Synchronous Collaboration in Distance Education: A Case Study on a Computer Science Course

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Abstract

This paper describes our experience with introduction of synchronous collaborative problem solving activities in the frame of a distance learning computer science undergraduate course of the Hellenic Open University (HOU). Groups of students worked collaboratively at a distance in order to build a flowchart of an algorithm to a given problem. The technological and organization issues involved, the first findings of analysis of peer students interaction during this study, as well as some general implications for distance education are discussed.

1. Introduction

Synchronous interaction and collaboration of students in distance education is very difficult for a number of technical and organizational reasons. For many, synchronous interaction is considered mainly synonymous to video-mediated tele-conferencing (e.g. [4], [7]), an approach that necessitates high bandwidth connections and special equipment, not widely available to the students of distance education.

New technological advances in peer-to-peer (p2p) computing propose an alternative synchronous interaction approach, which, as argued in this paper, is feasible to be implemented and used with the current commonly available infrastructure. So, an alternative approach for synchronous collaboration is the use of low-bandwidth text-based communication facilities and shared drawing boards implemented over peer-to-peer interaction protocols. According to Lethin [9], the technical advantages of such an approach are related to fault tolerance, performance, and security, while as a result, new person-to-person interaction structures may emerge (Lopez and Skarmeta [10]). However, development of an effective peer-to-peer facility for open and distance learning (ODL) involves tackling serious technical, educational and social challenges, as also discussed by Haake et al. [6] who conducted a similar experiment in the German Distant Learning University of Hagen.

The pilot study discussed in this paper involved setting up a technological infrastructure and making it available to students of a distance course of the Hellenic Open University. Through this facility, the students could interact in a synchronous way in pairs in order to work on a given assignment involving collaborative building of a flowchart. An analysis of the history of their interaction through server logs has revealed interesting patterns in relation to balance of activity between pair members, peer learning and support, while study of the chat dialogues provided us with an insight on the social implications of this approach for the isolated students of this distance-education establishment.

In this paper, first we provide a brief description of the deployed infrastructure. Then we describe the context of the study and outline the main findings. Finally, we discuss the implications of this work for open and distance learning settings.

2. Infrastructure for synchronous ODL

The students of Computer Science courses of the Hellenic Open University interact very rarely with each other. They interact mainly with their tutors to whom they submit assigned exercises and to whom they address for advice and tutoring on their studies, while occasionally they meet in face-to-face meetings in small groups of up to 30 persons. Asynchronous interaction through an ODL server in the form of a student forum also takes place. However, the off-task interaction within this facility is very sporadic. Synchronous distance interaction has been used occasionally in experimental basis through tele-lecturing, involving however no peer-interaction.

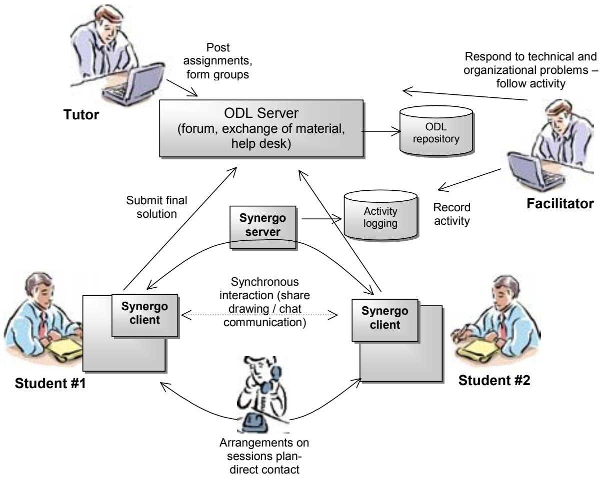

Fig 1. Main actors and components

Peer interaction and collaboration is considered beneficial for improving learning and increasing community cohesion in this context. However, its wide application needs to take in consideration constraints on bandwidth, restrictions on p2p protocols by firewalls and proxy servers, while a considerable new infrastructure should be established and organizational adjustments should be effected.

In the context of the reported study, we attempted to tackle these problems and setup and use a facility on top of the existing infrastructure. The setting of this experiment is described in fig.1 were the main components are shown together with the main actors that took part in the reported study (tutor, facilitator and students). For this purpose, we used a technological framework facilitating peer-to-peer interaction, which supports collaborative activities of partners at a distance over low-bandwidth connections. This framework, which has evolved through our work in ModelsCreator3 [5] and ModellingSpace [1], [2], has been used as the underlying architecture of a new application (Synergo), specially designed for this experiment. This application permits building and exploring flowcharts by distant partners who can manipulate the developed diagrams in a shared activity space and communicate directly through a chat tool. In fig.2 the typical client environment is shown: flow chart on the left and chat communication panel on the right.

A server component has been built to facilitate and mediate this peer interaction. The server, which is implemented using open source web server technology, permits tunnelling of communication in order to overcome the proxy restrictions on p2p communication and logging of interaction. This record of the activity can be used for recovering broken down communication and for recording peer interaction, a useful facility for a posteriori analysis of peer collaboration.

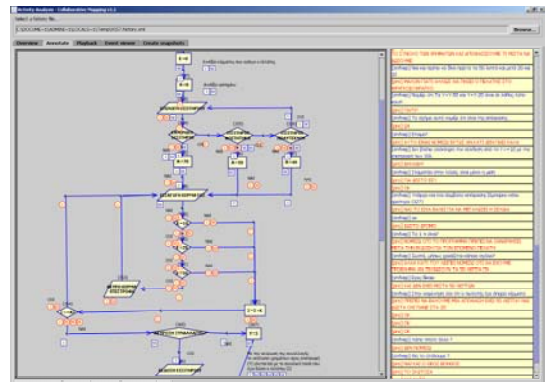

Fig 2. The client component of the application

3. Context of the study

The deployed technological infrastructure was made available to the students of the '*INF10 Introduction to Computer Science'* module of the Computer Science curriculum of the School of Sciences and Technology, Hellenic Open University. This is a 4-year curriculum structured in 12 modules (each one equivalent to 3 traditional university courses) that leads to a Bachelors degree. The students attending the INF10 module are distributed geographically in 29 groups, up to 30 students each. Each student group is assigned a single tutor and uses educational material either directly sent to them or made available through the Web. The tutor–student communication is largely based on e-mail and the use of electronic fora. A variety of educational material is offered through the module's web site, including reading material, exercises, solutions to exercises, compilers, brief lectures, examples from past examinations, etc.

Although a high number (approximately 800) of students register in the INF10 module each year, typically, only 350 students manage to successfully complete this module, which is mostly due to the high dropout and failure rates that are expected in similar distance learning situations [11]. Out of this active population of around 350 students for the academic year 2003-2004, 150 students registered to participate in our study (43%), while 130 of them submitted the solutions to the given assignment. The rate of participation in this optional study was considered high for ODL students, since one of the major problems related to their studies has to do with time limitations [11]. These 130 students were assigned to two-member groups in such a way that the group partners were geographically dislocated.

The assignment involved collaborative building of an algorithm of a *bus-ticket venting machine* using a flowchart representation. According to the exercise specifications, the venting machine could only accept three different types of coins: 50, 20 and 10 cents and issue three kinds of tickets of different values. The machine should return change and reject invalid coins.

The assignment was announced at the INF10 module web site. Participation to this assignment was optional, while an extra credit was offered to participating students. The deadline for submitting a solution was 40 days after the announcement. During this time, support was offered to the students using a forum, initiated especially for this assignment. A helpdesk with a staff of 4, handled problems and queries. Two helpdesk members were responsible for technical problems, one for administrative issues (such as the shipment of the CDs, the reassignment of some pairs, etc.) and one for academic questions related to the assignment. Most of the submitted queries were related to technical (51%) and administrative (40%) issues.

4. Analysis of peer interaction

From the 65 pairs that submitted a solution, only 17 (26%) based communication on the provided chat tool for collaborating, while the rest used other chat services or voice phone. Therefore, the interaction of just these 17 groups has been recorded and has been further analysed. These 17 pairs interacted for a number of consecutive sessions each, in order to complete their task. In average 6.6 sessions were needed per group. A total of almost 52 hours of interaction was recorded, around 3 hours of activity per group. The frequency of these sessions in some occasions was very high, spanning a period of just a couple of days while in some other occasions they were more distant, occurring in a period of almost a month, an indication of the diversity of availability of the students of such distant courses.

The analysis was performed using the Synergo collaboration visualization and analysis tools [3], which provided us with an insight into qualitative and quantitative aspects of the patterns of collaborative activity that took place.

Since the members of each group were allocated randomly in terms of their skills and background, an interesting characteristic to study is the symmetry of participation of the group members in the activity. For this reason an index was defined, called *Balance of group activity* (B). B takes values between 0 and 1. For B=1 the members of the group have acted in the same degree (equal number of flow chart building actions and chat messages), while B=0 indicates fully imbalanced group participation (only one member acting).

The correlation of this index with group characteristics was studied next and discussed here. It was found that more balanced groups did not necessarily produce more complex solutions to the problem, correlation factor=0.105 (see fig.3), similar finding to other studies.

On the other hand, it seems that more balanced groups are more active in terms of density of activity, measured as number of events/min, as shown in fig. 4 (correlation factor=0.441). It seems therefore that one should take care to encourage more balanced member interaction either by tutor intervention or by building more symmetrical groups in the first place.

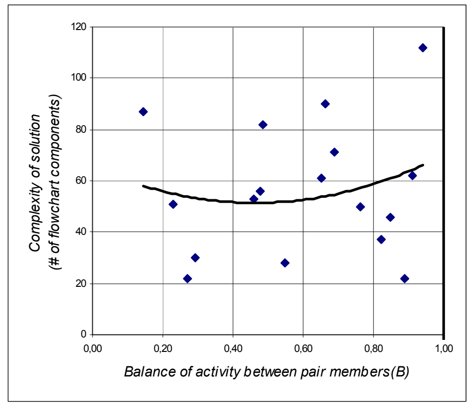

Fig 3. Correlation of complexity of solution and Balance of activity in pairs (B)

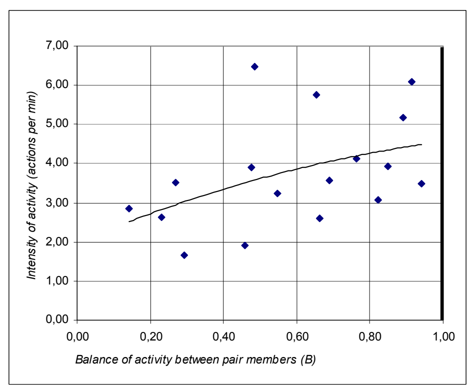

Fig 4. Correlation of Intensity of group activity (actions/min) and Balance of activity in pairs (B)

Another finding was related to the origin of imbalance in the activity of the groups. It was discovered that the actions (flow chart building) were more imbalanced than the communication acts through chat messages exchange. The average value of B for the first case was 0.762 (stdev=0.166) while for the second one it was 0.543 (stdev=0.317). By performing an unpaired t-test between the mean values, the P value was 0.0166, considered significant (t=2.527). This is due to the skills that these two activities require. Acting in the drawing space requires good knowledge of the task and the flow chart and algorithm concepts. Communicating through the chat tool can be a way of inquiring on the activity and making remarks on the process or even engaging in off-task conversation.

In terms of the complexity of the produced solutions, which was a strong indication of good quality of the solution for the given problem, in general the solutions were of high complexity. In average, the solutions of the 17 groups were made of 55 components, with min value 22 and max 112. Extracts of typical solutions are shown in fig. 5.

The sophistication of the produced solutions seems to be positively correlated to the amount of time allocated in collaboration and interaction by the corresponding groups. A positive correlation factor=0.398 was found between these two indices.

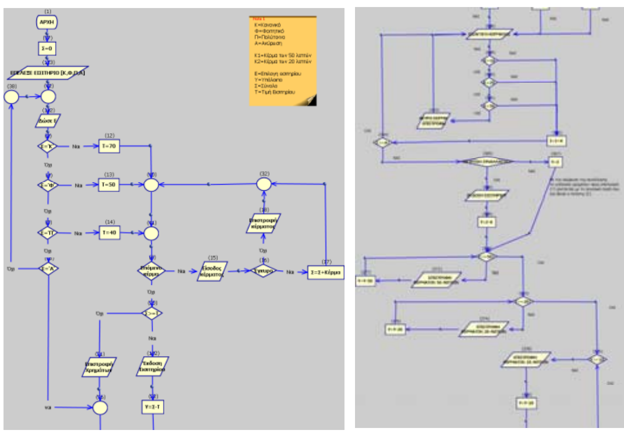

Fig 5. Extracts of two submitted solutions

A consequence of this observation is that ample time should be provided for collaboration, as this positive factor, is conducive to improved results. This requirement is particularly important in the context of ODL, where the students are often very constrained in terms of availability [11], while the pressure imposed by the commitment to peer collaboration can be beneficial for the partners involved.

4.1. Qualitative analysis of dialogues

Subsequently, a qualitative analysis of interaction was performed. In particular, we studied anonymised extracts of dialogues and actions in order to identify typical patterns of peer support. It was found that the spirit in all groups was highly collaborative and supportive, in much greater extend than similar studies with secondary education students, where often conflicts may occur in peer collaboration experiments (e.g. [8]). This is due mainly to the voluntary nature of the participation in this experiment and the maturity of the participants who perhaps enjoyed this occasion of interaction with their peers as a rare opportunity for social activity with fellow students. It was a common pattern, especially at the beginning of a session, the partners to engage in off-task conversation about everyday matters in their lives.

Typical extracts of peer support patterns of interaction are described next.

In group #1, partner A_1 has introduced the conditional expression Y DIV 50 > 0. Partner B_1 requests an explanation on the use of DIV and the meaning of this expression, partner A_1 replies explaining the use of this condition for calculating the coins that the vending machine should give back as change. B_1 requests further explanation in general about the use of the DIV function, which is promptly provided by A_1. Subsequently, B_1 admits that for the same part of the algorithm (s)he had in mind a longer process, acknowledging the elegance of the solution suggested by A_1.

In the second extract of dialogue of group #3, partner A_3 is attempting to create a conditional node using the wrong shape (barrel shape instead of diamond). In addition the text within this node is a full *if..then..else* expression. Partner B_3 intervenes making a suggestion on the shape and the expression. A_3 does not understand the suggestion and requests from B_3 to demonstrate it by acting in the shared drawing space. B_3 builds the conditional node of the flow chart and requests from A_3 to build the subsequent condition, since the algorithm involves a sequence of three tests. A_3 creates the second conditional node using the correct shape and wrong expression, B_3 makes a new comment, A_3 corrects in response the node and builds subsequently the third consecutive node correctly.

Both the above patterns are highly supportive and collaborative. In both, one of the two partners takes the tutoring role and the other one the inquiring role. In both cases, the tutoring peer, requests demonstration of the acquired new knowledge by passing the initiative to the inquiring partner. This positive attitude and beneficial use of this approach needs to be confirmed if used in a longer period in ODL courses. In any case, it seems interesting to investigate further relevant pedagogical approaches and activities as well as tools that further encourage the occurrence of such incidents in the context of ODL synchronous collaborative activities.

4.2. Impact on student performance

As regards the impact of the synchronous collaboration approach on student performance, it is difficult to safely draw conclusions from this study. Students who participated in this study achieved slightly higher scores in the next –obligatory and with the same subject– exercise than those who had not participated. This increase of performance, however, does not necessarily reflect the impact of collaboration; it could also reflect the fact that students who participated in the exercise gained extra practice on the subject.

On the other hand, during a questionnaire-based survey that followed this exercise, most of the students who had taken part in it mentioned that collaboration with other students through this framework helped them gain better knowledge of the subject and requested the use of this framework in other exercises as well.

5. Conclusions

The reported study is extensive in terms of number of participants and complexity of the given task, while it took place in the frame of authentic ODL educational conditions. The prime finding is that peer interaction was conducive to learning while it supports social cohesion of the community of the, otherwise isolated, distant education students. It is interesting to study in the long term the effect of such an approach to the high dropout rates of ODL courses. In addition, the proposed approach is particularly suitable for widespread adoption in ODL settings, since it does not necessitate any particular equipment and network connection by the participants. So, despite the considerable overhead of implementation by the educational organisation and the limitations of the technology involved, seems worth further investigation in experimental use.

The analysis of the groups' behaviour has indicated that special attention and support should be provided to students, by guiding the process and encouraging balanced participation of the group members. In addition, special consideration should be provided on the necessary technical support to the students involved, since the distributed character of the approach and the p2p architecture used, may cause many unforeseen difficulties that can hinder the process.

An advantage of the used architecture is the possibility of monitoring and processing of interaction data by instructors. This possibility in the future can be combined with automatic analysis tools and techniques that can be applied on large amounts of data, collected over the time, see Xenos [12].

The approach discussed in this paper is applicable in other educational activities involving joint manipulation of diagrammatic representations. However, the effectiveness of its large-scale implementation and its impact on the community of students of ODL courses needs further investigation.

6. Acknowledgements

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