Supporting Collaborative Learning in Recitation Sections Using an Ambient Awareness Tool

Hamed S. Alavi, Pierre Dillenbourg, Swiss Federal Institute of Technology, 1015 Lausanne, Switzerland
Email: Hamed.alavi@epfl.ch, pierre.dillenbourg@epfl.ch

Abstract: We study the effect of an ambient awareness tool, named *Lantern*, on the quantity and structure of collaboration in recitation sections (i.e. when students work in small teams on the exercise sets with the help of teaching assistants). Lantern is an interactive lamp that with colors, intensity of light and blinking represents a piece of information. In a Lantern-equipped recitation section, every team is provided with one Lantern which shows the current status of that team: the exercise they are working on, if they called the teaching assistants for help, and since when. The results show that (1) Lantern increases intra-team collaboration while teams are waiting for teaching assistants and (2) it increases the diversity of inter-team communication, that is, each team communicates with a larger number of other teams, and there are fewer teams who never communicate with others.

Introduction

In university teaching, recitation sections are sessions in which students solve pre-assigned problems while one or more teaching assistants (TA) provide support by answering questions. These sessions supplement lectures by providing an informal learning atmosphere that allows collaboration among students and supports it by supervision from the TAs. Consequently, the efficiency of a recitation section highly depends on the level and structure of collaboration among students as well as the effectiveness of TA supervision. In order to get insight on the efficiency of the recitation sections, we observed and videotaped 12 recitation sessions in our school. The analysis on the recorded data showed some problems. For example, (1) students spend a considerable amount of time and cognitive effort to catch the attention of TAs when they need help, (2) they usually have a limited circle of friends with whom they collaborate, and (3) in many cases, when choosing which team to assist, the TAs fail to notice or respond to more pressing requests.

We believe that many of the shortcomings are due to a lack of awareness information both on the part of the TA and among the students themselves. We thus proposed an awareness tool, called *Lantern*, which gives information on the status of students: who is working on what exercise, who has asked for help and since when. In our previous work we have shown that Lantern can improve the efficiency of interaction between students and TAs (Alavi, Dillenbourg, & Kaplan, 2009). We were also interested to find out whether informing students about the status of the others would encourage a higher level and more complex structure of collaboration. This paper focuses on answering the question of how does Lantern affect collaboration in recitation sections? For instance, from our previous study we know that, when using Lantern, students are much more productive while waiting for the TA. An interesting question is whether Lantern also increases collaboration in this waiting time.

Our comparative analysis on six Lantern-equipped and six regular recitation sections shows that Lantern increases the intra-team collaboration when students are waiting for TA. Moreover, Lantern changes the structure of inter-team communication, such that each team communicate with a larger number of other teams and that there are fewer teams who never communicate with others. Please note that we intentionally avoid referring to the interactions taking place among groups as collaboration. On the other hand, the joint effort within a team to solve exercises validates the criteria of collaborative learning (Dillenbourg, 1999).

The reminder of this paper is organized as follows. First we explain the recitation sections as the context of this work. The next section describes our tool Lantern. Then we explain our past experiment along with a summary of its results followed by the new research questions. We answer the questions, through an experiment described in the next section as well as the analyses on the collected data. We summarize the relevant research and finally draw some conclusion.

Context: Recitation Section

In general, the recitation section is a complement to the lecture session as a university pedagogical practice. Students work on their assignments, individually or in small groups. Depending on the demand of the class, a number of teaching assistants are present to give help, hints or in some cases public explanation. When they need help, students raise their hand and wait for the TA.

In particular, the recitation sections we studied shared the following properties:

- Attending the class was not mandatory for the students.

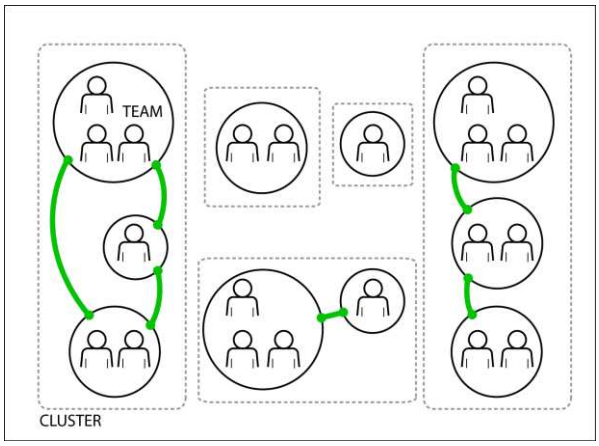

Figure 1. Structure of Interactions in Recitation Sections.

- 20-35 students attended each session, working individually or in small groups of at most 6.
- Figure 1 shows the structure of collaboration in a recitation room. Teams sat closely and went through the exercises together. They had limited interactions with some of their neighbors. In a session, there are 3-5 completely disconnected *clusters* of teams.
- 1-3 TAs ran each session.
- Each session lasted about 2 hours, while students were allowed to leave earlier.
- 3-8 exercises were assigned for each session.
- The exercises were usually theoretical in that they only involved pen and paper.

Tool: Lantern

Lantern, shown in Figure 2, is a small and portable lamp which consists of five pairs of Light-Emitting Diodes (LEDs) installed in a column and covered by a blurry plastic cylinder. A microprocessor controls the LEDs. Each team is provided with a Lantern, which makes use of a very simple visual grammar to show the status of that team:

- **Color:** The color of the team's Lantern indicates the exercise they are currently working on.
- **Intensity of light:** It grows up with time on the five floors of LEDS and specifies the time that has been spent on the current exercise.
- **Blinking:** It indicates that the team is calling the TA for help.
- **Frequency of blinking:** The rate of blinking increases with time, showing for how long the team has been waiting for the TA.

Users can interact with Lantern by turning it to choose an exercise and by pressing on it to call for help. Each lantern records all user interactions, which can be downloaded through a USB connection for analysis.

Figure 2. Lantern.

Past Observations

We started by conducting a field study in which we watched and videotaped three recitation classes for four consecutive weeks. The analyses on this observation led to the idea of Lantern. To evaluate the first prototype of Lantern, we set up an experiment in which Lantern was used in two courses through four weeks of recitation. The main result was that the *productivity* of students, *while waiting* for the TA, improved remarkably. The details of the field study and the first experiment along with the analyses and results are reported in our previous work (Alavi et al., 2009). In the following, we recall the concept of *while-waiting productivity* and use it to explain our new research questions.

While-waiting Productivity

According to our observations, in the control condition, when teams have to wait for the TA, they spend a considerable amount of time chasing the TA, i.e. trying to catch her attention. We defined while-waiting productivity as the fraction of the waiting time that is not spent on the chasing. We use this parameter as an indicator of the teams' efficiency during this waiting time. In the first experiment, students had 94% while-waiting productivity when they used Lantern and 38% when they did not (Alavi et al., 2009).

Note that the waiting time can be considerably long, (depending on the number of demands and the number of TAs). Table 1 shows how long, in average, a team had to wait for the TA over a session, in the field study and the first experiment. Furthermore, the performance of students during the waiting time is of special interest, since this is usually a high value period when students are challenged with and focused on the exercises.

Table 1: Waiting time in actual recitation sections.

	Field study	First experiment (with Lantern)
Avg waiting time (min)	21	16
Max waiting time (min)	36	27
Avg session length (min)	98	87

Research Questions

A while-waiting productivity of 94% means that students use 6% of their waiting time chasing the TA. An interesting question is what do students do during this 94%? Specifically, do they collaborate and what is the influence of Lantern on that?

We believed that, Lantern can encourage both intra-team collaboration and inter-team communication, especially when students are waiting for TA. If members of a team need help while trying to solve a problem together, they can press on Lantern and continue the collaboration, whereas without Lantern, they usually stop the collaboration and start chasing the TA to get her attention. On the other hand, if a team waiting for help on an exercise realizes that their neighbors have already solved that exercise may ask from that team, which triggers inter-team communication. We thus, posed the following questions:

- *Q1.* Does Lantern increase intra-team collaboration while the team is waiting for TA?
- *Q2.* Does Lantern increase intra-team collaboration while the team is NOT waiting for TA?
- *Q3.* Does Lantern increase inter-team communication while the teams are waiting for TA?
- *Q4.* Does Lantern increase inter-team communication while the teams are NOT waiting for TA?

We were also interested to evaluate the effect of Lantern on the structure of inter-team communication in the classroom level (Figure 1):

- *Q5.* How does Lantern affect the structure of communication among teams?

To answer the above questions, we designed an experiment which is explained in the next section.

Recent Experiment

Third-year students of computer and telecommunication sciences are observed during six regular and six Lantern-equipped recitation sections. Table 2 shows the basic parameters of the sections.

Table 2: Observed sessions in the control and Lantern conditions.

Condition	# sessions	# students	#teams	team size
Control	6	23-34	12-14	1.7-2.4
Lantern	6	20-29	10-13	1.8-2.2

Data Collection

One observer (the first author of this paper) tried to note every interesting event, especially the collaboration among students which are mostly recognizable as verbal interactions and certain body postures. Considering the small size of the classrooms, it was not a problem to distinguish the topic of the conversations (relevant or irrelevant to the course material). More precisely, the observer, with a one-minute precision, registered whether each student is (1) working individually, (2) collaborating with a teammate, (3) communicating with another team, or (4) not engaged in the exercise set (e.g. Table 3).

Table 3: The work status of the students.

time	Student 1	student2	student3	…	student34
min1	4	4	4		4
min2	1	1	1		4
min3	1	2	2		1
…					
min120	4	4	3		3

In addition, from the data logged by Lantern we know about the status of each team: when they start and finish an exercise, when they call for, and receive help. Altogether, the following data is collected from each session:

1. When a student starts collaborating with another member of her team and when they finish the collaboration.
2. When a student starts communicating with another team and when they finish the communication.
3. When a team calls for help, when the TA arrives to give help, and when the TA leaves the team.

The collected data also can be represented by the status of students, as visualized in Figure 3. For example in this figure, the student starts collaborating with her teammates at time *t1*. At time *t2* her team calls for help and starts waiting for the TA who arrives at *t4*. Meanwhile she stops the collaboration at *t3*. The TA leaves the team at *t5* and she goes back to the problem solving mode.

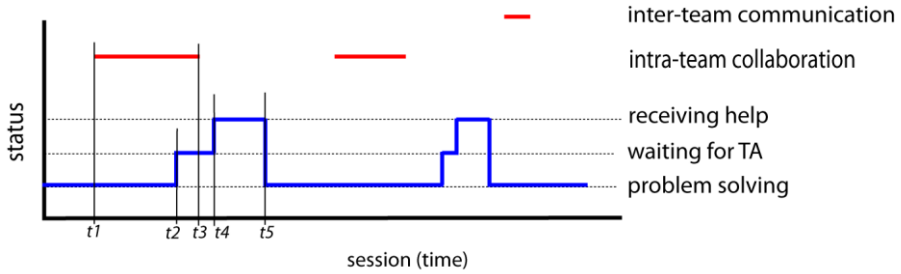

Figure 3. Status of a Student during a Recitation Section.

At the end of the experiment, the students and the teaching assistants completed a questionnaire about their experience with Lantern. We will refer to the responses when we try to explain some of our findings in the next sections.

Analysis

In this section, we analyze the influence of Lantern on intra-team collaboration and inter-team communication. We consider six Lantern-equipped recitation sections and compare them to six regular sessions as the control condition.

Intra-team Collaboration

We define four parameters for each session:

- Col_C^W, Col_L^W is the percentage of the ***W***aiting time each student spent on intra-team collaboration, averaged in the session, in the ***C***ontrol and ***L***antern conditions respectively.
- Col_C^P, Col_L^P is the percentage of the ***P***roblem solving time each student spent on intra-team collaboration, averaged in the session, in the ***C***ontrol and ***L***antern conditions respectively.

Note that, in our analysis, we exclude the time intervals when the team is receiving help (like *t4* to *t5* in Figure 3). This is because interaction among students is highly influenced by the presence of the TA, while receiving help.

We start by comparing $Col\ ^{W}_{L}$ against $Col\ ^{W}_{C}$. For the case of collaboration that begins before the waiting period and lasts through it (for example, the first collaboration in Figure 3), the second part (*t2* to *t3*) counts in the $Col\ ^{W}$ values. An unpaired t-test shows a significant improvement with Lantern ($m_{lw} = 42, m_{cw} = 11.17, t[10] = 10.97, p < 0.0001$): positive answer to question Q1.

One may explain this improvement as the direct effect of the improvement in while-waiting productivity. In order to test that, we modify the measures as follows:

$$\overline{Col}\ ^{W}_{C} = \frac{Col^{W}_{C}}{WWP_{C}} \text{ and } \overline{Col}\ ^{W}_{L} = \frac{Col^{W}_{L}}{WWP_{L}}$$

In which WWP is the average while-waiting productivity of the session. An unpaired t-test shows that $\overline{Col}\ ^{W}_{L}$ is still significantly higher than $\overline{Col}\ ^{W}_{C}$ ($m_{LW} = 47.1, m_{CW} = 24.2, t[10] = 5.8, p < 0.001$).

We found no significant difference between $Col\ ^{P}_{L}$ and $Col\ ^{P}_{C}$ ($m_{LP} = 33.8, m_{CP} = 32.6,\ t[10] = 0.40, p > 0.1$), meaning that Lantern has no significant effect on the intra-team collaboration when the team is not waiting: negative answer to question Q2.

We were also interested to know if students collaborate more when they are waiting than when they are in problem solving mode, in either of the conditions. To do that we compare $\overline{Col}\ ^{W}_{C}$ to $Col\ ^{P}_{C}$, and $\overline{Col}\ ^{W}_{L}$ to $Col\ ^{P}_{L}$ using a paired t-test. Interestingly enough, we found out that, in the control condition, students collaborate less than usual when they are waiting ($m_{CW} = 24.2, m_{CP} = 32.6, t[10] = -2.62, p < 0.05$), whereas in the Lantern condition students collaborate more when waiting ($m_{LW} = 47.1, m_{LP} = 33.8, t[10] = 8.19, p < 0.001$).

Figure 4 summarizes the result of the above comparisons.

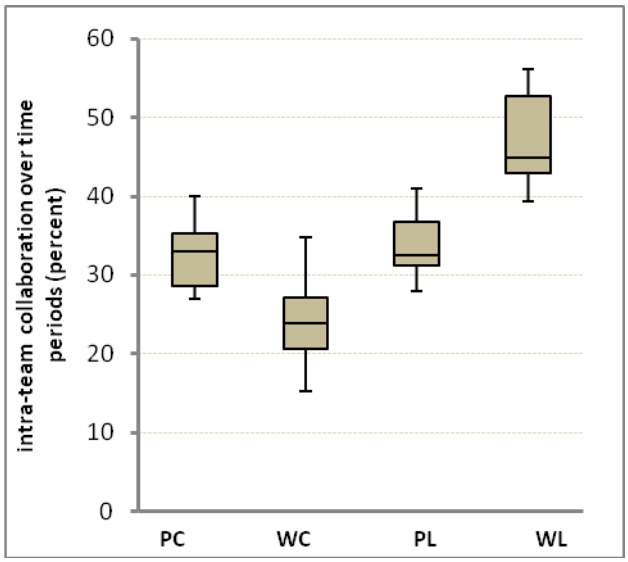

Figure 4. Intra-team Collaboration across the Conditions.
(PC: $\overline{Col}\ ^{P}_{C}$, WC: $\overline{Col}\ ^{W}_{C}$, PL: $Col\ ^{P}_{L}$, WL: Col^{W}_{L})

Inter-team Communication

This section analyzes the effect of Lantern on inter-team communication in terms of the duration of the interactions as well as their structure.

Duration

Our analyses show that Lantern does not significantly increase the duration of inter-team communication either while the communicating teams are waiting for the TA or while they are doing problem solving: negative answer to questions Q3 and Q4.

Structure

In order to quantify the effect of Lantern on the structure of inter-team communication, we define the following interrelated parameters, for a session:

- *Diversity of Communication:* is the total number of pairs of teams which communicate at least once in the session. In Figure 5 each link between two teams indicates an inter-team communication. In this figure the Diversity of Communication is 6.

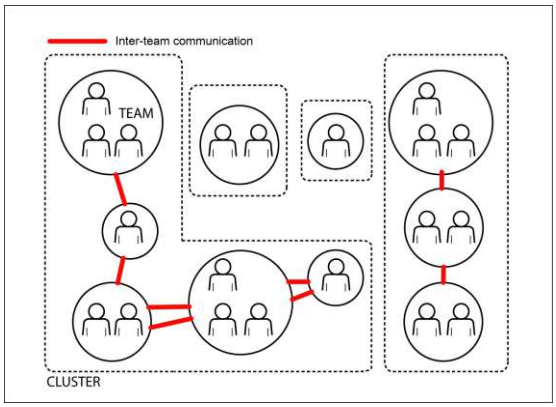

Figure 5. Inter-team Communication in Recitation Sections.

- *Number of Communicating Teams:* is the total number of teams who were involved in inter-team communication at least once. In Figure 5 there are 8 Communicating Teams.
- *Number of Clusters:* a Cluster consists of a set of teams such that, each team in the Cluster communicates with at least one other team of the same Cluster, and there exist no communication between two teams of two different Clusters. In Figure 5 the number of Clusters is 4. In an interpretation that considers teams as sources of knowledge, a recitation section with fewer clusters provides a better platform for the flow of knowledge.

Each parameter is averaged over the number of teams in the sessions and analyzed using an unpaired t-test. The results show significant increase in all the parameters. As a sample, the result of the t-test on the Diversity of Communication is ($m_L = 0.39, m_C = 0.26, t[10] = 3.52, p < 0.01$), summarized in Figure 6.

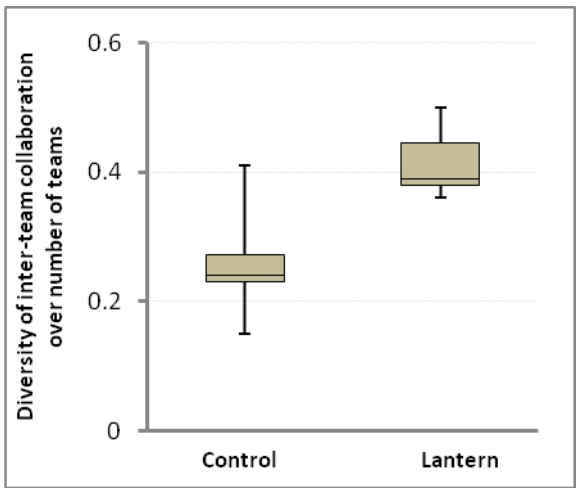

Figure 6. Diversity of Communication across Condition.

Summary of Results and Discussion

Lantern increased intra-team collaboration while the team is waiting for the TA. This can be explained by the combination of two facts: (1) according to the questionnaire, before pressing on Lantern the team members agree that they need help, which itself initiates a discussion, and (2) this discussion can last through the waiting time, since no effort to catch the TAs' attention is needed. The quantity of the improvement, comparing to the total time one student interact with her teammates in the control condition in average, is 22.1%. Moreover, it has been shown that, with Lantern, students do more intra-team collaboration when they are waiting for the TA than when they are doing problem solving. *We conclude that, when students are waiting for the TA there is a high potential for collaboration, which is lost in chasing the TA when Lantern is not used. As a consequence, the waiting time does not always need to be shortened: in some cases, using an awareness tool rather than adding new teaching assistants would maintain longer waiting times that become fertile grounds for collaboration to take place.*

Lantern did not increase the duration of inter-team communication. However, it has been shown that Lantern has effect on the structure of inter-team communication. More precisely, when Lantern is used each team communicates with a larger number of other teams (higher Diversity), (2) there are fewer teams who never

communicate (more Communicating Teams), and (3) the knowledge of one team can be spread over a larger part of the class (fewer Clusters). We explain this set of effects as the direct consequence of the main objective of Lantern: adding to the knowledge of students about other teams. The more students know about a specific team the more they are likely to interact with that team.

Related Work

In this section, we position our work among the relevant research from three different fields: (1) Computer Supported Collaborative Learning (CSCL) research on tools for regulating teams' interactions, (2) the Computer Supported Cooperative Work (CSCW) research on awareness tools and (3) the work of ambient interface and reality-based interaction in Human-Computer Interaction (HCI).

In CSCL, Soller et al. (2005) provided a framework that categorizes collaborative learning supporting systems into three classes: (1) mirroring systems, which display raw indicators to collaborators (2) metacognitive tools, which monitor the interactions, process the collected data and represent the state of interaction via a set of high-level indicators (3) coaching systems, which offer advice based on an interpretation of those indicators. We make use of this framework to compare our work against the others. Lantern fits in the first category as they mirror the state of student groups to the groups themselves and to the TAs without any pre-processing.

Chen (2006) designed a tool, called Assistant, which monitors the collaboration, visualizes the processed data and provides advice to the teacher. It can also learn from teacher's feedback to improve its performance. Assistant should be put in the third category of Soller's framework (coaching systems). Moreover, Assistant is tailored for the context of distance collaborative learning, while Lantern is designed for co-present settings.

Avouris et al. (2004) developed a collaboration environment called Synergo, for collocated and distance learning. Synergo monitors the activity, makes analyses and visualizes quantitative parameters like density of interaction, symmetry of partner's activity etc. It also provides teachers with useful information to manage the interactions that occur in the classroom. Synergo fits in the middle category (metacognitive tools).

Our work is also different than Chen's and Avouris' in terms of the level of interaction it considers. While Assistant and Synergo are mostly centered on interactions within one group, we are looking at the higher level, i.e. interaction between several groups and TAs as well as the interactions among groups.

In CSCW, there have been many efforts aiming for providing awareness information. They can be categorized in three dimensions:

1. The temporal nature, i.e, if the information is given and used at the same time and context as it is collected (synchronous (Beaudouin-Lafon & Karsenty, 1992; Ishii et al. 1994; Shen & Sun, 2002)) or not (asynchronous (Manohar & Prakash, 1994))
2. The type of provided awareness information which can be about workspace (Fitzpatrick et al., 1999; Fitzpatrick et al., 2002; Fuchs et al., 1995; Ishii et al., 1994) or presence (Shen & Sun, 2002; Tang & Rura, 1994), and activities of participants in the cooperative work.
3. The context, including the users, task and the structure of interaction among participants (e.g. conferencing (Shen & Sun, 2002), and distance learning).

Lantern gives *real-time* information, on students' activity in a *collocated* collaborative *learning context*.

Finally, in HCI, the seminal idea of ambient interface is to extend classical user interfaces (display, keyboard, mouse) to the whole environment. In contrast to the works described above, the primary concern of ambient display applications is the subtle embedding of information in our surroundings, while capturing and processing information is of a minor concern. The effectiveness of ambient interfaces for providing awareness information has been shown in many cases (Heiner et al. 1999; Pederson & Sokoler, 1997). In line with those works, we have proposed Lantern as a tool that embeds awareness information into the recitation classrooms, and evaluated its capability to support collaborative learning.

Conclusion

This paper analyzes the influence of Lantern on the collaboration in recitation sections. We show that, Lantern increases the intra-team collaboration taking place while the team is waiting for the TA. Lantern also has effect on the structure of inter-team communication in the recitation sections in such a way that, each team communicates with a larger number of other teams and that there are fewer teams who never communicate with others.

References

Alavi, H. S., Dillenbourg, P., and Kaplan, F. (2009). Distributed Awareness for Class Orchestration. In *Proceedings of the 4th European Conference on Technology Enhanced Learning: Learning in the Synergy of Multiple Disciplines* (Nice, France, September 29 - October 02, 2009). U. Cress, V. Dimitrova, and M. Specht, Eds. Lecture Notes In Computer Science, vol. 5794. Springer-Verlag, Berlin, Heidelberg, 211-225.

Avouris, N., Margaritis M., and Komis V. (2004). Modelling interaction during small-group synchronous problem solving activities: The Synergo approach, *2nd Int. Workshop on Designing Computational Models of Collaborative Learning Interaction,* ITS 2004, 7th Conf. on Intelligent Tutoring Systems, Maceio, Brazil, 2004, 13–18.

Beaudouin-Lafon, M. and Karsenty, A. (1992). Transparency and awareness in a real-time groupware system. In *Proceedings of the 5th Annual ACM Symposium on User interface Software and Technology* (Monteray, California, United States, November 15 - 18, 1992). UIST '92. ACM, New York, NY, 171-180.

Bickmore, T. and Schulman, D. (2007). Practical approaches to comforting users with relational agents. In *CHI '07 Extended Abstracts on Human Factors in Computing Systems* (San Jose, CA, USA, April 28 - May 03, 2007). CHI '07. ACM, New York, NY, 2291-2296.

Chen, W. (2006). Supporting teachers' intervention in collaborative knowledge building. *J. Netw. Comput. Appl.* 29, 2 (Apr. 2006), 200-215.

Cramer, H. S., Evers, V., van Someren, M. W., and Wielinga, B. J. (2009). Awareness, training and trust in interaction with adaptive spam filters. In *Proceedings of the 27th international Conference on Human Factors in Computing Systems*(Boston, MA, USA, April 04 - 09, 2009). CHI '09. ACM, New York, NY, 909-912.

Cramer, H., Evers, V., Ramlal, S., Someren, M., Rutledge, L., Stash, N., Aroyo, L., and Wielinga, B. (2008). The effects of transparency on trust in and acceptance of a content-based art recommender. *User Modeling and User-Adapted Interaction*18, 5 (Nov. 2008), 455-496.

Dillenbourg, P. (1999). Introduction; What do you mean by Collaborative Learning? In P. Dillenbourg (Ed.) Collaborative Learning. Cognitive and Computational Approaches, (pp. 1-19). Oxford, UK: Elsevier Science.

Fitzpatrick, G., Kaplan, S., Mansfield, T., David, A., and Segall, B. (2002). Supporting Public Availability and Accessibility with Elvin: Experiences and Reflections. *Comput. Supported Coop. Work* 11, 3 (Nov. 2002), 447-474.

Fitzpatrick, G., Mansfield, T., Kaplan, S., Arnold, D., Phelps, T., and Segall, B. (1999). Augmenting the workaday world with Elvin. In *Proceedings of the Sixth Conference on European Conference on Computer Supported Cooperative Work* (Copenhagen, Denmark, September 12 - 16, 1999).

Fuchs, L., Pankoke-Babatz, U., and Prinz, W. (1995). Supporting cooperative awareness with local event mechanisms: the groupdesk system. In *Proceedings of the Fourth Conference on European Conference on Computer-Supported Cooperative Work* (Stockholm, Sweden, September 10 - 14, 1995).

Heiner, J. M., Hudson, S. E., and Tanaka, K. (1999). The information percolator: ambient information display in a decorative object. In *Proceedings of the 12th Annual ACM Symposium on User interface Software and Technology* (Asheville, North Carolina, United States, November 07 - 10, 1999). UIST '99. ACM, New York, NY, 141-148.

Ishii, H., Kobayashi, M., and Arita, K. (1994). Iterative design of seamless collaboration media. *Commun. ACM* 37, 8 (Aug. 1994), 83-97.

Jacob, R. J., Girouard, A., Hirshfield, L. M., Horn, M. S., Shaer, O., Solovey, E. T., and Zigelbaum, J. (2008). Reality-based interaction: a framework for post-WIMP interfaces. In *Proceeding of the Twenty-Sixth Annual SIGCHI Conference on Human Factors in Computing Systems* (Florence, Italy, April 05 - 10, 2008). CHI '08. ACM, New York, NY, 201-210.

Lee, S. and Lee, W. (2009). Exploring effectiveness of physical metaphor in interaction design. In *Proceedings of the 27th international Conference Extended Abstracts on Human Factors in Computing Systems* (Boston, MA, USA, April 04 - 09, 2009). CHI '09. ACM, New York, NY, 4363-4368.

Manohar, N. R. and Prakash, A. (1994). Replay by Re-execution: A Paradigm for Asynchronous Collaboration via Record and Replay of Interactive Multimedia Sessions. *SIGOIS Bull.* 15, 2 (Dec. 1994), 32-34.

Pedersen, E. R. and Sokoler, T. (1997). AROMA: abstract representation of presence supporting mutual awareness. In*Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Atlanta, Georgia, United States, March 22 - 27, 1997). S. Pemberton, Ed. CHI '97. ACM, New York, NY, 51-58.

Shen, H. and Sun, C. (2002). Flexible notification for collaborative systems. In *Proceedings of the 2002 ACM Conference on Computer Supported Cooperative Work* (New Orleans, Louisiana, USA, November 16 - 20, 2002). CSCW '02. ACM, New York, NY, 77-86.

Soller, A., Martínez, A., Jermann, P., and Muehlenbrock, M. (2005). From Mirroring to Guiding: A Review of State of the Art Technology for Supporting Collaborative Learning. *Int. J. Artif. Intell. Ed.* 15, 4 (Dec. 2005), 261-290.

Tang, J. C. and Rua, M. (1994). Montage: providing teleproximity for distributed groups. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems: Celebrating interdependence* (Boston, Massachusetts, United States, April 24 - 28, 1994). B. Adelson, S. Dumais, and J. Olson, Eds. CHI '94. ACM, New York, NY, 37-43.