (89%) and four female (11%). Twenty eight of them (74%) were in their fourth year of studies and the other 10 (26%) were in their fifth year. Home internet access for 97% and internet use at the university for all of them (100%). All of them had been taught programming languages during their previous years of studies with most programming skills related to C, Java and JavaScript. Regarding their acquaintance with the course subject, most of them had not previous experience with designing, implementing and handling databases. 41% had not used any Database Management System before, 20% had used Microsoft Access, 20% mysql and 12% SQL Server and 7% other.

Concerning their attitude towards collaborative learning, 87% had worked collaboratively during exercises and projects in previous years. 77% of them agree that collaborative learning has important advantages compared to the traditional teaching approaches or individual work in the laboratories. They agree that it can be beneficial for problem solving (90%), in in-depth knowledge of critical concepts and development of cognitive skills (69%) and in the development of collaboration and group work skills that could be important in their future working life (90%). Also, 81% of them wanted a more structured aproach during the laboratory exercises in order to better handle the available time. Student's positive attitude towards Collaborative Learning in the questionnaire amplified our intension for the scripted approach to collaborative learning.

Next we started the implementation of a first trial session by applying the learning script that we had designed in LAMs and Synergo, in 3 groups of two participants, while 4 students worked individually. Students, who participated in the trial session,

were volunteers who informed about the aim and the content of the experiment about a week ago. The results of the learning process and the analysis and evaluation of the problems that were observed helped us to reorganize the process and reshape the script as further discussed in the next section.

Findings of the Empirical Study

A trial session for our collaboration script was implemented using LAMS and Synergo in order to test the main hypothesis of this research in a smaller group of students than the target group. Ten volunteer students took part in our study. 6 students formed pairs and executed the four-phase scripted sequence (experimental team), and the other 4 students executed the Control's team working in pairs only with Synergo.

After the conclusion of the trial session, the experimental team's students answered to a draft questionnaire that they found very constructive working in separate phases with particular subtasks to have completed in exact time from each one. As they mentioned, this enabled them to distribute their time more efficiently according the scheduling of the script. Almost all students agreed that the available time for each phase was adequate. They mentioned, also, that they liked the fact that some of the activities were collaborative and some individual. The activity they liked most was this in phace C, in which each partner inspected the other's solution proposal.

They also found LAMS' environment very friendly. Some of them suggested it as a suitable tool for distance learning experiences that could replace the physical presence of the student in the laboratory.

Students mentioned that they wanted to have a detailed description of the given task and of the way they will work at least one day before the laboratory session, to have time to get prepared for this process.

The three teachers that were engaged in the process as supervisors wrote their remarks for this learning experience in a draft report. Their main remarks were: a) the use of Synergo overcame successfully the lack of LAMS for a collaborative tool to formalize UML diagrams. Also, they found that the incorporated Analysis tool of Synergo provided them with the capability to observe and evaluate efficiently the collaboration. b) LAMS proved an adequate tool to apply scripted learning which enabled them to apply the pre-mentioned script as exact they had designed it. c) They found very useful LAMS' monitoring environment for each student progress but they pointed out the need for an intelligent module for supervising the whole learning process. d) Instant Messaging tool of LAMS was used a lot by the teachers to give feedback to the students. Stop Gates of LAMS assisted them to stop the learning process in crucial points of the sequence (figure 5).

A screenshot from Synergo Analysis Tool Environment in which student's movements and collaboration indices have been computed and described, are shown in figure 6. Having seeing, in the particular screenshot, that one partner executed 71% of the actions while the other executed only the 28% of them, the supervisor could encourage student with less participation, by adequate messages.

Figure 5: LAMS Monitoring Environment: Stop Gate

Supervisors mentioned that Synergo Analysis Tool also supported them, with many
useful indicators in order to evaluate first phase's collaboration and give appropriate
feedback.
So the results of the collaboration analysis based on Synergo Analysis Tool are going
to be used as a feedback for the supervisor in the following collaborative phases by
either aiding him to produce suitable messages to the users or by redesigning the
activities of the ER modelling lesson in LAMS, in order to promote the collaboration
and the learning outcomes.
Finally, some technical problems occurred regarding Synergo Relay Server's (SRS)
operation. All these problems have to be checked to find solutions before we apply the
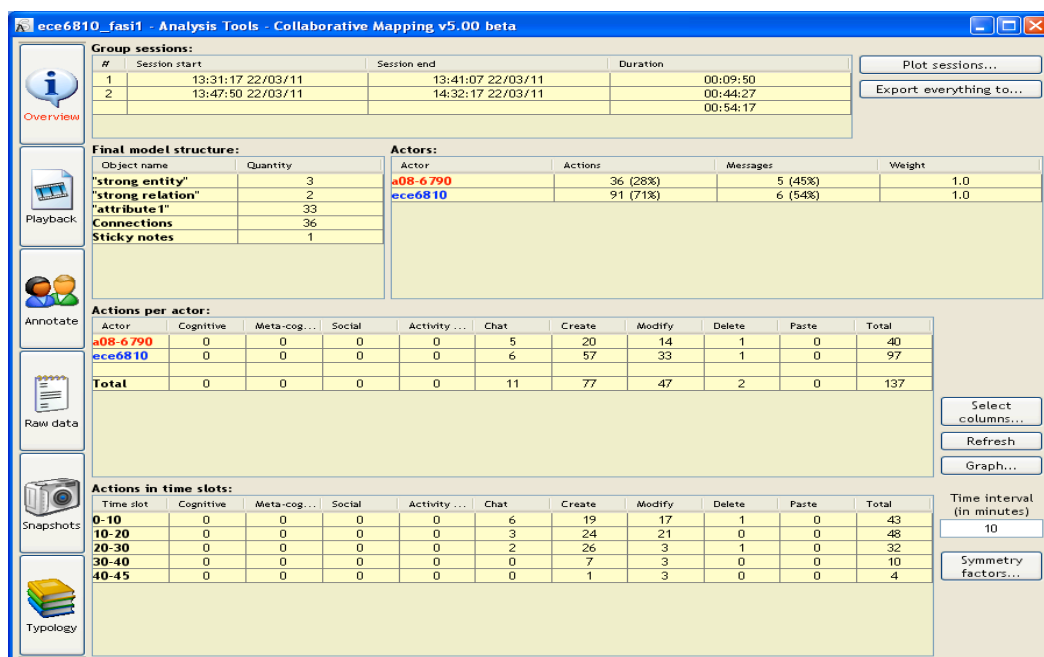specific LAMS Sequence to the whole classroom.

Figure 6: Screenshots from Synergo Analysis tool Environment in which shown students
Collaboration indexes.

Conclusions

In this paper we tried to investigate what benefits for educators and students could arise from the use of Synergo, a collaborative tool environment specific to concept mapping, in the activity-based Learning Activity Management System (LAMS).

We designed a particular collaboration script to test the hypothesis that scripts can promote the acquisition of cognitive skills and a pre-test of this script was performed in order to: test the validity and reliability of the script, to understand and experiment with the technical's aspects of the integration of the two e-learning collaborative systems and finally to investigate the students' feedback about the collaboration script.

A pre-test small case evaluation showed that Synergo integration as an external tool in LAMS for structuring a lesson for ER modeling in task and time, overcame the lack of LAMS of a collaborative tool specific to that domain. LAMS provided teachers with many capabilities such as: to design and run the script, to monitor the student's interactions to direct suitable messages or to redesign on line the collaboration script. Synergo on the other hand, offered to the learners a shared desktop and a specific toolbox to design collaboratively ER diagrams while provided teachers with useful collaboration information in order to supervise more efficiently the collaboration process.

Future Work

We intend to apply the previously described collaborative learning script (sequences) to a whole class, taken into account the points and the problems that occurred to the students during the trial session. We are going to evaluate student's solution proposals of each phase and also the collaboration that has been occurred. Finally by comparing these experimental team's grades with the corresponding grades of the control team we will produce experimental results to test if Scripted Collaborative Learning has positive infection to student's conception to a new cognitive object. We also intend to examine the needed effort and the benefits of incorporating Synergo as a special tool in LAMS.

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