Draft of Patterns of Female and Male Students’ Participation in Peer Interaction in Computer-supported Learning

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Abstract

The purpose of the study was to analyze how intensively female and male students participate in discourse interaction within two computer-supported classrooms. Technical infrastructure for the study was provided by the Computer-Supported Intentional Learning Environments, CSILE. The study was carried out by qualitatively analyzing written notes logged by two grade 5/6 classes to CSILE’s database over one academic year. The results of the study indicate that only one of the classrooms engaged in a progressive discourse focused on collaborative advancement of explanation whereas the other classroom performed more traditional learning tasks. Female students participated most actively in the progressive-discourse classroom whereas male students dominated discourse interaction in the other class, but the reasons for this are subject to debate. The investigators argue that the use of new technology should be thoroughly subsumed under pedagogical goals in order to facilitate female students’ participation in computer-supported learning.

Keywords: Cooperative/collaborative learning, distributed learning environments, gender studies, pedagogical issues
Introduction

An advanced information society is taking shape, in western countries, in which knowledge will be the most critical resource for social and economic development and where self-organized teams and networked activities, more and more, will characterize the emerging type of work. In order to provide students with skills and competencies needed for productive participation in such a knowledge society, educational institutions are required to find better pedagogical methods that guide students to collaborate for advancement of their ideas. Lehtinen and his colleagues argued that one of the most promising approaches to improving learning and instruction with the help of modern information and communication technologies is provided by the Computer Supported Collaborative Learning (CSCL) [1]. Although many educators originally worried that computer-supported learning would reduce possibilities for social interaction, the situation has dramatically changed after the breakthrough of network and mobile technologies; these facilitate a synchronous social interaction; provide new means for building communities across boundaries of time and space. They enable users to be continuously and reciprocally aware of each other’s activities and encourage sharing of knowledge and cognitive achievements. These innovative learning environments are likely to improve quality of education as well as equality of educational opportunity by fostering female students’ participation in computer-supported learning.

The objective of the present study is to intensively examine patterns of female and male students’ participation in computer-supported collaborative learning within two a single-classrooms. There are still significant differences between male and female students in their attitudes towards, knowledge about, or use of computers [2, 3, 4]. Male students are generally more enthusiastic about the use of information and communication technologies (ICTs) in their schoolwork. Even if the user-friendliness of computer programs has improved across the last ten years, female students still, frequently, experience computer phobia [5] or tend to minimize their use of computers. Because the gender difference in relation to new technology appears to increase as a function of age of the students, being less remarkable at pre-school age, it may be at least partially produced within the early school years [6, p. 25] and within those classrooms. Observations of students working with computers show that mixed gender pairs perform less well than single-gender pairs [7, 8, 9]. This may partially be because a male student often tends to dominate situations in which he are using a computer jointly with a female student. The results are not, however, entirely consistent, but vary as a function of the computer-based tasks; they may be influenced by having only one mouse control device [6, p. 125]. There is some evidence that new pedagogical methods, such as cross-age tutoring and peer tutoring, may facilitate the development of female students’ computer skills [10].

Special efforts are needed to introduce the new technology and computer software in gender neutral or even “girl-friendly” settings [11]. Novel pedagogical practices and social support may facilitate gender inclusive experiences where females and males are participating and performing equally [12]. Although male students are interested in using ICT regardless of the nature of the application, the nature of the application and related activities tend substantially to affect female students’ interest [13, 14]. A significant finding is that young girls are very interested
Patterns of participation …

in interactive technology that encourages collaborative learning, solving of complex social dilemmas, intensive writing, and flexible pursuit of problem solving [13]. Research on computer-supported learning indicates that female students are more willing to share their cognitive achievements and are more interested in collaborative learning than male students [7, 15].

In the present study, patterns of female and male students’ participation in collaborative learning were studied by comparing inquiry processes two computer-supported elementary school classrooms. Technical infrastructure for the study was provided by the Computer-supported Intentional Learning Environments, CSILE [16]. CSILE is a network environment for building, articulating, exploring, and structuring knowledge, and use of the system is thoroughly subsumed under pedagogical goals, that is, integrated with learning activities in all areas. In this regard, three features of the learning environment are essential:

Firstly, students are themselves responsible for producing all knowledge entered in the system; this design characteristic is based on extensive psychological research indicating that writing is one of the most effective ways to learn. The students work with the environment by producing computer entries called ‘notes’ in the context of their study projects (e.g., social studies, history, biology, physics).

A central part of the system is, secondly, a shared virtual database that allows the users to produce knowledge, categorize it by using their own keywords, conduct searches for finding relevant knowledge, and add connecting linkages between associated ideas. Rather than keeping only their own notebooks, the users work within a virtual and collaborative notebook that allows them to share knowledge and continuously to follow and comment on each other’s processes of inquiry.

Thirdly, the design of CSILE relies of a pedagogical model of progressive inquiry [16, 17, 15] that has been developed together with innovative teachers. This pedagogical model focuses on facilitating expert-like working with knowledge, even during early school years, by guiding students in a structured process of inquiry: to ask questions arising from their own puzzlement, to generate their own tentative answers to the questions, and to test their ideas by using multiple sources of information. A crucial aspect of this kind of inquiry is students’ engagement in collaborative effort aimed to improve shared ideas and thoughts instead of merely attempts to assimilate bodies of pre-existing knowledge [17, 18]. A successful process of inquiry takes the participants beyond surface-level phenomena and factual information to explore their own explanations and hypotheses.

In the present study, the problem of female and male students’ participation in computer-supported learning was addressed by qualitatively analyzing the nature of computer-mediated peer interactions in two classrooms of CSILE students. We examined the epistemic nature of written comments produced by the students, i.e., whether the participants worked with factual information or explanatory knowledge. Our investigation was, further, focused on analyzing the patterns of CSILE students’ participation by applying a method of social network analysis. This method provides statistical tools for examining relations between actors rather than only attributes of individual actors, such as standard statistical methods provide [19, 20]. We examined relations among students commenting on each other’s productions within CSILE’s
database in order to analyze how intensively students representing both genders participated in CSILE mediated discourse interaction. Another problem addressed in the study was to examine the degree of centralization (equally distributed or confined to a few students) of the students' interaction.

Method

Participants: Classrooms A and B

The study is based on an analysis of CSILE students’ written productions, posted to CSILE’s database. CSILE has been used as a part of normal education by these elementary school students. The study material represents data occurring naturally while the students carry out their study projects, working with CSILE. The study material consists of productions of two parallel grade 5 and 6 classes over a period of one year at an inner-city public school in Toronto, Canada. The analysis concerned 58 students representing both genders that participated in CSILE use in classroom A (n = 28) and classroom B (n = 30). The student population included a number of students from educationally disadvantaged homes.

Due to the nonexperimental context of the CSILE study, the students were assigned to classrooms A and B as a part of normal school administration. The gender distribution of the students in the classes differed from what might be expected with randomized sampling. In classroom A, there were 19 females and 9 males whereas, in classroom B, there were 10 females and 20 males.

Study Material: The CSILE Database

The study was based on a qualitative analysis of the students’ written comments posted to the system’s database within one academic year. In working with CSILE, the students posted daily computer entries called “notes” in the context of their study projects. For qualitative analysis of students’ discourse interaction, the present investigator selected all comments, regardless of domain of knowledge, in order to obtain a detailed picture of the students’ peer interaction. In order to make possible a reliable classification of the material, CSILE students' comments were first partitioned into ideas (regarding segmentation of data for content analysis, [see 21]). Examination of the comments revealed that there were 1.6 (SD = 0.9) ideas per comment. On average, the students in classroom A produced 18.6 (SD = 11.8) and those in classroom B 18.5 (SD = 10.3) communicative ideas. For practical reasons, communicative ideas will be referred to simply by talking about comments. Reliability of partitioning was assessed by asking two independent coders to segment 200 notes into ideas. The Pearson correlation between number of ideas identified by the two coders was r(200) = .94. Inter-coder reliability of classification, reported below, was based on this pre-segmented material.

CSILE students’ comments were classified according to type of communicative idea, i.e., whether an idea 1) supported the note commented on by expressing agreement, 2) represented a neutral exchange of ideas or 3) was critical in nature expressing disagreement. A communicative idea was classified as supportive if it included expressions such as "I like your note." A communicative idea was regarded as neutral if it was neither critical nor supportive, i.e., did not contain any
kind of evaluation. Asking and answering a question or requesting and providing knowledge usually represented neutral communication. A communicative idea was classified as critical if it suggested some changes to the object note, otherwise it was regarded as neutral or supportive. Critical communicative ideas included direct criticism ("you do not explain your theory") or criticism was expressed in an indirect way ("why don't you add analysis of x into your note").

The object of cognitive activity determines to a great extent the psychological nature of inquiry. Communicative ideas within a comment were analyzed by specifying, in each case, the object of inquiry: i.e., whether the communicative idea was about 1) linguistic form, 2) research questions, 3) research methods, 4) information, 5) explanation, 6) other, or 7) unspecified. Each communicative idea was considered to represent only one of the above mentioned categories.

**Linguistic form** was the object of communicative ideas that focused on linguistic form instead of content of ideas. Frequently these ideas contained a reference to spelling mistakes or other grammatical weaknesses of the note commented on.

I have read your note, about I think electricity works like this, and when I read it it was very well done and also you do not have any mistakes, you have written all the capital letters, that you have to write And now this is all I am going to say about your note.

Communicative ideas related to research questions were frequently general comments on such questions or requests to set up specific research questions or keep focus on the research questions, for example:

These questions are pretty good. I think you should do some more questions on HUMAN evolution, not just evolution in general. I can answer one of your questions, though. If humans are descendants from apes; then how come apes aren't considered homo sapiens? Well, apes aren't humans, are they? and humans took millions of years to become how they are now, so they're not just like the same as monkeys. Apes aren't considered homo sapiens because they're simply not humans like we are. (If you see what I mean) ... Your questions should take a lot of research to find the answer.

Some communicative ideas were related to practices and methods of inquiry. In these communicative ideas, students often requested reflectivity ("You should not copy information"), better collaboration ("You should work in collaboration with other members of your group"), or deepening inquiry ("You should do your inquiry in depth").

This sounds like you copied this out of a book in fact I'm almost positive you did, for I read a book that had that example word for word. I think it's okay to use the same example for very well thought out, but you could at least reword it a bit. By the way do you agree with Darwin?
CSILE students’ communicative ideas frequently either explicitly or implicitly focused on searches for information. These communicative ideas concerned the quantity of information found.

Your note sure does have a lot of information. I had a good time reading it. I cannot think of any other information to add. I will surely use some of your information in my note. I will probably use the part about peat. THANKS!

Some students also addressed quality of information, which might be taken as an indication of explanation-driven discourse although they did not seem to have conceptual tools for talking about explanations:

I think your note has some very good information but it is hard to understand. I think you should put your words in a clearer way. Because while your note has interesting information you should put it in such a matter that people can understand it and learn from it. I don’t think that many people in this class know what a lysosome or a mitochondria is. Or you could put some of the hard to understand words in your vocabulary list.

Explanation-related communicative ideas were either those designed to assess explanation constructed by the student being commented on or to provide an explanation generated by the student him- or herself. These communicative ideas usually contained an explicit reference to explanation, as in the following example:

Your note on breathing rates is really good. It was interesting to find out how our rates actually change. But I think something was missing. Your note would have been more interesting if you could have given a detailed theory of how you feel after you run, and why you feel that way. Otherwise I think the note was really well written.

Other communicative ideas referred, for instance, to technical aspects of CSILE use. Unspecified communicative ideas were ideas whose main object could not be specified even with respect to the object of comment.

The present investigator analyzed how CSILE students explicated the referential relations of their communicative ideas. The basic difference between spoken and written communication is that, in the former, the referents are contextual in nature and, therefore, usually familiar to all of the participants, while in the latter the referents have to be explicated and the context created. Explication of referential relations was analyzed through classifying the students’ communicative ideas as unexplicated or explicated. Some of the unexplicated ideas were completely unspecified; in these cases, the main object of the comment could not be specified at all, i.e., one could not determine whether a communicative idea focused on linguistic form or some aspect of the process of inquiry. Typically, in this kind of comment, reasons for disagreement or agreement were left completely open: ("This is a good note", "Bad."). The student being commented on would hardly have been able to make any improvements on the basis of this kind of communicative idea.
I have read the note that says, THE WAY I THINK ELECTRICITY WORKS, and it was very good but there are some things that I don't understand, and this is all I am going to tell you about your note.

Unexplicated referential relations made it impossible to determine what aspect of inquiry a comment was about or what was the specific aspect being criticized or supported. In explicated communicative ideas, the referent of a communicative idea was explicated quite clearly although a student may not have completely justified his or her criticism or support.

I really enjoyed reading your note on "Human Evolution". I really liked the part on the speech, the reason I liked it was because ever since I started on my research I wondered what types of form did they speak and ways they pronounced words. If you ever came across any information on that it would be a great help to know.

An explicated comment was self-explanatory; i.e., understandable without any background or contextual knowledge. For example, reading of the note being commented on was not necessary for understanding the comment’s main content. On the basis of an explicated comment, the receiver would be able to make specific corrections to his or her note.

To analyze reliability of the classification, two independent coders classified 300 communicative ideas selected by systematic sampling to represent each year and both classroom A and classroom B. Inter-coder reliabilities of the classification indicated that the reliability of classification was satisfactory; the agreement coefficient exceeded .70 across all variables used in the analysis. Disagreements were discussed after the reliability analysis, and those ideas that were classified differently by the two coders were discussed and coded according to mutual agreement. Results of the qualitative content analysis were examined at two levels: by analyzing frequencies of the contents of CSILE students’ productions and analyzing proportions of these contents in the context of an individual student.

Further, CSILE students’ discourse interaction was analyzed by applying social network analysis [19, 20]. Characteristics of CSILE students' social network were analyzed by examining the intensity of direct interaction among members of a learning community (density), the extent of each member's participation (centrality), and pattern of interaction in the community as a whole (centralization). Further, the properties of each student’s egocentric network was analyzed in order to get a more detailed picture of his or her social relations. A dense network indicates that a student worked as one actor in a cohesive group in which most students commented on each other’s notes. A sparse network, in contrast, implies that the student participated in the work of several subgroups, the members of which sent fewer comments to the members of other groups. These characteristics of networks were studied in order to examine whether female and male students had different strategies for participating in discussion across gender and other barriers.

The data consisted of the links between CSILE students' communicative ideas: who interacted with whom in constructing CSILE comments. The information was examined as a weighted and directed graph representing the structure of
communication, in which the teacher and the pupils were viewed as nodes and the comments as vertices. We analyzed the graph using social network analysis and multidimensional scaling (MDS). All analyses were performed by using the Ucinet program [22].

Results

The Nature of CSILE Students’ Peer Interaction

Table 1 presents frequency distribution for CSILE-mediated peer interaction of the students in both classrooms. From Table 1, it can be seen that explanatory discourse prevailed only in classroom A, whereas students in classroom B focused on discussion of research problems (presented math problems created by students) and factual information. In the former class, students were guided to engage in a very intensive research-like process of inquiry whereas in the latter class they used the learning environment to support their traditional school work.

We analyzed CSILE-mediated peer interaction for classroom A (n=28) and classroom B (n=30) students as a function of their gender. A direct discriminant analysis was performed using four variables representing the nature of CSILE students’ peer interaction as predictors of membership in a CSILE group. The predictors were mean number of comments, proportion of explicated comments, proportion of explanation-related comments, and proportion of critical comments. The grouping variable was a composite variable of class and gender (classroom A female (n=19); classroom A male (n=8); classroom B female (n=10); classroom B male (n=20). Of the original 58 cases, 1 case representing classroom A and 2 cases representing classroom B were dropped from this analysis because of missing data, i.e., no comments produced.

Three discriminant functions were calculated, with a combined \( \chi^2(12) = 98.2, p<.000 \). After removal of the first function, there was still a strong association between groups and predictors, \( \chi^2(6) = 18.3, p<.006 \). The third discriminant function, however, was not significant. The two discriminant functions accounted for 90% and 10%, respectively, of the between-group variability. As shown in Figure 1, the first discriminant function maximally separates the students in classroom A from the students in classroom B. The second discriminant function partially discriminates classroom A females and classroom B males from classroom A male students.

The loading matrix of correlations between predictors and discriminant functions, as seen in Table 1, suggested that the best predictors for distinguishing between classroom A and classroom B (first function) were the mean proportion of explanation-related comments and mean proportion of explicated comments.
The classroom A female ($M = .54$) or male ($M = .44$) students produced a higher mean proportion of explanation-related comments than classroom B females ($M = .13$) or males ($M = .03$). Further, a higher proportion of the classroom A female ($M = .77$) and male ($M = .81$) students’ comments were explicated than were comments of the classroom B female ($M = .34$) or male ($M = .22$) students.

Two predictors, number of communicative ideas and proportion of critical comments, had a loading in excess of .50 on the second discriminant function, which separates classroom A females and classroom B males from the classroom A male students. Classroom A females ($M = 22.6, SD = 9.3$) and classroom B males ($M = 20.5, SD = 12.7$) produced a significantly higher mean number of comments than classroom A males ($M = 9.1, SD = 6.0$). Classroom B females produced a lower mean number of comments ($M = 14.3, SD = 9.3$) than classroom B males but cannot be clearly separated from the latter group.

Pooled within-group correlations among the four predictors are shown in Table 3. There was a positive relationship between the mean proportion of explicated comments and the mean proportion of critical comments with $r(52) = .29$, $p < .05$, indicating that critical comments were more likely to be explicated than other kinds of comments.

Patterns of Interaction in Two CSILE Classes

In order to further examine patterns of interaction in classrooms A and B, we analyzed density of their networks of CSILE-mediated interaction. The density of a binary network is the number of observed connections between actors divided by the number of all possible connections, a measure that varies between 0% (no connections between actors) and 100% (each actor is interacting with everyone else [23, p. 78, 20, p. 74]. The analysis indicated that CSILE students’ network of
interaction was rather dense in both of the classrooms. In the case of classroom A, the density was 41% for symmetrized data (direction of commenting ignored). In the case of the asymmetric graph based both on sent and received comments, the measure was 28% of the possible networking linkages. The data set was dichotomized in these analyses (cut off point = 0). In the case of classroom B, the figures were 38% for symmetric data and 25% for the asymmetric graph.

Further, we examined how much interaction there was between students representing different genders within these two classrooms. Therefore, we partitioned the network into blocks, the densities of which were examined separately on the basis of gender (male; female) of the students (see Table 4). The densities of blocks with varying size cannot, however, be directly compared; keeping up network connections takes up cognitive resources so that larger graphs are likely to have lower densities than smaller graphs [20, p. 77]. The analysis indicated that the students preferred to communicate within their own gender group in both classrooms. This effect appeared, however, to be stronger in the case of classroom A than classroom B. The density of interaction between male and female students in classroom A was very low (0.10). The density of comments sent by female students to male students was, however, somewhat higher (0.18).

Further, Table 4 indicates that the density of interaction among female students in classroom A was at a very high overall level. Taking the number of females into consideration (n = 19), the density of their mutual interaction (0.41) was remarkable. It was substantially higher than for the corresponding interaction between male students in classroom B (0.31).

Further, we examined the extent to which a whole graph representing CSILE students’ interaction had a centralized structure, organized around cognitively central actors [20, pp. 92-93]. We calculated a centrality value for each student in order to identify the most important actors in the community by using Freeman’s ‘degree’ measure (i.e., number of sent and received comments, see Table 5). The results of the analysis indicated that the classroom A students’ interaction was not very centralized (25% and 29% in the case of sent and received comments, respectively). Classroom B’s interaction was considerably more centralized (40% in case of sent and 32% in the case of received comments) indicating that certain individual students were keeping up the interaction.

CSILE students’ network of interaction may be seen as a process of knowledge flow that consists of individual comments. A student’s position in this network may be assessed by Freeman’s ‘betweenness’ value that indicates how often that student mediates interaction between other students within the classroom (i.e., he or she is found in the shortest geodesic path between two other students) [23, pp. 82-87]. Because social networks usually have structural holes (disconnections between actors), interactions between two not-directly-linked actors depend on the other actors located in the paths between the two. A high betweenness value indicates that an actor is in interaction with several agents that are disconnected from each other and he or she is, thereby, in a position of regulating their networking connections [19, pp. 188-192.]
Table 5 presents means and standard deviations for centrality of classroom A and B students’ participation as function of their gender. The table reveals that there were large between-student differences in the intensity of engagement in CSILE-mediated peer interaction. The table indicates that the most active students could be found among females students in classroom A and male students in classroom B in the cases of both sent and received comments. Within classroom A, female students produced approximately twice as many comments as did the male students. We also can see that within classroom A, female students had more partners (M=13) than male students (M=8). The fact that the classroom A female students had a very high betweenness value (25.8) indicates that they had a significant role in the students’ inquiry, mediating flow of information between the other students. The gender difference in intensity of participation was, however, statistically significant only in the case of classroom A. In classroom B, there were many inactive male students and some active female students, so that within-group differences were larger than between group differences.

Further, MDS analysis was performed in order to examine whether classroom A and B students' cultures of discourse interaction consisted of distinguishable subcultures. MDS examines relational data in terms of space and distance [20, pp. 151-156]. The intensity of interaction was used as a measure of Euclidean (metric) distance: the more messages the students sent or received from each other, the closer they are located on the MDS map (see Figures 2 and 3). The stress values, measures of the quality of the MDS map, were at a satisfactory level (0.153 and 0.116, respectively). The analysis is calculated with a symmetric matrix created by summing the received and sent communicative ideas.

Figure 2 indicates that within classroom A, female students' pattern of participation differed considerably from that of male students. The female students formed a relatively close group that was separated from male students. A group of female students appeared to be very close to each other, indicating that their pattern of interactions closely resembled each other. In the center of the female group were the students with highest centrality and betweenness values. One of the students, a male who did not produce any comments, was isolated from the rest of the students. The analysis indicated that F4, F13, and F2 were participating in very intensive interaction; they had a very high degree of symmetrized interaction (i.e., a large number of sent and received comments). They were, however, mostly interacting with other members of their small groups as well as with other female students. However, F19, F18, and F5 were not only engaging in very intensive dialogue with their respective group members and fellow female students but also with male students by providing and requesting explanations. Thus, these female students broke the boundaries of their own networks and became "stars" of the students' overall social network in classroom A.

Figure 3 presents MDS for classroom B. From the figure one can see that there is not such a strong separation between cultures of female and male student participation. There were several exceptionally active students, all of them males
(M7, M14, M15) who had very high outdegree as well as betweenness values, located within the center of the figure. All of the other students are located around these active students. One of the students is separated from the others. As indicated by the qualitative content analysis reported above, these active male students did not, however, engage in a very deep process of pursuing explanations.

Discussion

In the study, we analyzed written comments posted by students to CSILE’s database. The analysis revealed substantial differences between classrooms A and B in the contents and patterns of their participation. Classroom A students’ peer interaction focused on advancing the students’ own explanations whereas classroom B students pursued more traditional learning tasks. The discriminant analysis indicated that it was characteristic of classroom A to conduct conceptually challenging study projects that focused on gaining theoretical understanding of the problems being investigated, whereas classroom B’s study projects focused on acquiring factual knowledge and empirical generalizations that usually did not go beyond everyday phenomena. Analyses of both the intensity of participation and the epistemic nature of knowledge produced suggested that female students carried out the main responsibility for pursuing this deeper kind of inquiry within classroom A [see also 15].

The social network analysis indicated that the density of CSILE-mediated interaction was rather high, and practically all groups of students participated in the discourse. The analysis further indicated that, within classrooms A and B, there were considerable differences concerning participation in social interaction mediated by the CSILE environment. Female students dominated discourse interaction within classroom A whereas male students dominated interaction within classroom B.

A potential explanation for the phenomenon is the biased gender distribution of classroom A. Young students seem to prefer communication within their gender group, and in a classroom in which females formed a majority (60-70%), males may have found it difficult to participate as intensively as they would have, otherwise. Our evidence from a single classroom cannot rule out the possibility that the male students’ lower level of engagement reflected the skewed gender distribution in the classroom A.

The relative intensity of female and male students’ participation appeared also to be associated with the kind of pedagogical culture. A culture of collaborative advancement of explanations appeared to encourage female students’ participation within classroom A. Male students, in turn, dominated pursuit of traditional learning tasks within classroom B. Presumably, young males students’ more competitive culture of learning may not support collaboration as well as that of female students (Hakkarainen, submitted). Results of other CSCL studies have found corresponding gender difference concerning engagement with computer-supported collaborative learning [e.g., 24]. A special effort is often needed to engage female students in computer-supported collaborative learning; male students often dominate discourse interaction within CSCL environments, as did the male students in classroom B.
The present investigators argue that without profound changes in pedagogy, it might be difficult to get the female students, who are not as interested in computer technology as male students, to commit themselves to intensive participation in computer-supported collaborative learning [similar results have been found in a LEGO-Logo environment in 15]. Female students’ active participation, where it occurs, may be explained as an effect of subsuming classroom activities to pedagogical goals as was the case, more so in Classroom A.

Bieleczyc [25, see also 26] has provided evidence that the key for successful implementation of CSCL – especially to female students’ equitable participation in computer-supported learning – is to build a supporting social infrastructure around the technical infrastructure. She argued that instead of focusing only on the collaborative technology, one should examine social settings that support the meaningful implementation and use of technology. The notion of social infrastructure implies that new technology should be an integrated aspect of pedagogical processes rather than a separate activity. This integrated kind of pedagogical situation appears to have prevailed within classroom A in which the use of CSILE was thoroughly inter-woven with all of the students’ learning activities. Within classroom B, in contrast, it was not clear whether CSILE was really an integrated aspect of curriculum. To conclude, it is essential that building a culture of collaborative learning be supported by the whole organization and structure of pedagogical activities rather than being ‘added’ to prevailing practices.
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References


Figure Captions

Figure 1.
Plots of four group centroids on two discriminant functions derived from four communicational variables: respective proportions for explanation related comments, explicated comments, critical comments, and number of communicative ideas.

Figure 2.
Multi-dimensional scaling of classroom A students’ social network
(the id number; m= males, f= females)

Figure 3.
Multi-dimensional scaling of classroom B students’ social network
(the id number; m= males, f= females)
Table Captions

Table 1.
Frequencies of Students’ Communicative Ideas Selected for Analysis in Classrooms A and B

Table 2.
Results of Discriminant Function Analysis of Communication Variables

Table 3.
Pooled Within-group Correlations Among Predictors of Communication

Table 4.
Density of Interaction Across Gender and Average Density of Egocentric Networks of Gender Groups Among CSILE Students

Table 5.
The Centralization of Participation Across Gender of CSILE Students
Patterns of participation …

Figure 1.
Plots of four group centroids on two discriminant functions derived from four communicational variables: respective proportions for explanation related comments, explicated comments, critical comments, and number of communicative ideas.

Canonical Discriminant Functions

Function 1: Degree of explanation-oriented communication

Function 2: Communicativity

Gender and Group

 cinéma Group Centroids

Classroom A female

Classroom A male

Classroom B female

Classroom B male

Function 1: Degree of explanation-oriented communication
Figure 2.
Multi-dimensional scaling of classroom A students’ social network
(the id number; m= males, f= females)
Figure 3.
Multi-dimensional scaling of classroom B students’ social network
(the id number; m= males, f= females)
Table 1.
Frequencies of Students’ Communicative Ideas Selected for Analysis, Classrooms A and B

<table>
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<th>Object of inquiry</th>
<th>Classroom A</th>
<th>Classroom B</th>
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<td></td>
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<td>55.1</td>
<td>30</td>
</tr>
<tr>
<td>Unspecified</td>
<td>5</td>
<td>0.9</td>
<td>11</td>
</tr>
<tr>
<td>TOTAL</td>
<td>532</td>
<td>100.0</td>
<td>528</td>
</tr>
</tbody>
</table>
Table 2. 

Results of Discriminant Function Analysis of Communication Variables

| Predictor variable                           | 1   | 2   | Univariate $F$  
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean proportion of explanation-related comments</td>
<td>-.78</td>
<td>-.16</td>
<td>41.3</td>
</tr>
<tr>
<td>Mean proportion of explicated comments</td>
<td>-.76</td>
<td>.34</td>
<td>39.4</td>
</tr>
<tr>
<td>Mean proportion of critical comments</td>
<td>-.16</td>
<td>.51</td>
<td>3.6</td>
</tr>
<tr>
<td>Number of comments</td>
<td>-.01</td>
<td>-.74</td>
<td>4.0</td>
</tr>
<tr>
<td>Canonical R</td>
<td>.89</td>
<td>.55</td>
<td></td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>3.9</td>
<td>.43</td>
<td></td>
</tr>
</tbody>
</table>
Table 3.
Pooled Within-group Correlations Among Predictors of Communication

<table>
<thead>
<tr>
<th></th>
<th>Proportion of explicited comments</th>
<th>Proportion of critical comments</th>
<th>Number of comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Proportion of explanation-related comments</td>
<td>.24</td>
<td>.25</td>
<td>.12</td>
</tr>
<tr>
<td>Proportion of explicated comments</td>
<td>.29</td>
<td></td>
<td>-.13</td>
</tr>
<tr>
<td>Proportion of critical comments</td>
<td></td>
<td></td>
<td>.17</td>
</tr>
<tr>
<td>Number of comments</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 4. 
Density of Interaction and Gender in Two CSILE Classes

<table>
<thead>
<tr>
<th></th>
<th>Classroom A</th>
<th></th>
<th>Classroom B</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Male</td>
<td>Female</td>
<td>Male</td>
<td>Female</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Male</td>
<td>9</td>
<td>0.26</td>
<td>0.44</td>
<td>0.10</td>
</tr>
<tr>
<td>Female</td>
<td>19</td>
<td>0.18</td>
<td>0.38</td>
<td>0.41</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Male</td>
<td>Female</td>
<td></td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>M</td>
<td>SD</td>
<td>M</td>
</tr>
<tr>
<td>Male</td>
<td>20</td>
<td>0.31</td>
<td>0.38</td>
<td>0.22</td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
<td>0.17</td>
<td>0.38</td>
<td>0.25</td>
</tr>
</tbody>
</table>
Patterns of participation …

### Table 5.
The Centralization of Participation Across Gender of CSILE Students

<table>
<thead>
<tr>
<th>Group</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
<th>M</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Classroom A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>9</td>
<td>7.7</td>
<td>5.4</td>
<td>9.9</td>
<td>7.6</td>
<td>7.9</td>
<td>3.3</td>
<td>2.0</td>
<td>1.2</td>
</tr>
<tr>
<td>Female</td>
<td>19</td>
<td>22.3</td>
<td>9.3</td>
<td>22.8</td>
<td>9.1</td>
<td>12.6</td>
<td>3.2</td>
<td>5.2</td>
<td>2.3</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>17.6</td>
<td>10.7</td>
<td>18.6</td>
<td>10.5</td>
<td>11.7</td>
<td>3.9</td>
<td>4.1</td>
<td>2.5</td>
</tr>
<tr>
<td>Classroom B</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>20</td>
<td>16.8</td>
<td>12.3</td>
<td>14.8</td>
<td>9.8</td>
<td>11.6</td>
<td>5.9</td>
<td>4.1</td>
<td>3.3</td>
</tr>
<tr>
<td>Female</td>
<td>10</td>
<td>9.0</td>
<td>6.2</td>
<td>13.1</td>
<td>8.7</td>
<td>10.0</td>
<td>4.8</td>
<td>2.5</td>
<td>1.9</td>
</tr>
<tr>
<td>Total</td>
<td>30</td>
<td>14.2</td>
<td>11.2</td>
<td>14.2</td>
<td>9.3</td>
<td>11.1</td>
<td>5.5</td>
<td>3.5</td>
<td>3.0</td>
</tr>
<tr>
<td>TOTAL</td>
<td>58</td>
<td>15.8</td>
<td>11.0</td>
<td>16.3</td>
<td>10.1</td>
<td>11.1</td>
<td>4.7</td>
<td>3.8</td>
<td>2.8</td>
</tr>
</tbody>
</table>

Note: Dialogue partners refer to number of fellow students that a student both sent and received comments so that the interaction was bi-directional. Betweenness value indicated cognitive centrality of a student, i.e., to what extent the student built bridges between actors that did not interacted with each other by commenting.