Educo - A Collaborative Learning Environment based on Social Navigation

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Abstract. Web-based learning is primarily a lonesome activity, even when it involves working in groups. This is due to the fact that the majority of web-based learning relies on asynchronous forms of interacting with other people. In most of the cases, the chat discussion is the only form of synchronous interaction that adds to the *feeling* that there are other people present in the environment. EDUCO is a system that tries to bring in the sense of other users in a collaborative learning environment by making the other users and their the navigation visible to everyone else in the environment in real-time. The paper describes EDUCO and presents the first empirical evaluation as EDUCO was used in a university course.

1 Introduction

When Dourish and Chalmers introduced the concept of *social navigation*, they stated it to be "navigation because other people have looked at something" [4]. The concept has evolved since then (see e.g. [8] for an overview of the topic), and various categories of social navigation have emerged (direct – indirect [3], intended – unintended [6]). Today, many of the systems incorporating social navigation use *collaborative filtering*. It means that these "systems provide the user with recommendations of their likely interest in data items on the basis of 'interest matches' derived from ratings from the set of users" [5]. Examples of such recommender systems include various web-stores, where the customer is recommended a product based on the actions of previous customers.

In the area of web-based learning, recommender systems based on collaborative filtering can have a positive impact on the overall learning process. However, these systems do not address the problem of the feeling of being alone in a web-course. Commercial or even research-level course delivery systems [1] have rarely taken this into consideration. There are various collaborative virtual environments [2] that include the "feeling" of other users, but the solutions are not necessarily directly applicable to web-based learning.

EDUCO is a system that visualizes other live users currently present in the learning environment. Navigation and initiating synchronous or asynchrornous discussions have been made as simple as possible. The movement from one document to another in the environment is updated for every participant in real-time, thus adding to the feeling of truly live action. Research on workspace awareness has notified this as an important issue in groupware [12].

The EDUCO system has been tested in one advanced university course. A detailed description of the system, the study setting and the results are discussed in the subsequent sections.

2 EDUCO

Before going into the system description of EDUCO, a few concepts should be clarified. A *user* is a learner participating in a course in a web-based learning environment using EDUCO. A *document* is an HTML-file within EDUCO that is visible to the users. Documents have visual representations on the screen, and they can be grouped into *document clusters*. An *instance of* EDUCO means a fixed set of document clusters, i.e. a unique course within the EDUCO learning environment. An *administrator* of EDUCO is a person responsible for an instance of EDUCO. It is typical that the administrator of EDUCO is the teacher of the course. Only an administrator can add users or documents to an instance of EDUCO. The document clustering is also conducted by the administrator. The administrator can also assign group information to the users, thus forming various *user groups*. The group information and the document clustering are static unless the administrator makes the required changes to the system.

The user interface of EDUCO consists of six views of which only one is visible at a time. The views are map, chat, search, alarm, preferences and help. The screen layout when using EDUCO is presented in Fig. 1. The six views of EDUCO are presented in a tool resembling a handheld computer (upper-left corner in Fig. 1, now in "map" view). The largest area is reserved for documents gathered into an instance of EDUCO (right-hand side of the web-browser in Fig. 1). The space below the EDUCO tool is for the comments provided by the users.

"Map view" presents the document clusters of an instance of EDUCO. Every document is visible, and the clusters are distinct. Documents are presented as paper-icons. The users in an instance of EDUCO are presented as coloured dots. The dot is located next to the document the user is currently viewing. When a user places the mouse pointer on top of a document or a dot representing a user, a tool tip text appears showing the name of the person or the document. In Fig. 2 the pointer is on a document called "Where did all the people go?". Double clicking a document opens the document into the right-hand side of the browser window and moves the dot representing the user to a corresponding location on the map view of every user in the EDUCO instance.

The rectangle at the bottom of the map view in Fig. 2 is a magnifying glass included in the map view. The purpose of the magnifying glass is to make it easier for the users to click on the dots or documents while navigating.

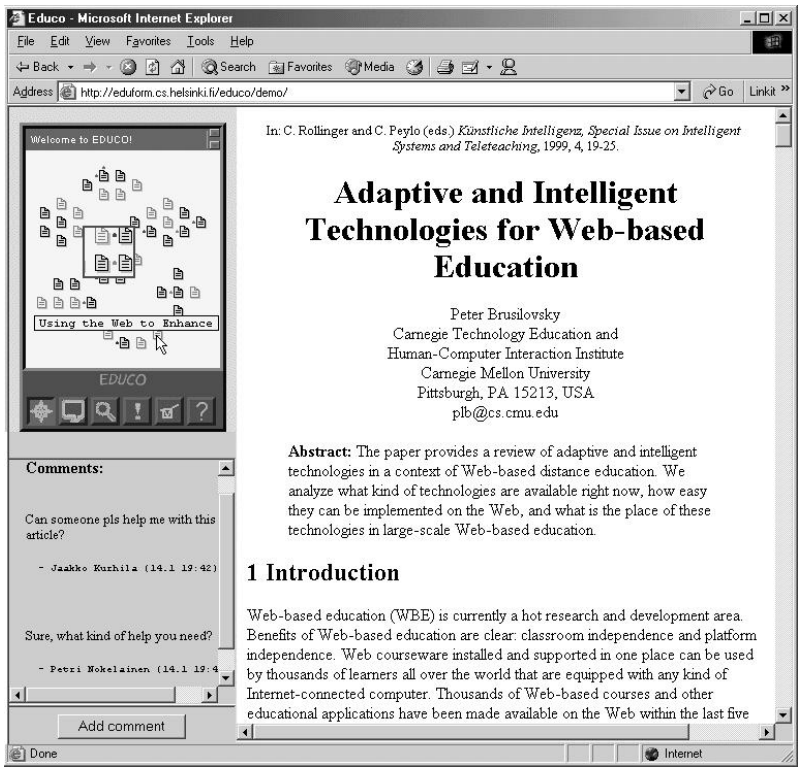

Fig. 1. The user interface of EDUCO.

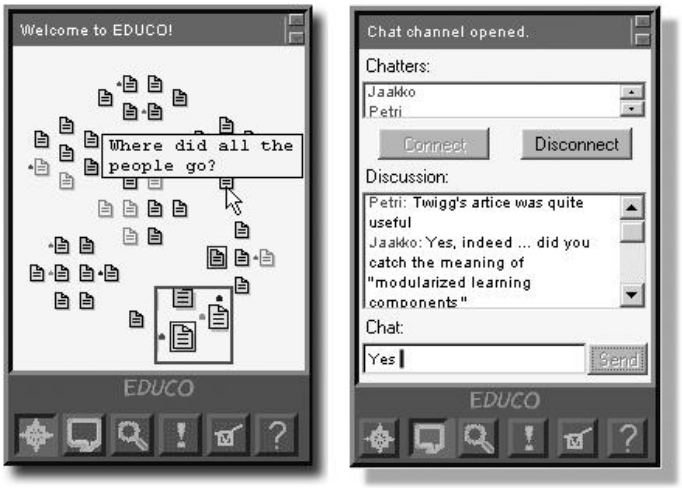

Fig. 2. The "map" and "chat" views of EDUCO.

The colours of the dots indicate different group memberships or types of user profile. The groups are assigned according to some metric the administrator of the EDUCO instance wishes to choose. For example, the groups can be assigned based on the students' interest in various topics within the course topics.

The documents change their colour on the map depending on how much they have been read in relation to the other documents. The colours range from bright (heavily read) to dimmed (not heavily read), as presented in Fig. 2. This way the user can get the "footprint" information at a glance and does not have to stay online and constantly watch where the other users navigate.

When in map view, clicking a user or a document symbol once selects it for further use. The further use can, for example, be a "Chat", which is the second view (Fig. 2). Any user can easily initiate a chat discussion with other users simply by clicking the corresponding user symbol and then clicking the "Connect" button in the chat view. The chat can be initiated with one to n other users. The restriction is that one person can be involved in only one chat channel at a time.

Chat is a form of synchronous communication in EDUCO. Depending on the situation, asynchronous discussions might sometimes be more useful. Therefore, every user in EDUCO has the possibility to write a comment when viewing a document. The comment is visible to users navigating to that document, i.e. the comments are document-specific. Other users can comment on the comment, thus continuing the chain of comments as illustarted in Fig. 1.

The third view is "Search". Users can search for other users and documents in an instance of EDUCO. When a user searches another user or a document, the results are shown textually in search view (Fig. 3) and graphically in map view by highlighting the corresponding user or document (the same effect as clicking a user or a document *once* in map view). The highlighting is illustrated in Fig. 2 where the magnifying glass is on a highlighted document. In addition to finding documents on the map, the operation of the search makes it easy to initiate a chat with a specific user.

"Alarm view" gives users the possibility to set up an alarm that is triggered if the requested condition occurs. For example, if a user seeks another user who is also interested in a certain document or topic, he or she can tell the system to give a notifying message when someone else arrives at the document. Alarm is a versatile tool, since the user can make different combinations of the three possible triggering events: users, group members and documents. Figure 3 shows the alarm view where the user is about to set the alarm to trigger if a user named "Demo user" or someone from group 2 arrives at the document named "Adaptive and Intelligent Technologies". Other highly used combinations include notifying if a certain user enters the system or if someone arrives to a specific document.

The last two views are "Preferences" and "Help". While viewing "Preferences", the user is allowed to change personal settings in the system. The settings include preferred nickname within the chat (in case the user wants to stay anonymous in the chat), and whether the user is visible to other users. If the user chooses to make her own navigation invisible in EDUCO, it automatically

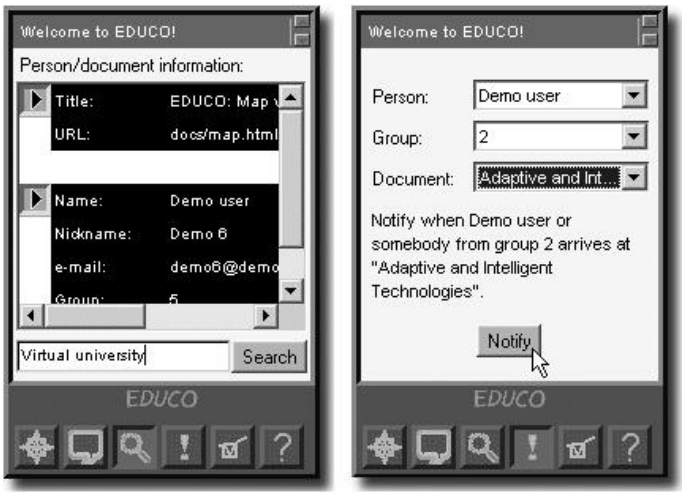

Fig. 3. The "search" and "alarm" views of EDUCO.

means that she cannot see the other users. Help view provides information about the system in general (Fig. 4)

3 Educo architecture

From a technological point of view, EDUCO consists of a socket server, a Java applet for every user and several CGI-scripts. The most important task of the server is to keep track of the state of the distributed system and inform the clients as changes occur. The changes include navigation from one document to another. If one of the users moves to another page, the new location has to be sent to everyone currently present in EDUCO. The implementation of this kind of communication scheme without delays requires that the clients maintain an open socket connection to the server throughout the session.

Besides managing connections as well as user and document information, the server forwards chat messages to their recipients and takes care of various bookkeeping activities related both to its own functioning and logging the users' actions for research purposes.

To avoid copyright issues and to make the use of EDUCO simpler for the administrator (course teacher), we have taken the approach that the documents (HTML-files) for a particular instance of EDUCO do not need to be copied to the EDUCO server. Instead, they can be located anywhere on the Web. To operate properly, the server still needs to know which document the user is reading to be able to send that information to all the other users in that instance. The operation has to work even when the users navigate along the hyperlinks in the documents and are not using the map view by double-clicking the document symbols. We have solved this problem by using the EDUCO server as a proxy. It

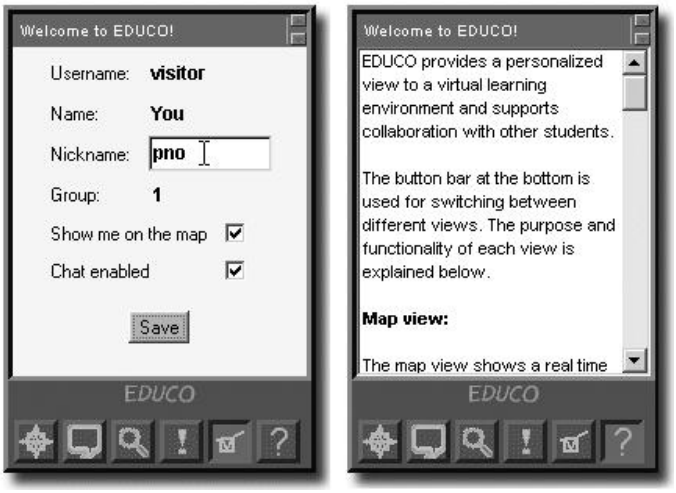

Fig. 4. The "preferences" and "help" views of EDUCO.

means that the documents are routed through the server instead of being sent to the client directly from their actual location. This requires two additional operations: clients are informed about the new location of the user and all of the links in the document are changed so that they point to their destination indirectly through the proxy. If the user then clicks one of these links, the same procedure is repeated in a recursive fashion.

Commenting the documents in an instance of EDUCO is technically based on the use of ordinary HTML-forms. Each document has an associated comment file, which is opened to its designated frame every time a user navigates to that document. The server keeps track of modifications and the visits of individual users. This way the documents that have been commented after the last visit can be distinguished visually from those that contain only comments the user has already seen.

As mentioned above, the documents change their colour on the map view depending on how much they have been read in relation to the other documents. The total time all users have spent reading each document is recorded by the server on an hourly basis. The change in the colour of an individual document is determined by the distance of its moving average for the last 24 hours from the same average for all the documents. Heuristic methods have been devised to make the colouring of the documents operate sensibly at the very beginning of the course and during the silent periods (weekends, holidays etc.). It is also appropriate to eliminate the disturbing effect of very long reading times by setting an upper bound after which the additional time is ignored. The value for the upper bound can be the same for all documents or adjusted according to the differences in the lengths of the documents.

4 Study setting

The course structure. The first empirical evaluation of EDUCO was conducted during a course entitled "Web-based learning" given at the University of Helsinki, Finland. The course is an advanced course in Computer Science studies. Twenty-four students participated in the course, some of them adult learners with varying backgrounds and degrees but most of them were CS majors. The type of the course was a "seminar" which means that the students have to pick a topic, prepare a 10-page paper on the topic and present it to the teacher and other students in the course. In addition, there were some short weekly assignments to complete.

There were only two face-to-face meetings during the course. The first was an initial meeting where the structure and requirements for the course were explained and the EDUCO system was introduced. The second face-to-face meeting was the final meeting where the students presented their papers. Everything else between the initial and final meeting was conducted on-line using EDUCO.

Only the real-time social navigation of the system was studied and not the use of the "footprint" information. Because of the small student population participating in the course, we fixed a primary time slot to make sure that there would be people in EDUCO at the same time. However, the time slot was not restrictive in any way.

Forty-three documents were first gathered into the instance of EDUCO to serve as a starting point for the topics in the course. The documents were clustered according to the six general areas to be covered: history of web-based learning, society and web-based learning, research findings, teaching and studying in a web-based course, course delivery systems, and providing adaptation in educational systems.

The data set for the study was gathered in three stages: (1) a pre test after the start of the course measured motivational level and learning strategies, (2) users' actions were logged during the course, and (3) a post test after the course measured how students' expectations met the reality.

Pre test. Motivational profiling in this study is based on the Motivated Strategies for Learning questionnaire (MSLQ), which is developed on the basis of a motivational expectancy model [7]. MSLQ measures both motivational factors and learning strategies. The motivation section (A) 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) Meaningfullness of studies, (4) Control beliefs, (5) Efficacy beliefs, and (6) Test anxiety [11]. We expected to find a similar structure in the sample data and thus to be able to construct sensible motivational groups.

Users' actions during the course. The user log from EDUCO (time stamp, user id, action) was recorded during the course from September 24 to November 20, 2001. The filtered log file of 1832 recorded actions (Fig. 5) was analysed in order to find what effect EDUCO's visual social navigation information had on the users' navigation behaviour.

occupied	occ_no	url	id	time_min	id_group
0	0	http://ijhcs.open.	mj	8,00	Group 2
1	4	http://ausweb.scu.	m	2,00	Group 3
0	0	http://194.100.30.	va	1,00	Group1
1	2	http://www.educaus	k	3,00	Group 2

Fig. 5. A sample of the filtered EDUCO log file.

The main level problem was operationalised into the following two sub-level propositions: firstly, did the users in general prefer occupied (someone else at the document, "occupied" = 1 in Fig. 5) documents over unoccupied (the document is "free" from other users, "occupied" = 0) ones? Secondly, did the users based on their pre test motivational group membership ("id_group") prefer occupied documents over unoccupied ones?

Post test. An email survey consisting of 17 open propositions was conducted two weeks after the course in December 2001. Propositions measured users' experiences and expectations towards web-based education together with attributes related to EDUCO (usability issues, user interface, functionality etc.).

5 Results

Pre test. The analysis of the "A" section of the motivational pre test questionnaire was carried out with a Bayesian dependence modeling tool named B-Course[3] [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, respondents were divided into three groups:

- Group 1 ("Blue", N=10) characteristics: (2) Extrinsic goal orientation, (6) test anxiety and (3) meaningfullness of studies.
- Group 2 ("Green", N=8) characteristics: (5) Efficacy beliefs, (1) intrinsic goal orientation and (3) meaningfullness of studies.
- Group 3 ("Red", N=6) characteristics: (4) Control beliefs and (1) intrinsic goal orientation.

The classification accuracy of the theoretical model [10] was confirmed with both a linear and nonlinear discriminant analysis (87.5% of original and 75.0% of

[3] B-Course URL http://b-course.cs.helsinki.fi

cross-validated grouped cases were correctly classified). There was no statistical signifigance between the group memberships of male and female respondents.

The group descriptions with clear explanations were published on the course web-site for all the participants, so that the students were able to use the information when completing weekly assignments or choosing a study partner.

Users' actions during the course. After filtering out the entry document from the log file, the analysis of the data (total number of logged events = 1832) indicated that the users preferred unoccupied documents (943 requests, 51.5%) over occupied ones (889 requests, 48.5%). The number of simultaneous readers in occupied documents varied from one to six with the following request frequencies: one reader (501 requests, 56.5%), two readers (268 requests, 30.2%), three readers (75 requests, 8.5%), four readers (35 requests, 3.9%), five readers (7 requests, 0.8%), and six readers (1 request, 0.1%). The results revealed no gender-related differences.

The results proved ($\chi^2 = 13.29$, p=0.01) that the respondents selected documents based on their pre test motivational group membership (Fig. 6). Members of the "Blue" group preferred unoccupied documents (N=496, 55.5%) over occupied ones (N=398, 44.5%). Students belonging to the "Green" group made no distinction between documents. This result is in balance with the group characteristics that emphasize intrinsic goal orientation and efficacy beliefs. Members of the "Red" group preferred occupied documents (N=234, 55.1%) over unoccupied ones (N=191, 44.9%) indicating a tendency towards social navigation.

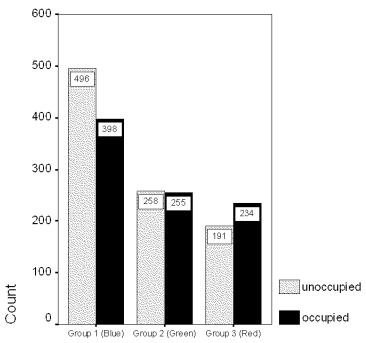

Fig. 6. Social navigation preferences based on pre test motivational group membership.

The third part of the log file data analysis focused on the reading times per document. The values of "Time" variable were categorised into six classes: 0–2, 2–5, 5–10, 10–30, 30–60 and 60–90 minutes. Reading sessions that lasted over 90 minutes were excluded from the analysis. This part revealed interesting group specific results. Members of the "Green" group spent the least time (x=2.7 min) per document compared to other groups ($\chi^2 = 19.38$, p=0.04). This result supports the "result-oriented" label of the group members. There was no difference

in reading times between the "Blue" (x=3.2 min) and the "Red" (x=3.6 min) group.

Post test. The third phase of this study was to analyse the propositions of the post test (the total number of propositions was 17). The total number of answers to the post test questionnaire was 17 (71%) out of 24. The sample data consisted of five female and twelve male students.

Results of the post test show that EDUCO was seen as a useful tool in the matters like adaptation to respondents learning, cognitive and motivational strategies, and means to implement collaborative actions.

> "It was very useful to see what documents other users were reading, it gave me many hints and saved time."
> "It was truly nice to be able to see what the most interesting document at the moment is and who is reading it."
> "Actually, in several cases I wanted to start a chat conversation with someone reading the same hyperdocument with me ...I guess this is social navigation?"

The presence of EDUCO increased task-related participation and was a valued tool for those who had difficulties to participate in face-to-face meetings:

> "The learning material was easy to access."
> "EDUCO gives more flexibility to the studying process."
> "It was possible for me to participate in this course and carry out all those tasks regardless of my domicile."

The real time interaction of EDUCO also elicited negative comments:

> "EDUCO hindered the formation of REAL social contacts!"
> "Chat never beats traditional face to face meetings."

EDUCO's tools for seeking work mates (group membership, search function) were truly useful for most of the respondents:

> "I was in a blue group, and when another blue was looking for a mate, I replied instantly. He had already chosen an article, I glanced at it and found that it was suitable for me too."
> "I had a group proposal via email message. As my forthcoming work mate had the same colour as I did, it was easy to make the decision to start collaboration. Afterwards I thought that I agreed so quickly because of the same motivational group, normally it takes more consideration. But to be honest, the topic was the most important factor."

6 Conclusions

EDUCO, a system based on social navigation for web-based learning, has been beneficial for some users. Moreover, using a system like EDUCO opens up other

important issues as well. The teacher of a web-course has an opportunity to re-think the learning process as a whole. Recent pedagogical approaches such as just-in-time learning can benefit, for example, from the possibility in EDUCO to form *ad hoc* study groups based on the motivational group information and the interest expressed for a certain topic. The students themselves are in control of forming the groups, thus shifting the emphasis towards peer-assisted and learner-centered education.

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