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Collaborative learning in an online course: A comparison of communication patterns in small and whole group activities

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Collaborative Learning in an Online Course: A Comparison of Communication Patterns in Small and Whole Group Activities

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Abstract

This article reports on the investigation of collaborative learning processes in an online course that examined students' communication during whole-group discussions and small-group activities. Content analysis and social network analysis methods were employed to code and categorize text messages to uncover students' communication behaviour. The results show that individuals' participation patterns were similar during the two different settings, but some inactive students during whole-group discussions were more active in small-groups. The social-out (sent-out messages) during whole-group discussions was a significant variable associated with cognitive contributions in whole-group as well as social and managerial contributions in small-group activities. This article also identified three indices, i.e., quantity, equality, shareness, that can be used as quantitative measures for evaluating small-group collaboration.

Résumé

Cet article rapporte une enquête sur les processus d'apprentissage coopératif dans le cadre d'un cours dispensé en ligne qui s'est penché sur la communication entre étudiants lors de discussions entre l'ensemble du groupe et lors d'activités pour groupes restreints. Des méthodes d'analyse du contenu et d'analyse des réseaux sociaux ont été employées pour codifier et catégoriser les messages texte afin de découvrir le comportement communicationnel des étudiants. Les résultats démontrent que les modèles de participation des individus étaient semblables dans les deux contextes, mais que certains étudiants inactifs lors des discussions en groupe élargi étaient plus actifs dans le cadre des groupes restreints. Le transmis social (messages envoyés) pendant les discussions en groupe élargi était une variable significative associée aux contributions cognitives dans le groupe élargi de même qu'aux contributions sociales et de gestion dans les activités tenues en groupes restreints. Il a aussi identifié trois index, c'est-à-dire, la quantité, l'égalité et le degré de partage, qui peuvent être utilisés en tant qu'indicateurs quantitatifs pour évaluer les collaborations en groupes restreints.

Introduction

Online courses are currently prevalent at post-secondary educational institutions around the world (Abrami et al., 2006; Rourke & Kanuka,

2009). Online courses frequently refer to a type of distance education course that is delivered completely through the Internet (Tallent-Runnels et al., 2005). These courses are characterized by three key common concepts: (a) a learner-centered framework (Garrison, 1993); (b) a collaborative learning method (Glasser & Bassok, 1989; Leidner & Jarvenpaa, 1995; Stahl, 2005); and (c) text-based communication (Johnson, 2006; Rourke, Anderson, Garrison, & Archer, 2001). In a learner-centered framework for online courses, students are expected to take responsibility to construct their own knowledge while they engage in learning processes (Garrison, 2009; Jonassen, 1999). Students need to participate actively in collaborative learning processes with peers while the instructor takes a role as the facilitator/moderator of the learning processes. Current online courses employ collaborative learning methods such as whole group discussions on course bulletin boards along with small group activities. In preparation for whole group discussions, students read suggested course materials and post messages to discuss issues about specific content topics while in small groups two to five members work to complete a team task. In order to collaborate in a group, students need to communicate to exchange information and narrow opinion gaps. Although the communication technologies are developing quickly, text-based asynchronous communication is the major component of communication among group members during online courses (Schrire, 2006).

A small group presumably provides members with opportunities to engage more deeply and actively in the learning process, allowing students a socially and emotionally safer climate with a small number of members (Davis, 1993). However, successful collaboration does not seem to be easy because students tend to avoid arguments and conflicts that might cause misunderstandings and hurt feelings during their text communications (Johnson, Johnson, & Stanne, 2000). Misunderstandings are common because on-line communication makes it difficult to process social and emotional cues (Baskin, Barker, & Woods, 2005). In the context of project-based small group activity, students should communicate intensively (Curtis & Lawson, 2001; Thompson & Ku, 2006). When group members fail to negotiate meaning, narrow opinion gaps among them, or overcome personal conflicts, they are essentially giving up on more sophisticated debates, the result of which may be that conversation remains at a superficial level. Further, group work can end up providing a poor quality learning experience (Francescato, Porcelli, Mebane, Cuddetta, Klobas, & Renzi, 2006; Ubon & Kimble, 2004). Little research has systematically evaluated collaboration levels in small groups and compared collaboration processes between small group and whole group activities.

Theoretical Framework and Research Questions

In this study, we blend aspects of a group effectiveness model (McGrath, 1964) with a collaborative learning model (Garrison, Anderson, & Archer, 2000) to consider how group processes influence group outcomes in an online learning environment. In particular, we adapt McGrath's *Input-Processes-Outcomes* (IPO) model. McGrath's three phases of input, process and output describing what groups need to be effective were elaborated by Ilgen, Hollenbeck, Johnson and Jundt (2005). *Inputs* generally include members' prior knowledge, the need for a group task and interpersonal factors. The collaboration *process* then leads to *outputs* that may include members' constructed knowledge, membership in the group, learner satisfaction or perceived learning. Thus, the collaborative process mediates inputs and outputs. For the current study, we needed a way to conceptualize this mediational influence in the online environment of the study and hence, developed a frame that would allow us to evaluate and compare collaborative learning processes during whole group and small group activities.

We have drawn on Garrison et al's (2000) *Community of Inquiry* (CoI) model to structure our analysis of communications during the online course. In the CoI model, learners can meaningfully engage in a learning community when they experience three kinds of presence: cognitive, social, and teaching. Cognitive presence refers to "the extent to which the participants in any particular configuration of a community of inquiry are able to construct meaning through sustained communication" (Ibid, p. 89). Social bonds between community members established through social presence enable members not only to instruct and support each other, but to feel confident enough to freely express their own ideas, particularly when the ideas might be contradictory to those of other group members. Teaching presence primarily refers to instructor's role in directing students' cognitive presence.

The CoI model has been validated for analyzing whole group discussions (see for example, Celentin, 2007; Schrire, 2006). This model, however, has some limitations for analyzing small group interactions for two reasons. First, learning processes in a small group are different from whole group discussions. A small group as a collaborative learning unit has critical attributes of independence from the instructor (autonomy) as well as strong interdependence between members (Ingram & Hathorn, 2004). A project-based small group activity is intended substantially for student-centered learning. Therefore, the course instructor is not supposed to be a participant in the group's collaboration processes, but rather, be a moderator or resource person. Thus, a teacher's presence is

not a component of small group learning process but rather a factor influencing the collaboration process. Secondly, the CoI model lacks recognition of the importance of a major portion of interaction in small groups, i.e., managerial statements. Group managerial statements are about coordinating group task processes such as scheduling, reducing confusion and assisting each other with technical problems. Thus, in our adaptation to Garrison et al's model, we substitute 'managerial presence' for teaching presence.

For the reasons described above, we need a further adaptation to the process portion of our model. We recognize two domains of process: *student-learning process* and *teacher-facilitating process*, as shown in Figure 1. Teaching/facilitating is a moderating factor influencing a student's learning processes. Further, both domains of teaching and learning processes include managerial presence. We explicate these indicators as analysis categories in the Analysis section of this paper.

In an online course environment, small groups are nested within the whole group. Thus, small groups are influenced by and influence whole group discussions across the course. Communication media and technologies are also crucial components influencing small group collaboration processes.

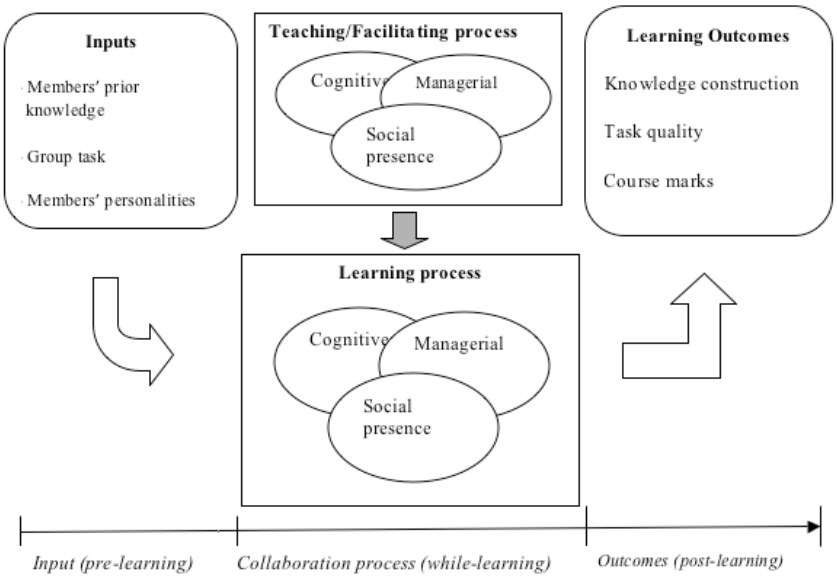

Figure 1: Small group learning framework

With the framework as adapted for this study, we investigate small group collaboration levels by analyzing students' interactions via their text communications. While active interactions are the basic requirement for collaborative learning (Alavi & Dufner, 2005; Graham & Misanchuk, 2004), not all groups experience successful collaborative learning (Cohen, 1994). Successful small group collaboration requires active interaction during small group work (Alavi & Dufner, 2005; Graham & Misanchuk, 2004). Additionally, to be an effective collaborative team, groups' communication structures should be democratic (e.g., de-centralized or equalized) (Cummings & Cross, 2003; Lipman-Blumen, & Leavitt, 2001). Further, members' communication should be open (Wheelan & Kesselring, 2005). Therefore, we need to analyze students' communication in a small group in terms of: (a) how much interaction occurs (*quantity*); (b) to what extent contributions are equal (*equality*); and (c) what portion of communications are shared with the whole group (*shareness*).

The purpose of the research is to investigate collaborative learning processes in an online course by examining students' cognitive and social communications during whole-group discussions and small-group activities. The research aims to evaluate small group collaboration levels using three interaction indices (quantity, equality, shareness) by categorizing the content of the text communication messages exchanged during small group activities and whole-group discussions. The specific research questions are as follows:

1. How is student communication behavior in small group activity different from that in whole-group discussions?
2. Do group interaction indices of quantity, equality and shareness indicate successful group collaboration?
3. Do more successful groups as evaluated by the three indices have different interaction characteristics than less collaborative groups?

Methods and Analysis

Data for this case study were text communication messages between students during an online course offered by a university in Canada. At the time when the researchers accessed the data, the course had been completed. Thus, intact data could be retrieved. There were twelve graduate students (five males and seven females) enrolled in the 13-week course. The course was designed to employ whole group topic discussions and small group projects for two written assignments. There were five modules for whole group discussions in the course where students were expected to post their own opinions and respond to others'. Two modules (Modules 1 and 2) were included in this study, which occured before small group activities started, because we focused on

communication behaviour during the early stage of whole-group discussions associated with those during small-group activities. Module 1 involved making a self introduction to the group. Module 2 involved discussions around a topic the instructor posted. Small group assignments required students to write two papers as a group, which were worth 15% and 35% of the final course mark. The remainder of the course marks involved individual assignments (40%) and a "participation" mark (10%) from the instructor's monitoring discussions on discussion boards. Each group had three members and the messages they sent and retrieved constitute our study data.

This case study employed Content Analysis (CA) alongside Social Network Analysis (SNA) to analyze the text communication data collected from whole group discussion boards and small group forums. CA is a technique that involves analyzing communication texts by counting word occurrences (Schwandt, 2001). There is an interpretive element to coding data for CA, and then a quantitative element in conducting further analysis. The method used in the current study involves both qualitative and quantitative elements. CA has commonly been used in analyzing online communication by allowing researchers to conveniently collect text transcripts of interactions from course management systems (Aviv, Erlich, Ravid, & Geva, 2003; Ingram & Hathorn, 2004). CA has been recognized as a 'useful instructional tool' that can identify the factors affecting the quality of learning processes, and, thus, helps educators to assist learners (Hara, Bonk, & Angeli, 2000; Henri, 1992; Mason, 1991). In this research, CA was used to identify and elaborate collaboration processes in terms of cognitive, social and managerial presences, which allows us to understand individuals' contribution to their groups and also to explain the emerging presences in the small groups. However, CA lacks the ability to examine interactional relationships between members. This weakness of CA can be compensated by employing SNA which is a methodological technique in analyzing interaction patterns and structures in a group learning context (Enriquez, 2008; Palonen & Hakkarainen, 2000). SNA was used in the current study to identify active and inactive students and their interaction patterns in whole and small groups. Combining both CA and SNA, small group collaboration was evaluated in terms of quantity, equality, and shareness.

We selected a 'thematic/meaningful unit' as a coding unit rather than a grammatical/structural unit. Each unit was coded into one of three categories: cognitive, social, and managerial (as shown in Table 1). A meaningful unit conveys a single thought or idea and thus allows flexibility to capture the meaning of a statement in a context beyond the confines of grammatical units (Budd & Donohue, 1967; Henri, 1992).

Thus, a meaningful unit can be a word(s), a phrase(s), a sentence(s), or a paragraph(s). There are two typical problems using a meaningful/thematic unit: firstly, analysis based only on the number of meaningful units can be biased because short and long units have equal weights (Palonen & Hakkarainen, 2000). To address this problem, we calculated word counts within the units. Secondly, high coding reliability is difficult to achieve between independent coders because of the subjective nature of coding decisions. In other words, one coder may divide a message into three units while the other coder divides the same message into more or less than three units. However, reliable coding is important for conducting content analysis (Rourke, Anderson, Garrison, & Archer, 2004). Thus, we conducted inter-coder reliability checks. Because of the volume of data, two coders independently coded about 10% each of whole group and small group transcripts. The agreement rate between the two coders was calculated to be 89% for the whole group discussion messages and 85% for the small group discussions. These percentages are approaching the 90% inter-coder reliability suggested by Miles and Huberman (1994), and indicate that the application of codes is adequately consistent for our purposes in this paper.

A second level of analysis considered small group collaboration levels, and evaluated them using the indices *quantity*, *equality*, and *shareness*. The *quantity* index is calculated as the total words sent by each member in a group. The *equality* index was calculated by using the standard deviation of the number of words sent by each member. This is to examine whether group members made equal contributions to their group's efforts. The *shareness* index is calculated from the number of words sent to all members as a portion of the total number of words exchanged in the group.

Table 1. Coding Scheme

Category	Definition	Indicator/Example
Cognitive	Statements directly related to on-task content of group assignment	• sharing knowledge • comparing information on facts • suggesting opinion on the assigned topics • brainstorming, questioning, refining, elaborating • suggested ideas with real life examples • evaluating by agreeing or disagreeing with each other • integrating and synthesizing the conflicted opinions
Social	Statements to build up friendship and group membership	• salutation: greetings, calling names, conventional thanks • openness: self-introduction, sharing personal feeling/emotional states; • humour, jokes • encouragement/compliments (e.g., good work! Great team!) • off-task information: statements not directly related to the course content or tasks, general information
Managerial	Statements to manage the collaborative process	• scheduling (e.g., I will post my work by 11am tomorrow); • dividing jobs; • arranging meetings • clarifying ambiguities and procedures about assignments (e.g., deadlines, word limits, technological problems) • discussing strategies (e.g., Let's post work individually and combine the works.)

Results

A total of 832 messages (76313 words) were coded into 2996 meaningful units (Table 2). Coding results revealed that 99% of Module 1 messages

(Self-Introduction) fell into the social category, while 89% of Module 2 messages (Topic Discussions) fell into the cognitive category. Small group messages were much more varied: 43% cognitive, 23% social, and 34% managerial. In terms of the average length of messages, Module 1 messages were shortest (71 words/message). We presume that this average is due to the fact that replies to initial posts tended to be short. Messages during small group communication also tended to be short (90 words/message), although this is roughly the same length as the average message for the entire data set. Topic discussions within Module 2 had the longest messages, averaging 133 words per message.

Table 2. Data Coded

Activity	No. of Messages	No. of Units	No. of Words	Words per Mess.	Cognitive Wrds. (%)	Social Wrds. (%)	Mngrial/ Wrds. (%)
Module 1	106	316	7533	71	< 1	99	< 1
Module 2	74	246	9868	133	89	1	10
Small Group	652	2434	58912	90	43	23	34
Total Data	832	2996	76313	–	–	–	–

Comparisons of Communication Behaviour during Whole Group and Small Group Activities

Students' participation in small group discussions was more equal than participation during whole group discussions. During whole group topic discussions in Module 2, for example, three students posted more than 1,500 words each while three students posted no messages (see Figure 2). Figure 3 shows that individuals posted more words during small group activities but, also, that posting and sharing messages is more equal during small group discussions. The variability coefficient (standard deviation divided by mean) of small group messages (CV = 0.383) is much lower than that for either Module 1 (CV = 0.683) or Module 2 (CV = 0.997). This finding shows that, generally, students participated more equally in small group discussions than in whole group discussions.

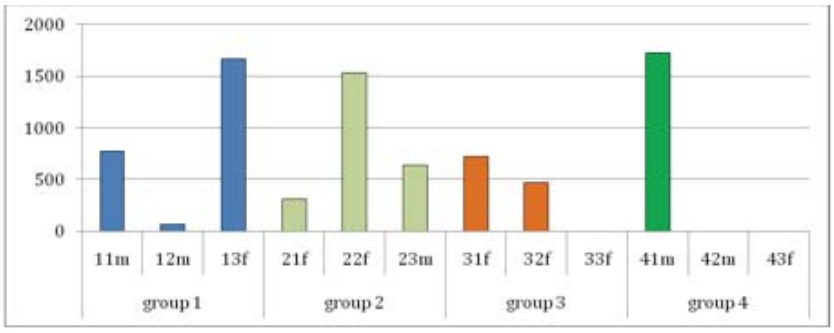

Figure 2. Amount of words posted by individuals in whole group discussions Module 2

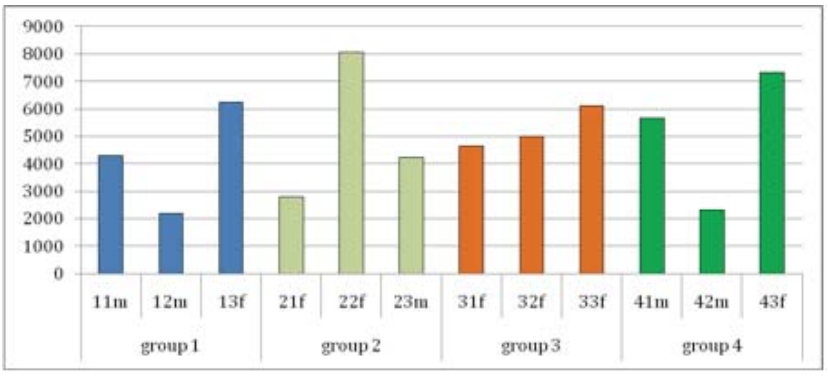

Figure 3. Amount of words posted by individuals in small group forums

Some of the correlations between communication categories in the two different activity settings were significant (see Table 3). 'Social-out' (i.e., social statements sent to peers), in particular, was significantly related to other variables. Within whole group discussions, the social-out category was substantially related to cognitive-in ($r = 0.74$) and cognitive - out ($r = 0.61$). This means that there were significantly more cognitive messages coming in when a student sent more social messages out. This indicates that those students who are most active socially (in terms of posting more messages during whole group discussions) also tend to be more engaged cognitively during whole group communications. Correlations between communication categories in small groups compared to those in the whole group revealed that only the

social-out category during whole group discussions was significantly associated with both social (r = 0.69) and managerial (r = 0.79) categories in small groups. Interestingly, however, the social-out category during whole group discussions was not significantly related to the cognitive-out category in small group discussions (r = 0.14). This means that the most socially active students in the whole group setting were not necessarily most active in their cognitive communications.

Table 3. Correlations between Small-group and Whole-class Communication

Activity			Whole-group				Small-group		
	Category		Cognitive		Social		Cog.	Soc.	Managerial
			Out	In	Out	In	Out	Out	Out
Whole-	Cognitive	Out	-	0.49	0.61*	0.29	0.40	0.45	0.31
group		In	0.49	-	0.74**	0.67*	0.11	0.25	0.47
Discussion	Social	Out	0.61*	0.74**	-	0.56	**0.14**	0.69*	0.79**
		In	0.29	0.67*	0.56	-	0.32	0.41	0.57

Note: *p < .05 (r = 0.576, p = 0.05), **p < 0.001 (r = 0.708, p = 0.01); Out: messages sent out to other students; In: messages received from other students

Evaluation of Small-group Collaboration: Three Indices and Achievement

For this section, data are presented in Table 4, where measures of group collaboration and participation/communication during small group activity are compared on the three collaboration categories for the study (cognitive, social and managerial) and three indices of participation/communication (quantity, equality and shareness).

Table 4. Measure of Group Collaboration Based on Amount of Words Sent During Small Group Activity

Measure Index	Quantity				Equality				Shareness			
Small Groups	1	2	3	4	1	2	3	4	1	2	3	4
Cognitive	5432	4721	8510	6548	545	518	334	800	38	63	91	91
Social	2731	4233	2187	4485	409	778	278	790	39	56	51	52
Managerial	4545	6150	5072	4298	1149	1456	717	1178	46	56	65	62

Note: Quantity: total exchanged words, Equality: group standard deviation of exchanged words; Shareness: per cent of the exchanged words to all other members of total exchanged words

Participation Quantity

Quantity is the most commonly used index of participation/collaboration in research on text communication analysis (Hathorn & Ingram, 2002; Thompson & Ku, 2006). For the current study, the quantity measure used was the total number of words exchanged within each group and sorted into categories of interaction (cognitive, social and managerial), as shown in Table 4. Overall, Group 1 exchanged the fewest words on average (n = 4236) while the other three groups exchanged over 5,000 words. In the cognitive message category, Groups 1 and 2 exchanged fewer words (n = 5432, 4721, respectively) as compared to those of Groups 3 and 4 (n = 8510, 6548, respectively). Group 3 devoted the highest percentage of words to cognitive communication (54%), while Group 2 was the lowest with 31% of their words being cognitive communications. Group 4 exchanged the largest number words in the social category (29%) as compared to that for Group 3 (14%). The managerial category showed the least variation between groups, with Group 2 highest (n = 6150) and Group 4 lowest (n = 4298).

Judging collaboration levels among the four groups from their overall averages on the Quantity index, Group 1 is the least active group followed by Group 2 which spent more effort in managing group processes than in discussing cognitive content. Discussions in Group 3 were predominantly cognitive and Group 4 was socially as well as cognitively strong. Communications in Group 4 tended to be more evenly distributed across the three content categories.

Participation Equality

Equality index is defined as the standard deviation of the number of messages exchanged among members, which is an indicator of how each individual member contributes to the collaborative task of the group. The average equality index for the four groups was 1,882 words. Variation within the managerial category (SD = 1016) was much larger than the social (SD = 619) or the cognitive (SD = 698) categories. It is possible that one member of the group may have taken a coordinator role in managing group processes, thereby skewing the variation. Group 3 revealed the highest equality (lowest variation) in each of the three categories of collaboration (see Table 4). The overall equality of Group 3 (SD = 773) was outstanding compared to that of other groups, Group 1 (SD = 2,014), Group 4 (SD = 2,551), and Group 2 (SD = 2,716), which supports the notion that the members of Group 3 were more egalitarian in how they made contributions to their group's discussions.

Communication Shareness

The Shareness index indicates the degree of open communication between members. It is measured as the portion of statements sent to 'all members' instead of to 'one member' in a group. In other words, shareness is the percentage of words sent to all as compared to the total number of exchanged words, and a higher percentage means that individuals share more messages with all group members.

As shown in Table 4, Groups 3 and 4 revealed higher overall shareness (69% and 68%, respectively) as compared to Groups 1 and 2 (41% and 58%, respectively). Notably, Groups 3 and 4 had particularly high percentages of their messages in the cognitive category (91% shareness for both groups). With such high levels of shareness in the cognitive category, it can be surmised that Groups 3 and 4 have good communication habits that may enable them to take advantage of the group context for collective learning activity. Conversely, Group 1 revealed only 38% shareness in the cognitive category, which means that 62% of cognitive statements were 'one-to-one' communications that were not shared with the third member. Overall, Group 1 revealed the lowest shareness in each of the three collaboration categories.

Collaboration Indices and Group Marks

Group collaboration indices (quantity, equality, shareness) and achievement marks were ranked from highest (score 1) to lowest (score 4), as shown in Table 5. Collaboration levels were calculated as averages of the three collaboration indices. Looking at the rankings from overall

collaboration levels, Groups 1 and 2 tied for last place. The collaboration rankings according to the indices are consistent with the marks for the projects assigned by the course instructor. Group 3 had both the highest collaboration level according to the indices and the highest achievement as a group. Groups 1 and 2 had the same achievement level and, as well, were ranked equally on collaboration. Group 2 exchanged the fewest words as cognitive statements but managed an overall quantity ranking of third. Therefore, the two rankings are exactly the same with the probability of 0.83, which means the three collaboration indices for evaluating group collaboration levels can be considered a valid measurement.

Table 5. Group Rankings for Collaboration Indices and Achievement Marks

	Group 1	Group 2	Group 3	Group 4
Quantity	4	3	1	2
Equality	2	4	1	3
Shareness	4	3	1	2
Overall collaboration	**3**	**3**	**1**	**2**
Achievement	3	3	1	2

Communication Characteristics and Patterns during Small Group Processes

Individual Members' Contributions

Female students were very active in small groups. In each group, the highest contributor was female, while the two least frequent contributors among all the groups were males (Figure 3). Group 3 was a female-only group while the other groups were mixed. Group 3 exchanged the highest frequency of words in total and was the most highly collaborative according to each of the measures reported in this study. Further, the members of Group 3 showed less variability in their contributions to group communication.

We calculated correlations between communication categories for the small group discussions. We found significant correlations between the social and managerial categories, at the $p < 0.01$ level ($r = 0.78$). These data are presented in Table 6. The significant correlation between the social and managerial categories suggests that students who sent many social messages tended to also be most active in group managerial processes.

Table 6. Correlations of Small-group Communication

Category	Social	Managerial
Cognitive	0.19	0.36
Social	–	**0.77***

*Note: *p < 0.01 (r = 0.708)*

Group Communication Patterns

Interaction trends in terms of total words exchanged during small group activities showed similar patterns among all groups as shown in graphical form in Figure 4. The communication volume peaked during weeks 4 and 6, corresponding to the lead-up to assignment due dates in weeks 5 and 7. After week 7 there was a designated period for classmates to offer comments and feedback about papers posted on the class bulletin board. While the peaks in the chart are not as high as they were in Weeks 4 and 6, the portion of social communications increased from 23% to 42%, while cognitive communications dropped from 45% to 32%. Groups 3 and 4, which were identified above as more highly collaborative groups in our sample, tended to continue their communications to the end of the course. Conversely, members of Group 1 rarely communicated after the period of small group work on their assignments.

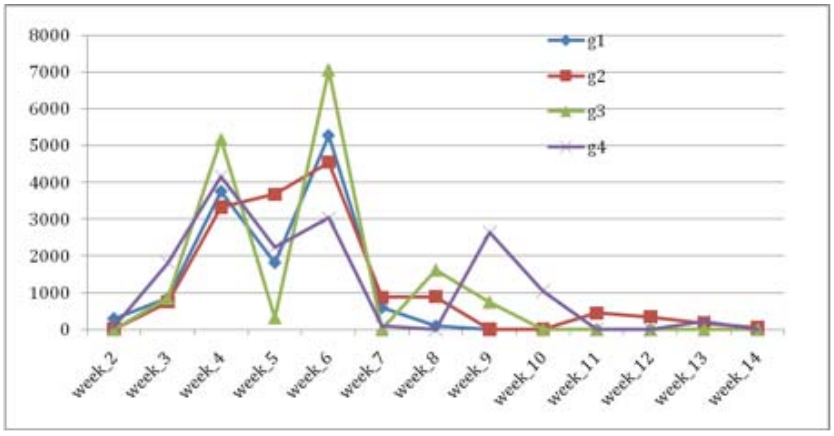

Figure 4. Total messages exchanged during small group activity

Discussion and Conclusions

The purpose of this research was to better understand small group collaboration in relationship to whole group discussion activities during an online course. In order to reach that goal, three specific questions were raised. The first question sought to identify if communication behavior was different during small group activity as compared to behavior during whole group discussions. To answer this question we compared individual communication behaviour in term of posting frequencies (in number of words that were contributed to whole group and small group discussions for the course). We found much smaller variance in interaction frequencies among members of small groups than among individuals in whole group discussions. More specifically, some highly inactive 'lurkers,' who could be invisible hiding themselves in a crowd, appeared to take more active roles in the small group setting. This finding is consistent with Alavi and Duffner (2005) and Graham and Misanchuk (2004), and may confirm the idea that small group activity provides a more emotionally safe environment even as it obligates students to take more active responsibility as members of a collaborative learning community.

Correlation analyses were performed on the content categories of interactions to explore individual communication behaviour in the two different activity settings. Social-out, calculated by frequency of sent-out social messages, was the most significant variable related to cognitive centrality and also managerial centrality. This empirical evidence supports the social constructivists' claim emphasizing the importance of social presence in collaborative learning processes in the community of inquiry settings (Garrison et al., 2000; Vygotsky, 1978). More specifically, this finding emphasizes the role of social interaction as individuals engage in the collaborative process (Beuchot & Bullen, 2005). Curtis and Lawson (2001) had claimed that online courses should be designed to encourage more social interactions, "perhaps through more structured online self-introductions" (p. 29). We hesitate to endorse this claim, as a higher degree of social communication does not necessarily indicate a higher level of collaboration for learning activity. As reported by the participation quantity in Table 4, Group 2 exchanged almost double the amount of social communications but just half the number of cognitive communications as compared to Group 3. Further, Group 2 measured lower on all three collaboration indices (as shown in Table 5). Such a result implies that there may be an appropriate level of social communication that supports collaborative activity more generally directed at a learning goal. More research is needed to identify the level of social

communication associated with high collaboration and successful group achievement.

The second question in this research considered how to evaluate successful collaboration in text communications during small group activity. We used three indices for evaluating collaboration levels (*quantity, equality,* and *shareness*). Employing these indices, we described attributes of successful collaborative groups: members interacted more through a higher quantity of messages, members tended to participate more equally, and messages were more often shared with all members of the group. We also checked the applicability of the three indices for evaluating collaboration levels in small groups by comparing them with group achievement marks. This checking revealed consistency between the rankings. Findings from our work with these indices have significant implications for evaluating group collaboration and facilitating small group activity. While we found few studies that explored evaluation measures or methods of collaboration in small groups during online courses, the three collaboration indices used here can readily be used to evaluate collaborative learning processes, thus extending the more common forms of evaluation that consist mostly of peer evaluation and outcome evaluation. While *quantity* (of messages posted) has been commonly used in research and course evaluation (e.g., Hathorn & Ingram, 2002; Thompson & Ku, 2006), *equality* and *shareness* offer new frames for evaluation.

Finally, we attempted to identify individual members' characteristics of interaction in successful collaborative groups that might have influenced online learning processes. We identified gender as one factor that could influence successful collaboration in small groups. In our study, which admittedly used a small sample size, the female-only group was the most highly collaborative group. Further, the most active contributor among all of the groups was female, while the two least frequent contributors to group discussions were male. This finding is similar to a study by Bostock and Lizhi (2005) that compared discussion groups having different gender combinations. A result was that female-only groups posted more messages than all-male groups. However, the study reported no significant difference between genders in cognitive quality of the groups' discussions. Other research on gender differences in online courses reported no significant differences in quality (Jeong, 2006) or in the use of language (Fahy, 2002; Graddy, 2006). These studies focused on bulletin board discussions, not on small group interaction, thus further research is needed on the topic of gender as a factor that might be considered when forming small groups.

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