

# The Impact of Negative Relations on Performance and Satisfaction in Group Work

Ling Xia<sup>1</sup>, N. Sadat Shami<sup>2</sup>, Y. Connie Yuan<sup>1,2</sup>, Geri Gay<sup>1,2</sup>

<sup>1</sup>Department of Communication

<sup>2</sup>Information Science Program

Cornell University

{lx33, ns293, yy239, gkg1}@cornell.edu

## Abstract

*This paper reports on a case study conducted to guide the design and implementation of a group support system. Network analysis of student self-reported interactions was conducted to obtain a better understanding of social relations, which are critical in informing the design of systems that support sociability. Building on previous research on group dynamics, the study examined the impact of negative relations and frequency of communication on performance and satisfaction among 13 groups of students. Results show that group members disliked by others were less likely to perform well; group members were less likely to feel satisfied with the group process when they disliked others; and frequent communication with others could make a person more likeable and help him/her perform better. We conclude by providing suggestions about how to incorporate findings from network analysis into the design of communication technologies to support group work.*

## 1. Introduction

Groups have been widely recognized as the key organizing unit in contemporary organizations [1, 2]. Group work promises wider access to new information and a greater pool of diverse expertise. However, not all groups collaborate effectively [32]. Advances in information and communication technology can help support the collaboration process as well as help manage its complexity. Scholars and practitioners have studied and experimented with different types of systems to support group work, including for example, expert systems, group decision support systems etc. [e.g., 34]. Yet despite significant investments in these information and communication technologies, many of these systems have encountered social and technical barriers [6]. Preece [35], and Barab, Kling & Gray [5] observed that the design of many existing group collaboration support systems focused too much on issues related to the *usability* of the technology rather

than the support of social interactions. As a result, these systems serve as mere platforms for information exchange, and do not necessarily support the development of social interactions and common values, that are instrumental for collaborative work [35].

Researchers need to understand much more clearly the social processes involved in online collaboration among groups. Requirement analysis for designing group support systems intended to improve social relations can greatly benefit by embedding social network tools in them. Most social network tools have been used to identify positive network structures such as advice, friendship, or communication networks. Using tools to identify negative or adversarial networks to support group work has remained a relatively unexplored area in Information Systems research. Previous research shows that when given a choice between working with a competent person and a likeable person, people tend to prefer a congenial colleague over a more capable one [13]. This preference for working with a highly liked individual over a highly skilled individual has important implications for group dynamics that has been frequently overlooked in empirical research. Social networking tools make it possible to describe interaction patterns among group members and to assess empirically the degree of collaboration among them. This feature can also be used to offer a window into negative group dynamics. For example, social networking tools that can be integrated into group work support systems can provide automatic measures of communication frequency [20], as well as analysis of message content [28]. While these tools alone cannot solve negative group dynamics; through easy and early identification of bottlenecks, they can ameliorate negative dynamics. In this case study, we were interested in examining how frequency of communication, performance and satisfaction relate to negative network structures, and exploring implications of the results for the design of computer supported collaborative systems.

In this paper, we first review related empirical studies in educational and organizational management research. We proceed by developing hypotheses based on these studies, and then discuss how we empirically tested our hypotheses by examining the complete social network data among 49 students engaged in a semester long group project. Based on the findings from our empirical case study, we end the paper with a discussion on possible implications for the design of a system intended to support productive group work and interactions.

## 2. Adversarial networks in social network research

Social network analysis studies how relations, in addition to individual attributes, influence human behavior [46]. The approach itself has achieved “a high degree of technical sophistication and has proven to be extremely useful in a strikingly wide range of substantive applications” [16], including sociology [46, 46], organizational behavior [8, 26, 29, 39] and communication [30].

Most of the social network analysis studies to date, however, have focused on the positive aspects of social networks. For example, studies show that positive relations like friendship ties and advice-seeking relationships can provide opportunities for social support as well as access to resources that are necessary for improved performance [29, 40]. For example, employees may obtain faster promotion through developing support networks with friends and colleagues [11]. However, on the other hand, there is evidence that employees may be demoted due to having negative relationships with others, especially if those negative relationships are with people in more powerful positions [9]. Therefore, people may be constrained by the same social structure that benefits others [18].

Compared with the large amount of empirical attention given to the positive aspects of social network research, little research has been done to examine the consequences of negative network relations: those adversarial relationships that may hinder or be detrimental to the performance of both individuals and the group as a whole. Therefore, in this paper we will focus on adversarial networks in students engaged in a semester-long group project. The general research questions we address include “how will negative relationship with other group members influence students’ satisfaction with the group?” and “how will negative relationship with other group members’ further influence students’ performance?”

Communicating with people around us may not always turn out to be an enjoyable or positive experience. In group work, people who are difficult to communicate with may be described by peers as irresponsible, not motivated, or indifferent. They offer “neither valued information and insights, nor support and fun” [24]. The relationships with these people may therefore involve negative exchanges and offer few benefits; and are therefore defined as “adversarial relationships” [3, 47]. Brass & Labianca define negative relationship as “social liabilities” (the opposite of “social capital”), and proposed that negative ties may have greater explanatory power than positive ties in groups/organizations [9]. The reason is that negative events may “elicit greater physiological, affective, cognitive, and behavioral activity and further lead to more cognitive analysis than neutral or positive events” ([43], p. 69).

A few studies have examined how an adversarial network structure may influence individual performance. A negative relationship was found between adversarial network centrality of MBA students and their performance [3]. Yang & Tang also discovered that adversarial network variables are negatively correlated with students’ online and offline performance [47]. Nevertheless, in both of the studies, the researchers either examined the in-degree centrality while neglecting out-degree centrality [47]; or did not distinguish in-degree from out-degree centrality [3]. In-degree centrality measures the number of network links a focal node receives reported by other group members in the network [37]. Out-degree centrality, on the other hand, measures the same structural property about the focal node, but is based on the focal node’s self-report data. When studying adversarial relationships in a group, we believe that a clear distinction between the two types of centrality measures should be made. The reason is that, similar to friendship ties, adversarial ties are not symmetrical. An observation of “Person A does not like Person B” does not necessarily mean that “Person B does not like Person A”. To address this limitation of existing research, we included both centrality measures to examine how adversarial network structures are related to individual performance and the satisfaction of each group member with their group experience.

A second contribution that this empirical study makes is to investigate whether frequency of communication, a key indicator of network ties [21], is related to a person’s centrality in an adversarial network. We are interested in finding out what types of people are more likely to occupy a central position in an adversarial network: the stars who communicate with many people, or the isolates, who barely communicate with others in the network. Further, we

are also interested in examining the influence of the frequency of communication on the individual's performance and the individual's satisfaction with the group. Baldwin et al., discovered that communication within MBA student teams was directly and strongly associated with perceptions of team effectiveness [3]. However, in this study, researchers only identified the centrality of the communication network and omitted the frequency of communication among team members, i.e., the strength of communication ties. Thus, the current paper extends research by Baldwin et al. by examining the frequency of within-group communication.

### 3. Theoretical background and hypotheses

#### 3.1. Adversarial network, frequency of within-group communication and performance

Baldwin et al. studied how network structures relate to team performance outcomes and members' satisfaction towards team effectiveness using a sample of 250 MBA students [3]. At the individual level of analysis, they found that centralities in friendship, communication and adversarial networks were related to both students' grades and their attitudes. Analysis at the team level also revealed that relationships within and between teams had significant effects on student perceptions of team effectiveness and objective team performance. One limitation with their study, however, was that they treated adversarial relationships as symmetric and unidirectional. They explained that because the adversarial matrix generated in that study was sparser than the friendship and communication network, "...adversarial relationship is assumed to exist if at least one of the actors reported it" (p. 1379). As discussed previously, adversarial relationships may not be symmetrical. Therefore, the in-degree centrality and out-degree centrality of the adversarial network should be differentiated. In-degree centrality of adversarial network counts only adversarial relationships with the focal individual reported by other group members, and therefore would be a better predictor of individual performance than the symmetrized centrality in an adversarial network. To explain, in-degree centrality of the within-group adversarial network reflects the extent to which the focal student is disliked by his/her group members. To successfully finish the group project and achieve a good grade, each student will depend on other group members' advice, efforts, and assistance. Therefore, the more adversarial relationships other group members report with the focal student, the more

difficult it is for the focal student to achieve good performance.

In another study of social networks in groups, Sparrowe et al. used a sample of forty-seven work groups to investigate friendship, advice and hindrance networks<sup>1</sup> [40]. In their study, the "in-degree centrality" and "density" variables of social networks were especially emphasized in order to understand how an individual's network position within the group and his/her job performance is related. Density is used to describe the overall level of interaction of various kinds reported by network members. As predicted, they found that individual job performance was positively related to centrality in the advice network and negatively related to centrality in the hindrance network. They also found out that hindrance network density was significantly and negatively related to group performance.

Based on above-mentioned reasoning and results from similar empirical research, we propose that

**H1:** *In-degree centrality in the adversarial network will negatively affect individuals' performances.*

Communication among group members is very important for a group to successfully accomplish its task. As Baldwin et al. pointed out, embeddedness in a communication network would keep group members informed about the quirks of certain professors and changes in assignments [3]. They also found out that communication within MBA student teams was directly and strongly associated with perceptions of team effectiveness. In the current study, instead of focusing on "how well a group member is embedded in the communication network", we emphasized the magnitude of communication ties, i.e., how frequently group members communicate with each other. We expected that the more frequent an individual communicates with his/her teammates, the better the quality and quantity of information and assistance

<sup>1</sup> Although Sparrowe et al. used the terms "hindrance relationship" and adversarial relationship interchangeably, their definition of "hindrance network" was somewhat different from the commonly defined adversarial network [40]. According to the authors, centrality in hindrance network "reflects the extent to which the focal individual is described by co-workers as a person who makes it difficult for them to complete their work by withholding valuable information, resources, and opportunities" (p. 8). However, in most other adversarial network research, adversarial relationships only involve negative exchanges which cause emotional distress, anger or indifference" [e.g., 47]. In other words, the "hindrance network" discussed in the Sparrowe et al. study contains more "negative" substantive information than the commonly accepted definition of "adversarial network" in other research.

gained by him/her would be. To the extent that this information and assistance are beneficial for students, we expected a positive relationship between the frequency of communication and an individual's performance.

**H2:** *Frequency of within-group communication will positively affect individuals' performances.*

At the same time, the more frequently individuals communicate with other group members, the more they are going to be regarded as conscientious and highly motivated by their peers. Since people with a good work ethic and high motivation are more likely to be respected in the work group than those who are indifferent and careless of others, we expect that individuals who communicate more frequently with group members will be less likely to take the central position in adversarial networks.

**H3:** *Frequency of within-group communication will be negatively related to the in-degree centrality of the adversarial network.*

### 3.2 Adversarial network, frequency of within-group communication and individuals' satisfaction with groups

Understanding how group members are satisfied with their group is very important for studying group experiences because positive affect, as reflected in group satisfaction, has the potential to influence motivation and performance [10, 19]. Peeters et al. mentioned that if individuals are dissatisfied with their group, they will develop negative attitudes toward group tasks [32]. This can lead to decreased effort when working with groups in the future. Previous empirical studies have discovered significant associations between group satisfaction and group effort and between group effort and final performance ratings [27]. Given the increasing prevalence of collaborative group work in nearly all aspects of our lives, how satisfied individuals are with working in groups is an important research topic.

Individual satisfaction with the team was defined to be related "either to the team members or the team's composition or to the way team members worked together during the project" ([32], p. 189). In other words, if individuals feel comfortable with either the team members or the cooperation within the team, they will be satisfied and consequently more motivated to work with teams in the future.

In the field of social network analysis, the study of Baldwin et al. [3] stands out as one of the few efforts

which looked into the relationship between network structure and group members' satisfaction with group effectiveness. Their results revealed that centrality in the adversarial network was negatively associated with satisfaction with teams and the program overall. Nevertheless, again as noted earlier, their study was limited to the extent that the in-degree and out-degree centrality of the adversarial network were not differentiated. The negative evaluation individuals reported with others, instead of the negative evaluation they received, may influence their evaluation of team effectiveness as well as their enjoyment and satisfaction with the group. Accordingly, it is the out-degree centrality that should be measured instead of the symmetrical and non-directional adversarial network centrality to predict the satisfaction levels individuals hold towards their group experiences.

**H4:** *The out-degree centrality of the adversarial network will negatively affect the individual satisfaction of their group experience.*

Baldwin et al. also discovered that individual centrality in the communication network was positively associated with perceptions of learning and enjoyment of the program [3]. Communicating with other group members may provide access to valuable information, which will in turn reduce individuals' uncertainty and ambiguity about group tasks. Besides, communicating with group members may also enhance mutual understanding and help to build group morale. We therefore expect that the more frequently individuals communicate with their group members, the more likely they are going to be satisfied with their group experience.

**H5:** *The frequency of within-group communication will positively affect individuals' satisfaction of their group experience.*

## 4. Method

### 4.1. Sample

The sample used in our study was comprised of university students enrolled in an undergraduate human-computer interaction class in a large northeastern university. Altogether 56 out of 60 undergraduate students volunteered to participate in this study in order to receive extra credit, resulting in a participation rate of 93.3%. Seven students failed to provide complete data and were therefore removed from consideration. This resulted in a final sample of 49 students.

Students were assigned to small groups at the beginning of the semester based on instructors' understanding of their common interests and goals for this course (the four students who did not choose to participate were assigned into one group and were excluded from the study). Group size ranged from 3 to 5 students. There were a total of 13 groups. Students stayed in the same group throughout the whole semester to finish a semester-long project.

Students were asked to fill out an online survey about feeling of distance, frequency of communication, and feeling of satisfaction with the group experience. The URL of the survey was sent to students through an email after they had finished final group project presentations. Our sample was composed of 46.9% female and 53.1% male students. Students came from various disciplinary backgrounds, including communication, information science, computer science, etc.

**4.2. Measures**

**4.2.1. Network data.** The adversarial network data was measured using an adapted version of the scale used by Burt [12]. Students were asked to identify those in class that they felt close to and those they would avoid and keep at a distance. To do so, the students were provided an alphabetized list of all their group members and asked to report how they felt about each of them. In our scale, "1" meant "especially close (one of the respondents closest contacts)" and "5" meant "distant (avoid contact unless necessary)". Both in-degree and out-degree centralities of the adversarial network were computed following Freeman's [17] definition as implemented in the UCINET 6.0 software package [7]. The higher the in-degree score individuals received, the more they were disliked by group members. On the other hand, the higher the out-degree score individuals received, the more they disliked other group members. To control for the influence of differences in group sizes, normalized degree centralities, which varies from 0 to 100, were used for data analysis.

**4.2.2. Frequency of communication.** Students were asked to report their frequency of communication with other group members when facing problems related to the group project (e.g. problems in design, research, computer skills, programming etc.). The frequency of communication with group members was measured by a five-point scale with "0" meaning "never" and "4" meaning "very often (more than 10 times a week)". Since students sometimes recalled the actual frequency of communication with one another differently, the average of these self-reported data was calculated to

represent the actual frequency of communication. The resulting centrality data was also normalized to vary from 0 to 100 in order to control for differences in group size [7, 40]. The higher the degree centrality an individual received, the more frequently he/she discussed project-related issues with group members.

**4.2.3. Individual performance.** The variable was measured by the individual's final percentage grade. The instructors took into account individuals' performance in lab exercises, group project assignments, mid-term exams scores, as well as final group project presentation and group paper.

**4.2.4. Group satisfaction.** The variable was measured using a multi-item scale asking students to report their satisfaction with the group process, as well as the final output. Five point scales were used for each of the items with 1 as "extremely dissatisfied" and 5 as "extremely satisfied". The Cronbach's [15] alpha for the multi-item scale was .92.

**5. Results**

Because our subjects were clustered by groups and were therefore not completely independent, running regular regression tests on the raw data would not be appropriate [38]. To deal with this nested nature of data, we group-centered the data prior to running analysis because our focus was on examining relationships at individual level of analysis, but not on studying cross-level interactions, or across-group differences in means [25]. When the data is group-mean-centered, the grouping effect of the data has essentially been removed.

Table 1 shows the descriptive statistics and zero-order correlations among study variables.

**Table 1. Descriptive statistics and correlations for study variables (N=49)**

Var.	M.	SD	1	2	3	4
1.	64.5	13.5	-			
2.	64.5	22.0	-.44**	-		
3.	76.3	10.6	-.39**	-.14	-	
4.	92.2	9.2	-.35*	-.08	.50**	-
5.	3.9	.9	.35	-.39**	-.07	.06

Variables:

1. Adversarial in-degree centrality (Scale: 0-100)
2. Adversarial out-degree centrality (Scale: 0-100)
3. Frequency of communication (Scale: 0-100)
4. Individual performance (Scale: 0-100)
5. Group satisfaction (Scale: 1-5)

\*\* Correlation is significant at the 0.01 level (2-tailed).

\* Correlation is significant at the 0.05 level (2-tailed).

### 5.1 Adversarial network, frequency of within group communication and individual performance

Because the dependent variables for hypothesis 1 and 2 were the same, multiple regression analysis was run to test the two hypotheses simultaneously. Table 2 shows the results of the analysis with individual performance as the dependent variable. In Step 1 of our analysis, adversarial in-degree centrality had a significant impact on performance when it was entered into the regression alone. However, its influence on performance lost its significance when frequency of within-group communication was entered in Step 2 of multiple regression. Thus, Hypothesis 1 was not supported while Hypothesis 2 was supported. This means that being disliked by group members may be detrimental to individual's performance. However, frequency of communicating with group members seemed to play a more important role in determining individuals' performance.

**Table 2. Summary of multiple regression analysis for variables predicting individual performance (N=49)**

Variable	B	SE B	$\beta$
Step 1			
Adversarial in-degree centrality	-0.24	0.09	-0.35*
Step 2			
Adversarial in-degree centrality	-0.12	0.09	-0.18
Frequency of within-group comm	0.37	0.12	0.43****

Note.  $R^2=.12$  for Step 1 ( $p<.10$ );  $\Delta R^2=.16$  for Step 2 ( $p<.01$ )  
\* $p<.10$ . \*\* $p<.05$ . \*\*\* $p<.01$

Hypothesis 3 predicted that individuals who communicate more frequently with group members will be less likely to take the central position in adversarial networks. The hypothesis was supported because frequency of within-group communication was significantly and negatively related to the in-degree centrality of the adversarial network ( $r=-.39$ ,  $p<.01$ ) as shown in Table 1.

### 5.2 Adversarial network, frequency of within-group communication and individuals' satisfaction with groups

As hypothesis 4 and 5 had the same dependent variable, multiple regression analysis was run to test the two hypotheses simultaneously similar to before. Table 3 summarizes the results of this multiple regression analysis with group satisfaction as the dependent variable. Consistent with Hypothesis 4, the adversarial out-degree centrality had significant

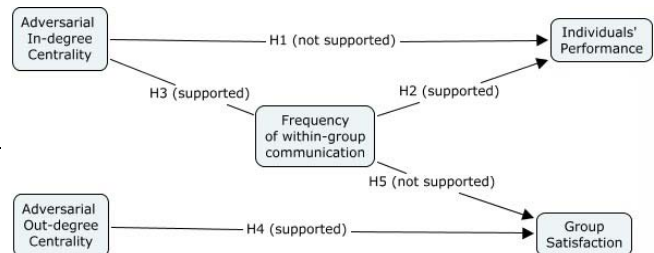
influences on individuals' satisfaction with group experiences (in both steps of the regression analysis). Frequency of within-group communication, however, did not show expected power influencing individual's satisfaction on group experiences. Hypothesis 5 was therefore not supported. This means that whether individuals liked or disliked their group members was the most important factor in deciding their satisfaction with the whole group.

**Table 3. Summary of multiple regression analysis for variables predicting group satisfaction (N=49)**

Variable	B	SE B	$\beta$
Step 1			
Adversarial out-degree centrality	-0.02	0.01	-0.39***
Step 2			
Adversarial out-degree centrality	-0.02	0.01	-0.41***
Frequency of within-group comm	-0.01	0.01	-0.13

Note.  $R^2=.15$  for Step 1 ( $p<.01$ );  $\Delta R^2=.02$  for Step 2  
\* $p<.10$ . \*\* $p<.05$ . \*\*\* $p<.01$

Figure 1 provides a visual summary of our proposed hypotheses, as well as the testing results. Overall, three out of five hypotheses were supported in the current study.



**Figure 1. Summary results illustrating the five hypotheses in the current study**

## 6. Discussion

The increasing level of complexity of tasks in contemporary organizations calls for more group work. Yet not all groups can fully reap the benefits of working collectively [31]. Negative group dynamics can actually make a group less efficient than individuals working independently. To facilitate group work, many group support systems have been designed. Unfortunately many such systems failed to achieve anticipated success [6]. One possible reason is that system designers focus too much on the usability of the system, rather than functionalities that support social interactions and collaborative work [5]. We plan to design a group support system that is grounded in findings from social network analysis because network

relations are the foundation for building sociability. Prior to the actual implementation of a design, we conducted a case study similar to other researchers [e.g. 22, 41, 42] to deepen our understanding of group dynamics. We chose the adversarial networks in our study because compared with other informal social networks such as advice and friendship networks, adversarial networks are more than often neglected due to their sensitive nature, while at the same time, they may exert stronger influence on group dynamics. Our case study extends previous empirical findings about how adversarial network relations were related to students' academic achievements and satisfaction toward their group experiences because it does not focus exclusively on the rosy side of network relations.

As the findings of our study demonstrate, the in-degree centrality of adversarial networks significantly and negatively correlated with individual performance. The out-degree centrality of adversarial networks, on the other hand, was found to be significantly and negatively related to individuals' satisfaction with their groups. These results in turn indicate the fact that both the state of being disliked by group members or disliking group members may have great negative influences on students' experiences with group work, and thereafter negatively influence performance. Given the paucity of both theoretical and empirical research about adversarial networks, it thus becomes very important for future research to examine the causes of adversarial relationships as well as how the adversarial relationships can be improved.

## 7. Limitations

One major limitation with the current case study was that the number of participants was relatively low. Although the sample size was sufficient for studying a complete social network, it was less than ideal for running regular regression analysis.

Besides, the current study was based on a one-time survey result. Although most of the results of our hypothesis testing were consistent with our theoretical predictions, as well as earlier studies on adversarial networks [3, 9, 13, 24], overtime data is still needed to confirm the causal relations among the variables.

## 8. Implications for design

The influence of adversarial networks on performance and satisfaction holds important implications for design of technologies used to support group work. Yang & Tang, for example, suggested that a web-based forum may offer a medium for students to communicate with each other and provide

an environment with fewer interpersonal conflicts and problems [47]. Although frequency of communication with group members was not found to be influential on how individuals were satisfied with their groups, it was found to be significantly related to both the in-degree centrality of the adversarial networks as well as to students' performances. Technology offers unique capabilities in terms of identifying adversarial networks and facilitating ways of overcoming negative dynamics inherent in such networks. Most technologies designed to support group work have an online forum component where participants can post messages to the whole group, to individual group members, or to a supervisor. By analyzing message patterns among participants, we can obtain adversarial network information automatically, instead of using surveys, which might be more intrusive to the on-going process of group work. Some efforts have been made to integrate social network analysis with group support systems that enable analysis of both the frequency and content of messages [e.g., 20, 28, 36]. The design of technologies to support group work would thus be greatly improved by incorporating social network analysis tools within them. The following implications derived from our study highlight some of the advantages of identifying adversarial networks through software to support group work.

### 8.1 Communication and interaction are important facilitators of group work

Hypothesis 2 of our study showed that frequency of communication within groups was positively related to performance. Group members communicate in order to cooperate, coordinate and collaborate. When given the ability to ask and answer questions, to post comments, and to generally engage in an intellectual exchange with peers and supervisors, group members verbalize their current understanding. This verbalization process is similar to self-explanation and articulation of cognitive processes [33]. Both self-explanation and articulation processes are beneficial to group work because they promote the expression of tacit knowledge and its reinterpretation into explicit statements. This verbalization activity is hypothesized to improve understanding of topics discussed directly, by making tacit knowledge more explicit and available for use [14], as well as indirectly, by revealing knowledge gaps and lack of comprehension. Group members who do not communicate and interact with each other exclude themselves from the group knowledge creation process and cannot reap the benefits of intellectual exchange with fellow group members. Our results demonstrate

that such individuals performed poorly. They may be highly skilled, but only through communication and interaction would that skill be used for the greater good of themselves and the group. Group-support technologies enabled with social network analysis tools can identify group members who are not communicating and interacting with other group members. This is achieved by identifying individuals who are isolates in the social network that are not communicating with the rest of group. Because these members are a source of possible negative group dynamics, timely identification of these isolates can help supervisors or even fellow group members intervene before the problem spirals out of control. We believe that this goal can be more easily achieved with the implementation of group support systems.

## 8.2 Increasing participation

Decreased participation or ‘social loafing’ is one of the main problems of group work. Researchers have sought out different ways to increase participation in groups. One such method is through making contributions explicit, an approach adopted from Karau & William’s Collective Effort Model (CEM). CEM states that when contributions to the group are made identifiable, as opposed to anonymous, group members will be motivated to increase contributions [23]. Making participation explicit increases ownership of content and encourages members to contribute more. It also creates a positive social pressure since group members know that others can observe and evaluate their output. Similarly, social network analysis tools that make explicit the centrality of individuals in communication networks may motivate group members with fewer contributions to contribute more. In fact, many online communities highlight top contributors by using methods such as distinctive avatars, taglines beneath usernames, the number of posts made, the number of posts others found useful etc. In our study, we found that group members who communicated more performed better. Social network analysis tools can automatically illustrate group members who are communicating more through simple visualizations. It would be a worthwhile research endeavor to see if displaying names of group members with the highest communication frequencies increased participation of group members with lower communication frequencies.

## 8.3 Group member redistribution

Hypothesis 4 showed that individuals having high out-degree centrality in an adversarial network felt less

satisfied with group work. Decreased satisfaction with group work may lead to decreased motivation and contribution, and consequently foster ill-feelings among group members. Through automatic identification of individuals with low out-degree adversarial network centralities, social network analysis tools can help supervisors make informed decisions about group composition. A group member with low adversarial network centrality can be reassigned to other groups that do not function well. Serving as a change agent, s/he may energize the group by providing needed leadership. Although it takes time to find out who dislikes whom in a group, a good understanding of adversarial relations may provide an avenue to counter negative group dynamics. Aided by social network analysis tools, supervisors can thus play a better role as a leader, a facilitator, or a moderator to support collaborative work.

## 8.4 Software as a knowledge artifact

The group support system itself can be viewed as an artifact. It contains a persistent history of the group’s interaction. It contains all the learning material, the messages exchanged, and the documents shared. As a knowledge artifact, its meaning can be collaboratively interpreted and refined, providing valuable insight regarding group processes to group members and supervisors. Such a repository can be mined to determine what caused a group member to not interact with other group members. By analyzing message patterns and content, we may be able to draw meaningful connections regarding what caused him to have a high adversarial network centrality. Lessons learned from this repository can then be passed down from one generation of collaborative groups to the next to build ‘best practices.’

## 9. Conclusion

This paper reports results from a case study designed to examine how negative group dynamics may influence group performance and satisfaction. The contributions of the research are twofold. First, it clearly differentiated the effects of in-degree and out-degree centrality on performance and satisfaction. Second, it linked centrality of adversarial networks to strength of ties, and provided empirical guidelines for possible interventions. Our case study informs the design of computer systems to support group work and collaborative knowledge building. Through incorporating social networking tools into system design, we believe that managers/supervisors can more easily identify and help alleviate negative group

dynamics.

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