

# The Sociability of Computer-Supported Collaborative Learning Environments

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## ABSTRACT

There is much positive research on computer-supported collaborative learning (CSCL) environments in asynchronous distributed learning groups (DLGs). There is also research that shows that contemporary CSCL environments do not completely fulfil expectations on supporting interactive group learning, shared understanding, social construction of knowledge, and acquisition of competencies. There appear to be two major pitfalls impeding achievement of the desired social interaction in CSCL environments: taking social interaction in groups for granted and the lack of attention paid to the social psychological dimension of social interaction outside of the task context. Current solutions offered to avoid the pitfalls placed responsibility on instructors and teachers to encourage collaborative learning and social interaction. To both free educators from this burden and be more cost effective, we propose an intelligent CSCL environment. The environment is based upon a theoretical framework that suggests embedding certain properties in the environment to act as social contextual facilitators - social affordances - to initiate and sustain learner's social interactions. Finally, a group awareness widget (GAW) - a software tool providing the learner group awareness about the others in the task and in the non-task context - is introduced as an embodiment of this theoretical framework.

## Keywords

Computer-supported collaborative learning (CSCL), Distributed learning group (DLG), Group awareness widget (GAW), Social affordances, Social interaction, System sociability

## Introduction

The proliferation of new information and communication technologies provides new opportunities for designing and implementing advanced systems for computer-mediated *communication* (CMC) extended with facilities for group *coordination* and *collaboration*; we refer to these extended systems as CM3C systems. Integrating the advanced CM3C systems and deployed for group use, CSCL environments permit members to be geographically dispersed, thus relaxing the need to be co-located for meetings and discussions. In addition, members may engage in their working or learning tasks at any time, hence dismissing the need for co-presence - being physically together at the same location. The anywhere-anytime characteristic enables a shift from contiguous, real time learning groups to asynchronous distributed learning groups (DLGs). Embedding CM3C systems in CSCL-environments also increases their potential to support current insights in teaching and learning that rely heavily on the social interaction amongst the group members. These insights include interactive group learning, deep learning, sustained critical discourse, the social construction of knowledge and competency-based learning which we define as learning based on the acquisition of knowledge, skills, and attitudes and on the application of these in an ill-structured environment (Kirschner, Vilsteren, Hummel, & Wigman, 1997).

The anywhere-anytime characteristic and its potential to support interactive group learning have convinced many educators to believe CSCL environments to be the promising next generation of educational tools for distance education. Indeed, there is already a considerable body of research reporting positive overall performances of DLGs using contemporary CSCL environments. This euphoria should be tempered by the concomitant body of research reporting low participation rates, varying degrees of disappointing collaboration and low learning performances in terms of quality of learning and learner satisfaction in CSCL-environments (Hallett & Cummings, 1997; Heath, 1998). The negative results suggest that contemporary CSCL environments do not completely fulfil the high expectations of educators and learners. Hobaugh (1997, as cited in Muirhead, 2000) suggested that this might be why educators increasingly question whether the online format will provide adequate opportunities for genuine dialogue and social interaction vital for the learning process.

This discrepancy may be due to factors which, when not recognized, potentially could have a negative effect on overall group performance. Gunawardena (1995) observed that “In computer conferences, the social interactions tend to be unusually complex because of the necessity to mediate group activity in a text based environment. Failures tend to occur at the social level far more than they do at the technical level.” (p. 148). Our literature study (Kreijns, Kirschner, & Jochems, in press) has revealed two major pitfalls that impede achieving the desired social interaction in CSCL environments. The first pitfall is the tendency to assume that social interaction will occur just because the environment makes it possible. The second pitfall is the tendency to forget the social-psychological/social dimension of social interaction that is salient in various levels of *non-task* contexts (i.e., off-task interactions). Social interaction encompasses all interactivity between group members, including casual conversations and task-oriented discussions.

This article starts with a brief description of the two pitfalls. We emphasize that educators tend to limit social interaction to the task context (i.e., interaction only takes place in tightly defined learning settings) and the educational dimension (i.e., social interaction only serves on-task processes). We then propose an intelligent CSCL environment that is based upon a framework that advocates an ecological approach to social interaction. This ecological approach goes beyond the task dimension and suggests the incorporation of social affordances in the CSCL environment. The discussion is followed by the introduction of a group awareness widget (GAW) – an embodiment of social affordances – as a technological solution for initiating, encouraging, and sustaining social interaction in the two dimensions and in both task and non-task contexts. To concretize the concept, we present an example of a GAW that is hypothesized to exhibit some degree of social affordances contributing to the system sociability of CSCL environments.

## Two Pitfalls to Successful Social Interaction

The shift from face-to-face learning groups to asynchronous DLGs introduces specific requirements for the design of CSCL environments to overcome the constraints of space and time, and to compensate for many of the elements that typically occur in face-to-face learning groups. One of these elements is the seemingly effortless social interaction that takes place and has been recognized as the crucial element underlying the current interactive learning perspectives meant to encourage shared understanding (Mulder, Swaak, & Kessels, 2002, in this issue of *ET&S*), critical thinking (Bullen, 1998; Garrison, Anderson, & Archer, 2001), social construction of knowledge (Jonassen, 1991a, 1991b, 1994) and the acquisition of competencies (Jochems, 1999; Keen, 1992). According to Kearsley (1995) one of the most important instructional elements of contemporary distance education is interaction due to its positive affects on the effectiveness of distance educational courses. Social interaction appears to be particularly important for achieving shared understanding and the construction of knowledge based on the social negotiation of views and meanings. Hiltz (1984) underlined this when she stated that “the social process of developing shared understanding through interaction is the ‘natural’ way for people to learn” (p. 22). CSCL environments embracing group learning, critical thinking, constructivist learning, and competency-based learning emphasize social interaction.

Though there are many positive reports on learning and working in DLGs with CSCL environments (Cronjé, 1997; Gunawardena, 1995), there is also a body of research exposing negative learning experiences, low participation rates, and various degrees of disappointing collaboration and learning performances (Hallett & Cummings, 1997; Heath, 1998). In a recent literature review, Kreijns, Kirschner and Jochems (in press) found two factors or pitfalls that seem to account for the discrepancy. The first pitfall is the assumption that *social interaction can be taken for granted* and that it will automatically happen in the CSCL environment. Some educators think that because social interaction is easy to achieve in face-to-face learning groups, the same patterns of social interaction will be encountered in DLGs as well. Research has shown that this is not the case. Johnson and Johnson (1991a), for example, observed that when studying collaboration in face-to-face groups

just placing students in groups and assigning them a learning task does not in itself promote cooperation between and among group members. Rourke (2000b) concluded that social interaction in computer conferences cannot be taken for granted, just as it cannot be taken for granted in face-to-face settings.

The second pitfall is *forgetting the social-psychological/social dimension of social interaction* that is salient in non-task contexts. Wegerif (1998) pointed out that: “Many evaluations of asynchronous learning networks (ALNs) understandably focus upon the educational dimension, either learning outcomes or the educational quality of interactions, overlooking the social dimension which underlies this” (p. 34). He further noted that “forming a sense of community, where people feel they will be treated sympathetically by their fellows, seems to be a necessary first step for collaborative learning. Without a feeling of community people are on their own, likely to be anxious, defensive and unwilling to take the risks involved in learning” (p. 48). Rourke (2000b) found that certain conditions must exist before students will offer tentative ideas to peers, critique the ideas of peers, and interpret criticism as valuable rather than as a personal insult.

Figure 1 depicts the foci of educational research. Area 1 depicts the traditional focus. Area 2 depicts the focus we advocate in the design of collaborative group learning in DLGs. Although social interaction in the social-psychological/social dimension has little to do with task execution, we expect that various non-task contextual settings will foster this dimension of social interaction more than a task context. Additionally, social interaction in the non-task context tends to be more casual and more informal than in the task context.

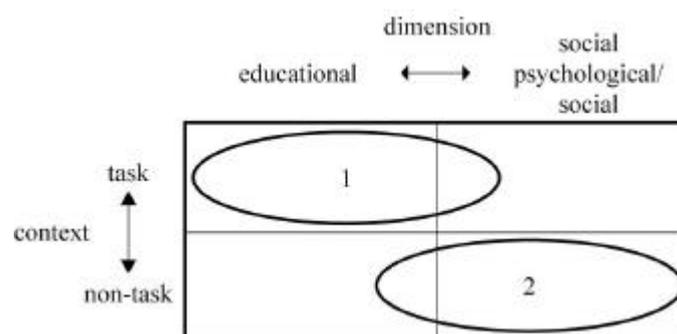


Figure 1. The foci of research and work in the design of collaborative group learning in DLGs

Task and non-task contexts have no fixed walls between them. We often see that students working on tasks easily and frequently switch to a non task-context for a short while and then back to the task context. Northrup (2001) stated that through social interaction (i.e., casual interaction) “learning more about peers and connecting them in non-task specific conversation is more likely to occur. Although social interaction may have very little to do with a course, it is still valued as the primary vehicle for student communications in a Web-based learning environment” (p. 32).

## Outcomes of Social Interaction

Social interaction is important for establishing a social space in which a structure can be found that encompasses social relationships, group cohesion, trust and belonging, all of which contribute to open communication, critical thinking, supportive interaction, and social negotiation. This is why educators have found a positive relationship between social interaction in the social-psychological dimension/social dimension and learning performance in terms of the learning outcomes and learner satisfaction. Without this, achieving consensus and agreement are not likely (Walther, 1996). Once positive affective relationships and a sense of community have been established, enhanced task accomplishment may be achieved (Gunawardena, 1995).

Jehng (1998) further noted that “collaborative learning involves social interactions between participants, and the psycho-social processes underlying collaborative interactions could be an important factor that impacts learning” (p. 22). Liaw and Huang (2000) noted that “social and interpersonal interaction are able to directly foster content and instructional interaction” (p. 43). Additionally, Gunawardena and Zittle (1997) found that social presence - the social climate perceived by students and created by using CMC - is a good predictor of learner satisfaction. The object of good educational design is not only the improvement of efficiency and effectiveness, but also the improvement of *satisfaction* – the third component of good instruction and instructional design (Kirschner, Hermans, & de Wolf, 1995)

Both of these outcomes (learning performance and social performance) are depicted in Figure 2 - the outcomes and factors are boxes and processes are circles.

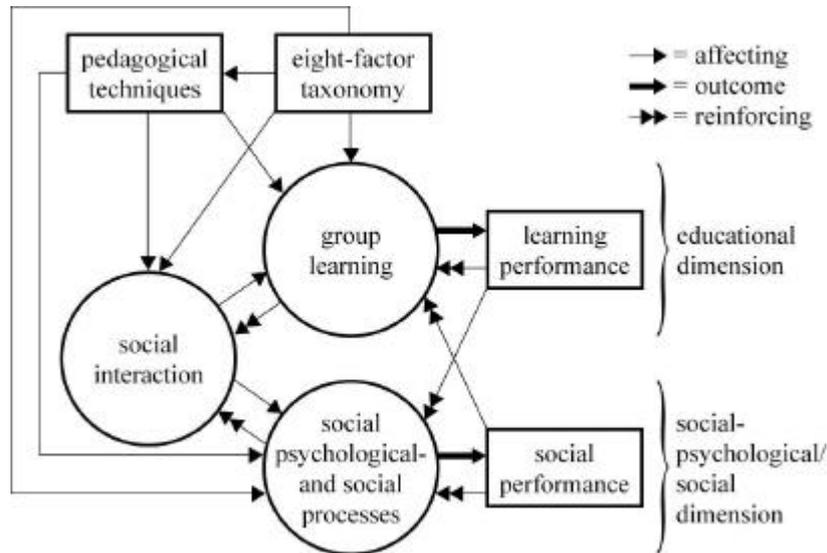


Figure 2. The dimensions of learning in distributed learning groups with their outcomes

A taxonomy of elements affecting social interaction and group learning was derived from a literature study on the stimulation of social interaction in collaborative learning environments (Kreijns, Kirschner, & Jochems, in press). The eight factors are: (1) appropriate teacher behaviour; (2) appropriate member behaviour; (3) nature of the learning tasks; (4) member roles; (5) task resources: knowledge or physical resources that enable execution of the task; (6) goal definition: describing the purpose of the collaboration; (7) formative evaluation with feedback from peers or from educators; and, (8) summative evaluation and reward structure.

This taxonomy provides educators and instructors with concrete ‘handles’ for developing pedagogical techniques to stimulate collaboration, member participation, and/or social interaction. Examples of such pedagogical techniques include the jigsaw classroom (Aronson, Blaney, Stephan, Sikes, & Snapp, 1978) and student teams-achievement divisions (Slavin, 1994). This taxonomy can also be used to classify research efforts. Johnson and Johnson (1989), for example, advocate positive interdependence as a key for successful collaboration. Positive interdependence is “the degree to which participants perceive they are interdependent in that they share a mutual fate and that their success is mutually caused” (Johnson & Johnson, 1991b, p. 174). Using or combining primitive factors from the taxonomy such as member roles and goal definition can create positive interdependence. This can then create goal interdependence, which is defined by them as the state in which “individuals perceive that they can attain their goals if and only if the other individuals with whom they are cooperatively linked attain their goals” (p. 181).

## The Support of Social Interaction

Encouraging social interaction in either dimension requires tremendous effort. Mason (1991, cited in Muirhead, 2000) found that tutors play a major role in directing on-line discussions, influencing the discussion by entering new topics, sharing new material and redirecting conversational patterns. Gunawardena (1995) noted that “the impetus falls upon the moderators of computer conferences to create a sense of online community and make space for social interaction to take place” (p. 162). Muirhead (2000) concluded that “educators play a vital role in promoting consistent and relevant interaction between students and with their tutors.” (p. 5). Other researchers (Berge, 1995; Hiltz & Wellman, 1997) also place responsibility for social interaction on instructors and teachers.

Intelligent CSCL environments can be used for supporting or automating some guidelines, strategies, and recommendations suggested by educational researchers thereby freeing educators and instructors from some coaching responsibilities. Intelligent CSCL environments promise to be more cost-effective since there are less educators and instructors needed or their involvement in the education process is reduced. Soller (1999) and

Soller *et al.* (1999) have developed two collaborative learning tools that automate the analysis of collaborative learning interaction and activity.

However, research on intelligent CSCL environments is just beginning, particularly for research on environments incorporating support software for initiating, sustaining, and promoting social interaction in the social-psychological dimension. Until the arrival of such intelligent CSCL environments, we only have contemporary CSCL environments relying on common/generic software. For collaborative learning and social interaction in DLGs to be successful we can do no more than carefully look at present strategies, guidelines and recommendation and apply them when and where relevant.

In the rest of this article, we take a next step in furthering intelligent CSCL environments, concentrating on the social-psychological dimension. Our interest is in how technology can be exploited to autonomously support the initiating and maintaining of social interaction rather than supporting teachers and educator in their efforts to establish social interaction. It is not our aim to draw on the educational strategies developed for face-to-face learning groups for encouraging social interaction and then transfer or apply these in a DLG. Many education researchers have suggested this approach (Brush, 1998; Harasim, 1991; Hooper, 1992). We feel this would be too limiting and constrain us to an older model. Instead we prefer to start from a quite different point that leaves face-to-face groups behind and takes the intrinsic characteristics and possibilities of technology into consideration when designing the CM3C systems of these CSCL environments. It is analogous to the beginning of the area of television when the first television programs were no more than looking to a performance on a stage from a fixed camera position. In that era it was really ‘tele’-vision. Television now has totally changed because television makers started to exploit the typical characteristics of television, merging this with modern technology. Examples include working with and superimposing/morphing multiple cameras and camera angles or even simpler by using visual techniques such as blurring to signify thoughts and/or dreams.

We primarily consider DLGs in distance educational settings such as those found at the Open University of the Netherlands (OUNL). The characteristics include:

1. *History*: Participants are initially unacquainted with each other and the DLG starts with no history. Face-to-face (e.g., kick-off) meetings are impractical due to the geographic distance between participants.
  2. *(A)synchronicity*: Collaboration is predominantly asynchronous and there is a long-term engagement (a couple of weeks to months). Time deferred collaboration not only complicates social-psychological and social processes taking place, but also the task execution due to the need for task coordination- and participation on problems. This in turn indirectly affects the social psychological- and social processes.
  3. *Sequencing*: The DLG will be engaged in a number of tasks; the sequence of execution is not known in advance.
  4. *Topology*: We associate a node in an electronic network with a single computer connected to that network. Since OUNL-students usually work ‘alone’ and have their own computer, each group member is considered to be a node in the electronic network (Figure 3a).  
Other educational contexts may use sub-groups of face-to-face contiguous members, each sub-group sharing one computer that connects the group with the computers of other sub-groups. Since a sub-group has only one computer, the sub-group is considered to be a single node in the network (Figure 3b).
- We focus on students working alone with their own computer, because we are interested in the social interaction between individuals rather than between groups.
5. *Group composition*: Group composition comprises: (1) group size; (2) grouping of abilities; (3) age; and, (4) gender. Our groups typically have no more than ten members and are heterogeneous with respect to gender, age and ability.

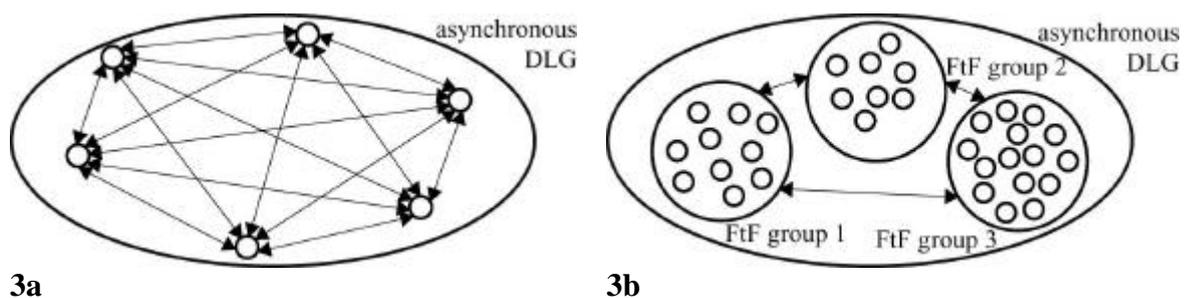


Figure 3. Topology: a) each member is a node; b) a sub-group is a node

## Theoretical Framework

### Social Affordances

The framework suggests incorporating properties into the CSCL environment that facilitate the triggering of a new phase in which social interaction may take place. These properties – social affordances – ultimately create a social space amongst the members of the DLG. Before formally defining social affordances, we first present an example to elucidate the ideas behind the concept from a more general perspective. The example discusses the ‘sit-affordance’ of a wooden bench.

A log can be considered to have a sit-affordance. A hiker who has walked for hours and passes the log on a walk along small country roads might perceive the sit-affordance of the log as a function of the degree of fatigue. A very tired hiker will sit on the log but will not lie down (unless the log is fairly long, i.e., also has a lie-affordance). A fit hiker might not even pick up on the sit-affordance of the log and pass it by. The log is in that case no more than a piece of wood with no further meaning.

Social affordances are properties of CSCL environment that act as social-contextual facilitators relevant for the learner’s social interactions. When they are perceptible, they invite the learner to act in accordance with the perceived affordances, i.e., start a task or non-task related interaction or communication. This definition of social affordance is inspired by the term technological affordance (Gaver, 1991). Both are specializations of the general term ‘affordance’ described by Gibson (1986).

Social affordances encompass two relationships:

1. The *reciprocal relationship* between the DLG member and the CSCL environment: On the one hand, the social intentions of the member must be fulfilled by the CSCL environment as soon as these intentions arise or the opportunity for a meaningful episode of interactivity is lost. On the other hand, the social affordances of the CSCL environment must be meaningful and must support or anticipate the social intentions of the DLG member.
2. The *perception-action coupling*: Once a fellow DLG member becomes salient (perception), the social affordances not only invite but also guide another member to initiate a task or non-task related interaction or communication with the salient member (action). The salience of the other member may depend upon factors such as expectations, attention focus, or current context.

The two relationships are interdependent and thus closely related. Perception and action are the result of both the intentions of the group member and the social affordance of the CSCL environment. Similarly, intentions and social affordances elicit both perception and action. The two relationships are depicted in Figure 4. How a set of social affordances can be operationalized will be discussed later.

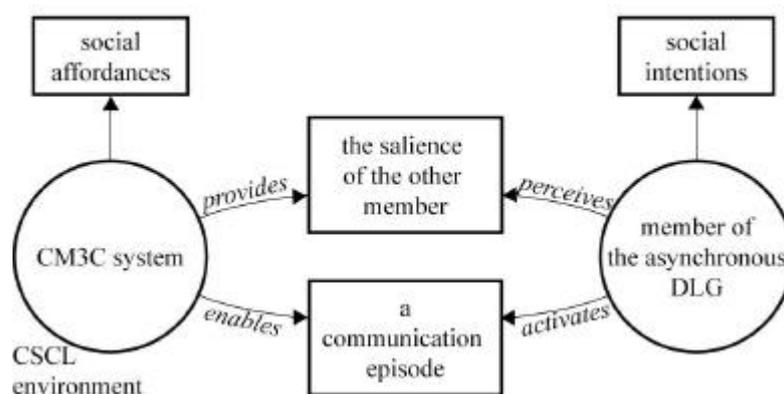


Figure 4. The reciprocal relationship and the perception-action coupling

### The sociability of CSCL environments

Social affordances encourage social interaction, which is responsible for establishing a social space. The extent to which a social space arise depends, among other things, on the quality of the set of social affordances. We might expect that a good set of social affordances will establish the desired sound social space that is

characterized by an affective structure, trust and belonging, its warmth and unthreatening element. We define the (*system*) *sociability* of a CSCL environment to be the extent the CSCL environment is able to give rise to such a social space. This definition corresponds with Rourke et al. (1999) who assessed the social presence in two computer-conferencing classes: “This [the results of the assessment] confirmed the intuitive impressions that we formed while reading the transcripts of the sociability and educational effectiveness of the two conferences” (p. 66). At this point, we need to define two key concepts: social space and system.

*Social space* is a commonly used concept by researchers and teachers (Harasim, 1993), although similar terms such as ‘social climate’ (Gunawardena, 1995), ‘on-line atmosphere’ (Brandon & Hollingshead, 1999), and ‘social environment’ (Rourke, 2000a) are also used. Systems with low sociability may experience problems with the emergence of a social space. CSCL environments that are high in sociability are referred to as *social CSCL* environments.

A *system* is a set of interacting, interdependent components which when used in combination accomplish something that no one component can do alone. This can include a *social system* which is defined as “a set of interrelated units that are engaged in joint problem-solving to accomplish a common goal” (Rogers, 1995, p. 23). Preece (1999, 2000) considered sociability to be a property of a human *social* system such as a virtual community. In her definition sociability deals with the set of social policies that support the community’s purpose. We limit the use of the term system to technical systems such that sociability is associated with social-technological systems. Both connotations, however, focus on social interaction.

There is a relationship between social presence and system sociability. *Social presence* is associated with communication media and is defined as the “degree of salience of the other person in the interaction and the consequent salience of the interpersonal relationships ...” (Short, Williams, & Christie, 1976, p. 65). In other words, the degree to which a communication partner appears to be physical real to the one communicating. This definition differs from Gunawardena’s (1995) definition of social presence as the perceived social climate in a CMC environment. Sociability is a strength or potential associated with an environment. We are exploiting this relationship in the construction of an assessment instrument for system sociability. We assume that social presence (per Short, Williams, and Christie, 1976) might be a predictor of system sociability.

### **Achieving teleproximity through group awareness**

Social affordances in CSCL environments need to be based upon the concept of *teleproximity*. Teleproximity is a term used to designate that proximity (i.e., nearness/immediacy) is brought to a group of people via telecommunication systems, computer networks, et cetera. Another term for teleproximity could be ‘virtual proximity’. Proximity (Festinger, Schachter, & Back, 1950) leads to social relationships and even close friendships between people. Kraut, Egido, & Gallegher (1990), while confirming this, also found that through informal communication collaborative relationships can be established. Informal communication is also important at the task level. Studies of informal communication in organizations have suggested that informal communication facilitates the transfer of essential information related to task-specific activities (Tang & Morris, 1996). Research shows that most interactions in the work environment take place during chance encounters (Kraut, Fish, Root, & Chalfonte, 1990; Whittaker, Frohlich, & Daly-Jones, 1994).

We synthesize these findings in Figure 5. The connecting lines may have different meanings, ranging from “will encourage” to “will affect” to “will lead to”. Thick lines have the connotation of “highly”, “more” or “strong”, dashed lines of “less” or “weak”. For example, a feeling of ‘proximity’ (level 1, top left) will encourage both impromptu and planned encounters (level 2), while a lack of this feeling (level 1, top right) might encourage only planned encounters. The figure is not complete and many more other aspects might be integrated. The four levels that satisfy our purposes are proximity (near/far), encounters (planned/not-planned), conversation (on-task/off-task) and communication (non-formal/formal).

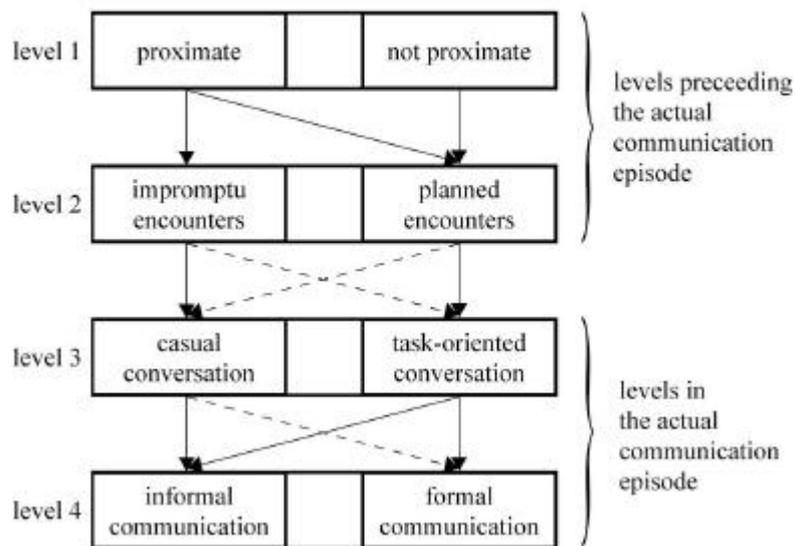


Figure 5. Synthesis of the findings in four levels

#### About group awareness: Media-spaces

Teleproximity is created through *group awareness*, the condition in which a group member perceives the presence of the others and where these others can be identified as discernible persons with whom a communication episode can be initiated. The provision of group awareness was inspired by *media-space research* conducted at Rank Xerox EuroPARC (Cambridge, England), and Xerox PARC (Palo Alto, California). Prototype systems were built using media-space technology to support general awareness in the geographically split research group. Media-space research on group awareness concentrates on supporting impromptu encounters that will facilitate informal communication. This research deals with levels 2 and 3 as depicted in Figure 5.

A media space is an environment built from video, audio, and computing technologies. More specifically, it is “an electronic setting in which groups of people can work together, even when they are not resident in the same place or present at the same time. In a media space, people can create real-time visual and acoustic environments that span physically separate areas. They can also control the recording, accessing and replaying of images and sounds from those environments” (Bly, Harrison, & Irwin, 1993, p. 30). Computer screens display low-resolution video images, simple animations, or glances (occasional one-way full video connection of a few seconds duration) to determine an appropriate moment of contact (Boming & Travers, 1991; Dourish & Bly, 1992; Gaver et al., 1992). Media-space researchers believed that group awareness provides opportunities for chance encounters, thereby stimulating informal communication.

Media-space research touches the problem of *privacy*. In a media space, a user might feel uncomfortable knowing that someone may be observing her or him at any given moment. This makes video images and glances very intrusive. Gaver et al. (1992) disputed that social convention will regulate privacy concerns. Other researchers do not fully agree with this suggesting that this might be why these systems will not fully support informal communication and unintended encounters (Obata & Sasaki, 1998; Tang & Rua, 1994). To handle issues related with intrusiveness, Xerox PARC and EuroPARC researchers have formulated two design principles: control and symmetry. Control enables the user to regulate the kind of information that is being made available to the observer; symmetry requires that in turn, information delivery will be reciprocal (Boming & Travers, 1991). Whatever the case, it is clear that privacy will have to be addressed by any system creating group awareness.

Although media-space researchers neither examined the social psychological aspects nor the details of group forming and group dynamics of mediated communication, they report that informal communication did establish collaborative relationships (Kraut et al., 1990). This suggests that group awareness in a non-task context provides just enough opportunity for the transfer of socio-affective information.

## Group Awareness Widgets

Media-spaces use group awareness as a vehicle to provide teleproximity. The provision of teleproximity in media space currently limits group awareness to information about who are present, where they are, and a global indication of what they are doing. In other words, one can see that someone is working at the computer or having a discussion with a colleague but remains uninformed about the subject of the discussion or the kind of activity that is being done and how that activity is related to the (probably also unknown) task. In order to provide more information than is the case with media spaces, we introduce the concept of commonalities and associate it with group awareness.

*Commonality* is a container term for anything that refers to a mutually shared thing, activity, use, idea, background, interest, status, and so forth. A common term can be used to give group awareness a context. The use of more than one commonality allows us to have different kinds of group awareness at the same time. Each kind of group awareness is limited to those members who are engaged with the underlying commonality. This information is supplied passively through detectors or actively through input from the DLG member. The former is preferred, but the latter is sometimes unavoidable. The commonalities used in media-space research can, for example, be identified as ‘being in the office of researcher x’ and ‘being in the public place’. Examples of commonalities not found in media -space research are ‘visiting the digital library’, ‘writing a paper about pipeline data hazards in microprocessors’, and ‘having an interest in agent technology’.

A *group awareness widget* (GAW) is a software tool for implementing different kinds of group awareness while at the same time enabling its members to communicate with each other. GAWs create social affordances and, therefore, should be embedded in CSCL environments. We have depicted this in Figure 6, along with the asynchronous DLG operating at the task-oriented and socio-emotional levels. The former encompasses group learning and represents the educational dimension. The latter encompasses the social-psychological and social processes. Because the CSCL environment embeds the CM3C system, it is a technical system, and because the asynchronous DLG is a social system, both are drawn in Figure 6 as circles. Figure 6 also shows how the CSCL environment affects learning and social performance, both of which are outcomes of the asynchronous DLG. The factors that set up the eight-factor taxonomy can either initiate learning processes or socio-emotional processes. GAWs may vary in the number of commonalities and in the way these commonalities are distributed over task-orientation and socio-emotional-orientation.

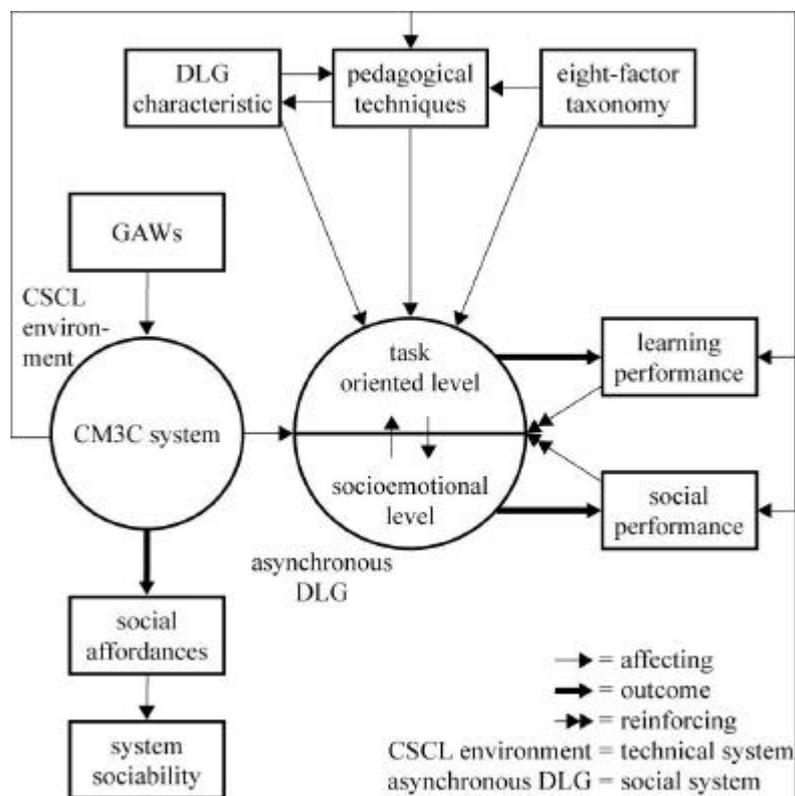


Figure 6. GAWs , social affordances, and asynchronous DLGs

Contrary to media-spaces, GAWs do not use persistent connections to transfer group awareness data. A more practical and realistic situation is where DLG members expose their own distributions of connection times and durations. This is a consequence of asynchronous DLGs. In order to let DLG members know what has happened while they were not connected to the CSCL environment all group awareness data are logged. Of course, not all kinds of data can be logged due to the nature of the data (e.g., long video streams) and technological constraints (e.g., limited system memory). For these situations, substitutes for the genuine data are found. The logged group awareness data is the 'history' of the group members' engagements with the commonalities involved. When group members connect to the CSCL environment, this history - in combination with recent group awareness data - is presented to them. Both history and group awareness data are continuously updated at regular (short) time-intervals: recent group awareness data becomes part of the history, and up-to-the-minute group awareness data becomes recent data. By inspecting the history, the DLG member can, for example, see where fellow members were at an earlier time and what they were doing. Inspection of the recent group awareness data shows which fellow DLG members are also currently online.

## **An Example of a Group Awareness Widget**

In order to make the GAW more concrete, we present an example of a GAW as one of the many possibilities that could be designed and implemented. Figure 7 presents how such a GAW *could* look to achieve a number of commonalities. This mock-up is only meant for giving a first impression of how we think some data *might* be displayed.

### **Managing group awareness through inspectors**

In this GAW, we assume the existence of a number of *inspectors* (representing a type of software agents), each of which is responsible for exactly one commonality. The perceived social awareness results from graphically displayed data collected over time by these inspectors. An inspector logs specific member behaviour (their actions, utterances and expressions that address commonality). Depending on the kind of member behaviour, and thus on the type of data that have to be collected, inspectors may be anything from an intelligent autonomous software agent to a simple piece of software, such as a counter. Inspectors may be customized to meet certain member needs. If, for example, the inspector's commonality is a website (e.g., a virtual team library), the member may specify the URL of that web site. Members can also define personal sets of inspectors. Through selection of a subset of inspectors from a (large) predefined list, members can select the kinds of social awareness that they either need or wish. Defining a personal subset of inspectors is not definitive. Members may augment their personal subset by adding new inspectors from the predefined list, replace old inspectors or even may define a complete new personal subset of inspectors.

### **Interaction design**

Each inspector graphically displays its collected data in a separate segment within a window, each having its own time-axis. When a DLG member is engaged with the inspector's subject of focus, the inspector will display a stroke along the time-axis. The stroke-length is an indication of the duration of the engagement. If a member has multiple engagements with the same subject, but at different times, then the inspector will associate the member with a series of strokes. An inspector logs the behaviour of multiple members. The strokes do not differentiate between members, but the inspector knows which series of strokes belongs to which member. By moving the mouse over a stroke, the complete series of strokes to which the single stroke belongs, will be highlighted, and the name of the owner is displayed.

The time-scale chosen is not linear, but 'logarithmic'. This enables displaying both a point that is close to time ' $t = 0$ ' (now), and a point that is close to time ' $t = -\infty$ ' (long time ago). Strokes close to time ' $t = 0$ ', indicate engagements that just happened a moment ago; these strokes are detailed. When strokes are time ' $t = 0$ ', this indicates that the stroke-owners are currently online. Strokes in the neighborhood of point ' $t = -\infty$ ', indicate engagements that happened a long time ago: these strokes are compressed and less detailed.

The window containing all the segments will be displayed as a circle. Figure 7 gives an impression of this. As can be seen, ' $t = 0$ ' is on the edge of the circle and ' $t = -\infty$ ' is at the center. If an inspector detects an engagement, the segment associated with the inspector will start to display a stroke at time ' $t = 0$ '. As time

passes, the strokes will move towards the center. Due to the logarithmic time-axis, this movement will gradually slow down. As a result, the area around the center will become full of strokes.

Using a logarithmic time-axis and displaying the segments as depicted in Figure 7, reflects a way of giving more attention to events that have happened just a moment ago than to events that happened longer ago. The longer the time passed, the more an event loses its topical value.

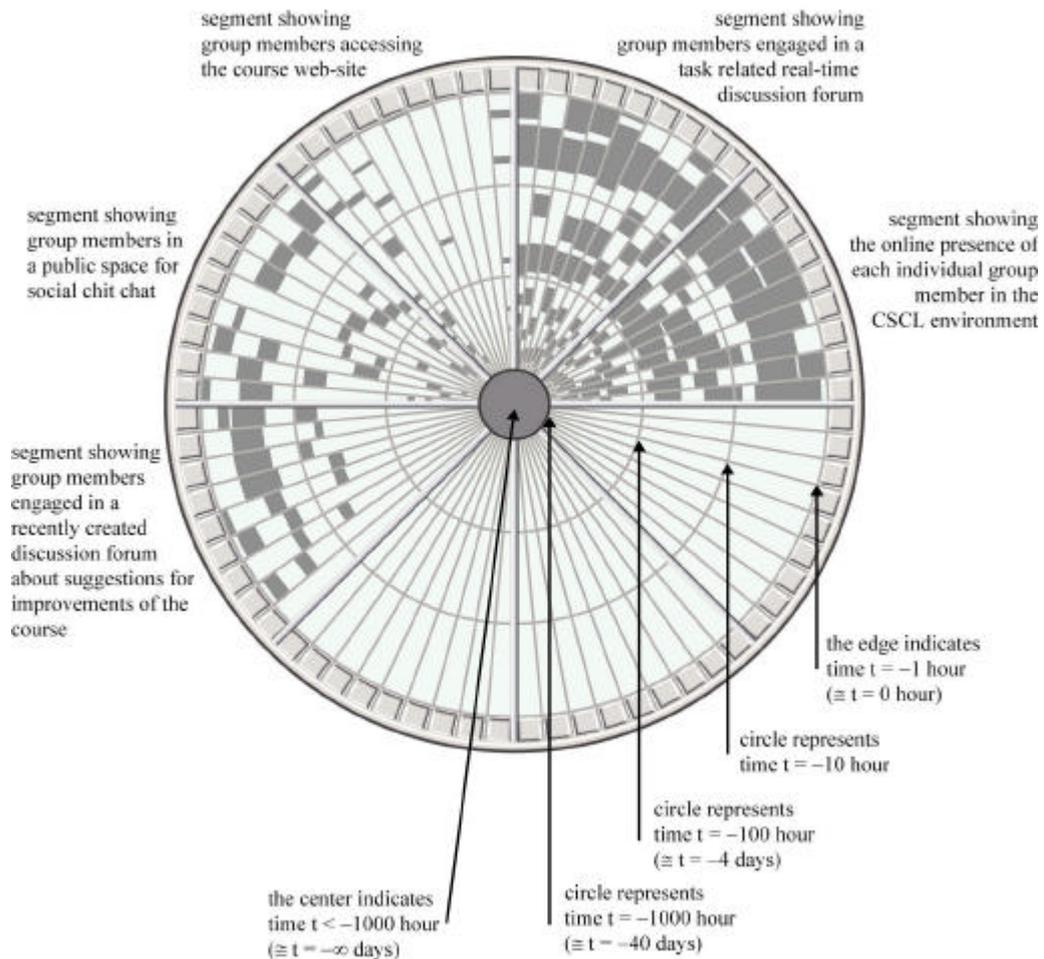


Figure 7. Mock-up of the window displaying data in five segments.

## Communication

The system will provide real-time communication as well as asynchronous communication. Clicking on the edge of a segment will open a dialog box (not shown in Figure 7) displaying the names of the DLG members who are currently online and are associated with the segment. Clicking on a name opens a second dialog box in which the allowed communication modes appear. This may be text-only, audio-only, or video conferencing. A request for conversation is sent prior opening the communication channel. Asynchronous communication modes will encompass e-mail and other asynchronous possibilities (e.g., real audio files, et cetera).

## Future Work

As in face-to-face groups where teachers and learners are walking around, learning and working, having meetings, searching in the library or resting in the coffee corner, embedding of GAWs in a CSCL environment can help bring such a social environment (including the task- and non-task contexts) into a DLG. Embedding GAWs in a CSCL environment completes the full range of collaboration in a DLG to enhance social interaction and, thus, interactive group learning, collaborative knowledge construction and competency-based learning.

There is a lot of work to do. Presently we are designing and implementing a GAW. We are also constructing and validating an assessment instrument for determining the sociability of CSCL environments. This instrument is a questionnaire composed of Likert scale items and is predominantly based upon two existing instruments developed for social presence by Gunawardena (1995) and Gunawardena and Zittle (1997). Factor-analysis of data gathered will either determine the elements of the required sociability measurement instrument or reveal that the instrument is actually encompassing the two existing instruments.

Once the GAW and the sociability measurement instrument are completed we will conduct empirical research to answer the following two research questions:

1. How and to what extent does a well-designed (i.e., meeting a number of usability criteria) GAW affect the sociability of the CSCL environment?
2. How and to what extent does sociability affect learning performances?

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