

Enhancing Groupwork with Social Navigation in Collaborative Learning Environment

Jaakko Kurhila
Department of Computer Science
PO Box 26
FIN-00014 University of Helsinki, Finland
kurhila@cs.helsinki.fi

Miikka Miettinen
Petri Nokelainen
Henry Tirri
Helsinki Institute for Information Technology
PO Box 2700
FIN-02015 Helsinki University of Technology,
Finland
firstname.lastname@hiit.fi

ABSTRACT

EDUCO is a computer-supported collaborative learning environment that is designed to serve as a platform for self-evolving ad hoc study groups. Instead of trying to modify the environment to the individual, the underlying idea behind EDUCO is to equip the learners with information about the other learners so that meaningful collaboration is possible. This is achieved by revealing the actions of others with real-time social navigation and supporting interaction via synchronous and asynchronous discussions. EDUCO has been used in an advanced university-level course, where self-organizing and self-directing group work was required. This paper examines how the groups were formed, how the students viewed the group work, and what was the effect on group performance if the group consisted of students with varying motivational factors.

Categories and Subject Descriptors

H.5.3 [Group and Organization Interfaces]: Computer-supported cooperative work; K.3.1 [Computer Uses in Education]: Computer-aided instruction

General Terms

Human Factors

Keywords

Collaboration, awareness, group sizes

1. INTRODUCTION

Student-centred learning often requires working in groups. One popular approach is that the teacher or a tutor assigns students to groups, possibly according to various characteristics of the students. This paper examines how groups can be formed in self-organizing manner in computer-supported

collaborative learning so that each individual can benefit from the group. The key issue is to provide the students with information about their study companions and make the learning process transparent to other students so that they can see and make use of the actions of other learners in the environment.

The tool used in this study is called EDUCO. EDUCO relies on aspects of social navigation to make the actions of others visible. When Dourish and Chalmers introduced the concept of social navigation, they stated it to be "navigation because other people have looked at something" [2]. The concept has evolved since then and various categories of social navigation have emerged.

In the seminal book of social navigation, Munro et al. [8] use an on-line grocery store as an example: if people visiting the store are given recommendations what other people have bought, it is a form of indirect social navigation. If a shopper in the grocery store has a sense of other people moving about the store and can engage in seeking e.g. assistance, it is a case of direct social navigation.

Direct social navigation and awareness issues have been applied in various contexts (see e.g. [6, 5]), but experiments with social navigation in educational setting have mostly fallen into the category of indirect social navigation (see e.g. [1]; of course, exceptions exist [13, 4]). However, EDUCO is a system for collaborative learning to employ real-time direct social navigation in education. Real-time aspects of EDUCO create the feeling of live companions in the system [7]. Other important facilities include tools for synchronous and asynchronous communication, and support for forming study groups and publishing their work.

2. EDUCO TOOL

2.1 Map view for social navigation

From the users' point-of-view, EDUCO tool consists of six different views for various activities, a document area and a discussion area (Fig.1). The views are map, chat, search, alarm, preferences and help. They are presented in a tool resembling a handheld computer (upper-left corner in Fig.1, now in map view). The map shows documents anywhere in the Web that are linked to EDUCO that serve as a learning

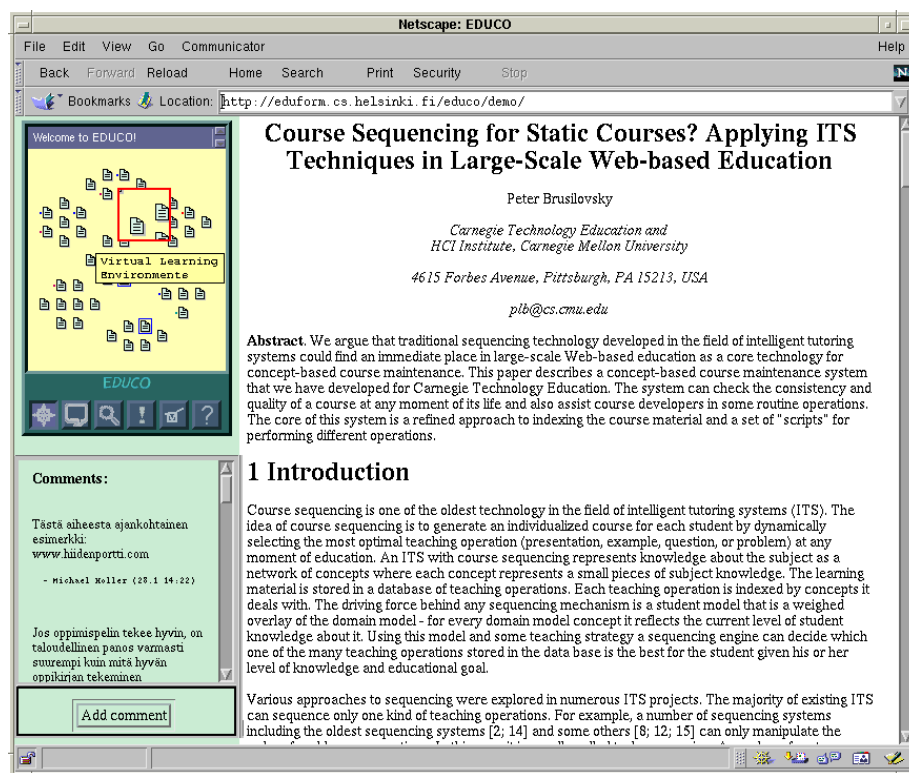


Figure 1: Educo tool.

material for the course.

In addition to presenting documents currently available in the environment, map view provides a way to navigate to them directly. By double clicking a document a user can open it in the right-hand frame in the browser window, as seen in Fig. 1. A user is represented as a coloured dot around the document he or she is currently viewing. Other users are visible to every user in real-time, so that their navigation is visible to everyone present.

The colour of a dot indicates a group membership. This type of group membership is assigned by the teacher or course administrator and is independent of the groups the students form. An example of grouping could be teachers, tutors, observers, and students. Another suitable way to differentiate students is their motivational profiles or learning strategies, as described later in this paper. By representing different groups with different colours, the participants have one additional source of information they can use when selecting their study partners or teams for group work.

The documents change their brightness level and colour on the map depending on how much they have been viewed relative to the other documents. The total time all users have spent viewing each document is recorded every hour. The change in the brightness and in the colour of an individual document are determined by the distance of its moving average for the last 24 hours from the same average for all documents.

Map view provides the users of EDUCO with two essential

features of social navigation. Colouring the documents according to how much they have been viewed is a form of asynchronous social navigation. Presenting users as moving dots next to the documents they are currently viewing is a form of direct synchronous (i.e. real-time) social navigation. Both of these features can help the users to follow the footsteps of others.

2.2 Finding and forming groups

Finding team members to complete an assignment is often obligatory in student-centred learning. When searching for a companion for group work, regular search is useless unless a student already knows the person he or she is willing to team up with. However, another type of search can be used for the purpose. EDUCO's alarm offers each user a possibility to set "triggers" into the documents, groups and the overall system. In other words, a user can set EDUCO to alert when certain conditions occur. This feature is useful in a case where a user searches for a companion (possibly from a certain group) showing interest for a certain document or topic, or wants to contact a particular person when he or she enters the system. The alarm function also enables making combinations of triggering events.

Even though the navigation of others is visible to the other participants, initiating the communication between the students also has to be made as simple as possible. EDUCO has a built-in chat integrated to the map view to enable ad hoc synchronous communication between peers and other users. The chatters can be picked up from the map view by clicking the dots representing users. The number of participants in

the discussion is unlimited, but one person may use only one chat channel simultaneously. Thus the functionality of the chat is restricted when compared to many commonly used chat services. However, the chat in EDUCO is targeted to a small exchange of ideas when searching for a team member for group work.

Of course, there is also a search function in EDUCO. It can be used to find both persons and documents. The search is targeted to the titles of documents and names (and nicknames) of users, both online and offline. The search results are shown in the search view, but also in map view by highlighting the document with a blue rectangle, as can be seen in the map in Fig. 1.

2.3 Publishing group work

Working in groups is an essential part in student-centred learning. An important feature in EDUCO is the support for forming groups. Alarms, chat and navigational patterns can be used when screening for potential partners for group work. When the students have found and agreed upon their study companions, any one of them can start a group by clicking a button "Add a new group". Other people can join such a group, or they can start a new group and try to persuade people to join. People not yet in any group are shown in the column on the left, groups already formed in the middle column, and the work published by the group in the right column (Fig. 2). Publishing joint work, such as a report or the draft of a report, is done by submitting the URL of the Web page containing the work.

The way group forming is handled in EDUCO is particularly suitable for a course where the groups are not stable for the entire course, and more importantly, the groups are formed by the students themselves without teacher assistance. This approach requires metacognitive skills by forcing the students to think about what kind of expertise they will need for the task at hand. However, the features in EDUCO makes the actions of others visible so that the students can form better opinions about fellow students for selecting study companions.

Document icons in the map view of EDUCO can each represent a collection of student reports. Otherwise, the space for documents in the map view could be overwhelmed especially in large courses. These documents that are actually a collection of documents, are used for reports that students produce. In Fig. 2, the group of nine bright documents in the lower part of the map each represent a collection of weekly reports. The reports are accessible by clicking the corresponding link anchor (i.e. report name) on the right-hand column.

In addition to the synchronous discussions described above, EDUCO has two possibilities for asynchronous communications. A document in the EDUCO map can have one of these types of communication chains "attached" to it, i.e. the comments are always document-specific. A discussion chain for a report document published by a student group working together for a weekly assignment is a typical hierarchical discussion chain, where previous discussions can be quoted and a new discussion chain can be started. The discussion is meant for building knowledge together, by publishing an

early version of a report for an assignment, for example, and soliciting comments from other course participants.

Another type of comments is shown in the lower left-hand corner in Fig. 1. Whereas the documents with student reports have newsgroup-type hierarchical discussions, other documents gathered into EDUCO have a space for general notes or comments. A typical use of these comments is to ask others about an unclear point in an article, or note an issue in the article. Course participants used this type of comments frequently to announce that they are seeking study companions to form a group. Both types of comments are open to everyone in the system.

3. STUDY SETTING

3.1 Course description

EDUCO was tested empirically in an advanced course in Computer Science entitled "Computer Uses in Education". There was no final exam but the students had nine weekly reports (assignments) to produce from nine different topics in varying teams. The reports were to be prepared in groups. Group size was not fixed, but groups of two or three were recommended. Moreover, the groups were not allowed to stay the same during the course. An important requirement was that a student had to be involved with at least three different groups.

Weekly assignments were presented as open-ended problems, projects or cases, such as consulting a higher education institute on what kind of course delivery system they should choose or drafting an approach on how to evaluate web courses. There were no lectures and no pre-made learning material other than research reports and other appropriate resources. Although the deadlines were very strict, within the deadline the students were using self-paced collaborative learning.

Apart from the documents containing the reports of the student groups, the documents in the EDUCO map discussed the issues covered during the course. The documents were organized into eight different clusters under a common theme. The themes were close to the weekly topics but not completely the same. The document cluster sizes varied from two to ten, giving a total of ca. 40 documents. The exact amount of documents varied slightly during the course, since new resources were added or replaced occasionally.

The course included only two face-to-face meetings lasting 45 minutes. The first was an initial meeting where the structure and requirements for the course were explained. The second face-to-face meeting was organized the next day, and participants had an opportunity to get familiar with EDUCO. After that, every communication took place in EDUCO apart from some email announcements.

The course relied heavily on peer-commenting, since the teacher and the teaching assistant were not able to extensively guide or comment the reports of the student groups. The topics covered different aspects of Web-based learning, such as platforms, learning theories, interaction and adaptive educational systems. The reports were graded by two teachers together on a scale of 0 to 6.

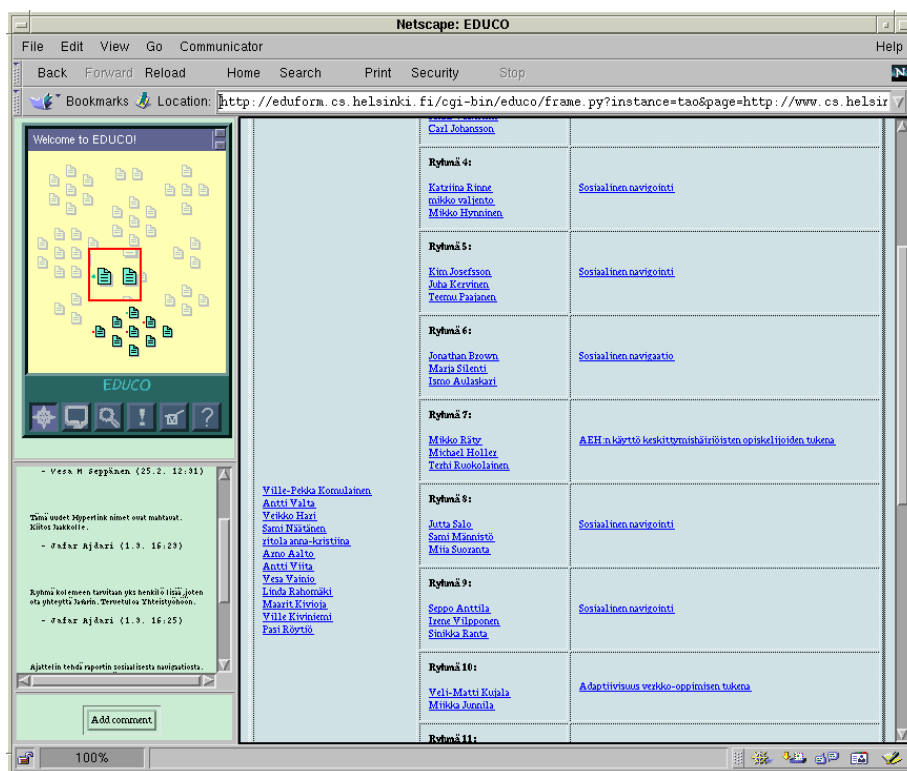


Figure 2: Students not yet in any group, groups and their published reports.

3.2 Motivational profiling of the students

Before the course started, the students filled in a questionnaire to clarify their motivational profiles. The results were used in colouring the dots in the EDUCO map view, so that every participant knew the motivational profile for every student. The group descriptions with clear explanations were published for all the participants, so that the students were able to use the information when choosing a study companion or group.

Motivational profiling in this study is based on the Motivated Strategies for Learning questionnaire, MSLQ [3]. MSLQ measures both motivational factors and learning strategies. The motivation section of MSLQ consists of 17 items that were used to assess students' value for a course, their beliefs about their skill to succeed in the course, and their anxiety about tests in the course. A 5-point Likert-scale ranging from 1 ("Not at all true of me") to 5 ("Very true of me") was used for all items.

The theoretical model of motivation [10] is constructed out of six factor solution: (1) Intrinsic goal orientation, (2) Extrinsic goal orientation, (3) Meaningfulness of studies, (4) Control beliefs, (5) Efficacy beliefs, and (6) Test anxiety. We expected to find a similar structure in the sample data and thus to be able to construct sensible motivational groups.

The analysis of the questionnaire was carried out with a Bayesian dependence-modeling tool named B-Course [9]. The results indicated that the theoretical model of six factors [11] was a viable solution for this small number data set. Based on the motivational level scores on six dimensions, respon-

dents were divided into three groups:

- Group 1 ("Red", N=20) characteristics: (2) Extrinsic goal orientation, (6) test anxiety and (3) meaningfulness of studies.
- Group 2 ("Blue", N=11) characteristics: (5) Efficacy beliefs, (1) intrinsic goal orientation and (3) meaningfulness of studies.
- Group 3 ("Green", N=11) characteristics: (4) Control beliefs and (1) intrinsic goal orientation.

The classification accuracy of the theoretical model was confirmed with both a linear and nonlinear discriminant analysis. There was no statistical significance between the group memberships of male and female respondents.

4. RESULTS

This section examines self-organization of the groups, how the students viewed the group work, and the effect of different group formations. The quotes in this section are excerpts from the students' learning diaries with no specific questions given beforehand. The quotes have been translated from Finnish to English.

4.1 About the study groups

Learning diaries of the students revealed different types of behaviour for group formation. "Active" participants started a group and tried to lure other members to join in. "Hopeful" participants started a group but did not actively try to

find other members, just waited people to join in. "Scared" participants formed groups with people they knew outside the environment. "Rude" participants joined a group without asking permission. "Picky" participants evaluated carefully the quality of the previous work of others before asking to join a group. "Planners" made agreements into the future with a particular group to ensure that there is a safe backup group if no better comes along.

These types of behaviour evolved throughout the course so that every student was acting according to different behaviour in different stages of the course. It was typical that students stayed with their friend for the first assignment (or, in a case where the student did not know anyone from the course, asked the first person visible in the system to be a study companion). When the confidence grew, many of the students started to use different strategies for selecting study companions, as can be seen in this quote:

"Forming groups was stressful at first, but one got used to it quickly, and it didn't cause any problems."

It is important to note that the logged data revealed that there were no clear leaders or followers (always starting a group or always joining an existing group). However, some students saw this differently:

"I noticed such behaviour that some students wanted to start their own group even though there were groups of one already."

In many cases, where the study group was viewed to function well, group members agreed to come back together to complete at least one weekly report at some point of the course:

"I would like to be a part of this group also next week, but I think that these two members of my group are just on leave from their 'actual' groups, so that they fulfil the requirement of participating in different groups. [...] I also wonder if we, who do not know anyone or do not succeed in finding a good group right from the start, are we just drifting from one group to another every week?"

Only a few students consciously used the work produced by others as a basis to evaluate potential group members. However, when using EDUCO as a learning environment, the actions of everyone are highly visible to everyone, so the reports and comments made are likely to have an influence on the learners' behaviour, consciously or not.

The amount of study companions for each participant during the course varied heavily. The lowest possible amount (when acting according to the course requirements) was 3, and there were five students who chose not to have more study companions than 3. On the other end, one student had 11 study companions, while the average amount of study

Table 1: Amount of study companions, size of clusters, and average amount of points for each cluster type.

Amount of companions	N	Points (average)
3	5	30.2
4	8	30.9
5	9	28.3
6	5	29.2
7	6	29
8	6	32.2
9	2	30
11	1	30

companions was 6.05. The amount of companions did not have any effect on the course grade, as can be seen in Tab. 1.

Overall, students valued the self-organizing and self-evolving groups:

"There were few groups, whose composition did not change much during the course. I wonder if they get as much out of the course? I think that forming groups [without the teacher] was educational. You had to learn teamwork skills, since my groups were very different in character."

4.2 About the motivational groups

It is clear from the student learning diaries that in the beginning many of the students did pay attention to the motivational groups of others, and used the colour of a dot as one factor for group formation. In the end, no one admitted to that dot colour was a factor. Motivational groups were still seen as one additional piece of information characterizing fellow students:

"Colour [of a dot on the map view] gave a student a personal character, which was nice compared to just a name."

Generally, different motivational profile of a study companion was not seen as problematic as differences in timetables and study habits. This view is also supported by the final results. Study groups with students with the same motivational profile (the entropy of profiles is 0; during the course there were 36 such groups) averaged 4.3 points per assignment, whereas groups with the greatest variety in motivational profiles (entropy 1.58) scored 4.6 points on the average (Tab. 2).

Students in the second motivational group ("Blue") were slightly more eager to seek different study companions; the average was 6.6 compared to 5.4 and 5.5 for the first ("Red") and third ("Green") motivational groups, respectively. Because of the small sample size, these differences are anecdotal.

5. CONCLUSIONS

Table 2: Differences in motivational profiles within groups, amount of such groups and average amount of points.

Entropy	N	Points
0	36	4.3
0.81	1	5
0.92	41	4.6
1	26	4.5
1.58	8	4.6

Computer-supported collaborative learning consisting intentional active learning and knowledge-building resources necessitates a flexible and synchronous learning situation [12]. EDUCO offers an environment that can be used in flexible manner to make the learning process more transparent so that the students have enough information of peers to organize meaningful study groups independently from the teacher. The study presented suggests that self-organizing groups are equal in performance, regardless of the group formation (i.e. groups consisting of people with the same or different motivational factors). Staying with the same study companions (i.e. only a few companions in total) or rotating study companions rapidly (i.e. a lot of different study companions) appear to have no impact on performance, either.

6. REFERENCES

- [1] A. Dieberger. Social navigation in populated information spaces. In A. Munro, K. Höök, and D. Benyon, editors, *Social Navigation of Information Space*, pages 34–54. Springer, 1999.
- [2] Dourish, P. and Chalmers, M. (1994). Running Out of Space: Models of Information Navigation. In Proc. Human-Computer Interaction (HCI'94).
- [3] Garcia, T. and Pintrich, P. (1994). Regulating Motivation and Cognition in the Classroom: The Role of Self-Schemas and Self-Regulatory Strategies. In D. Schunk and B. Zimmerman (Eds.), *Self-Regulation of Learning and Performance: Issues and Educational Applications*. Hillsdale, N. J.: Erlbaum.
- [4] A. Girgensohn and A. Lee. Making web sites be places for social interaction. In *Proceedings of the 2002 ACM conference on Computer supported cooperative work*, pages 136–145. ACM Press, 2002.
- [5] W. Grther and W. Prinz. The social web cockpit: support for virtual communities. In *Proceedings of the 2001 International ACM SIGGROUP Conference on Supporting Group Work*, pages 252–259. ACM Press, 2001.
- [6] R. E. Kraut, D. Gergle, and S. R. Fussell. The use of visual information in shared visual spaces:: informing the development of virtual co-presence. In *Proceedings of the 2002 ACM conference on Computer supported cooperative work*, pages 31–40. ACM Press, 2002.
- [7] J. Kurhila, M. Miettinen, P. Nokelainen, and H. Tirri. EDUCO - a collaborative learning environment using social navigation. In P. de Bra, P. Brusilovsky, and R. Conejo, editors, *Adaptive Hypermedia and Adaptive Web-Based Systems (AH 2002)*, LNCS 2347, pages 242–252. Springer, 2002.
- [8] A. Munro, K. Höök, and D. Benyon. Footprints in the snow. In A. Munro, K. Höök, and D. Benyon, editors, *Social Navigation of Information Space*, pages 1–14. Springer, 1999.
- [9] Nokelainen, P., Silander, T., Tirri, H., Tirri, K and Nevgi, A. (2001). Modeling Students' Views on the Advantages of Web-Based Learning with Bayesian Networks. Proceedings of The 10th International PEG2001 Conference, pages 202-211. Tampere, June 2001.
- [10] Ruohotie, P. (2000). Conative Constructs in Learning. In P. Pintrich and P. Ruohotie (Eds.) *Conative Constructs and Self-Regulated Learning*, pages 1-30. Saarijvi: Learning and Change Series of Publications.
- [11] Ruohotie, P., Nokelainen, P., Tirri, H. and Silander, T. (2001). Modeling Student Motivation and Self-regulated Learning with Bayesian Networks. In P. Ruohotie, P. Nokelainen, H. Tirri and T. Silander (Eds.) *Modeling Individual and Organizational Prerequisites of Professional Growth*, pages 174-195. Saarijvi: University of Tampere.
- [12] M. Scardamalia and C. Bereiter. Computer-Support for Knowledge-Building Communities. *The Journal of the Learning Sciences*, 3(3):265–283, 1994.
- [13] H. Wang and Y. Chee. Supporting workspace awareness in distance learning environments: Issues and experiences in the development of a collaborative learning system. In C.-H. Lee, editor, *International Conference on Computers in Education/Schoolnet 2001*, pages 1109–1116, Seoul, Korea, 2001. Incheon National University of Education.