Computer-mediated Group Interaction Processes

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Abstract

The use of computer-mediated groups has become common particularly in international organizations and global companies. In light of this growing phenomenon, the traditional group interaction should be re-observed. The research questions deal with the interaction between the computer-mediated group members, trying to figure whether (and how) the media change the way people interact, in hope of improving the group interaction using group structure. Based on Bales' IPA model we present an experiment in which subjects, who were grouped, had to share information in order to complete an intellective task. The findings indicate that the positive level of the computer-mediated unstructured group discussions is significantly lower than the positive level of the face-to-face unstructured group discussions. The structure seem to act as a partial solution, since structured group discussions is positive than unstructured group discussions. Therefore, structure should be manipulated in order to reduce the virtuality influence on the positive level of the discussion. The importance of the theoretical and practical implementation of the research is obvious and will be discussed.

1. Introduction

There has been a transformation from individual work to team work in the last few decades (Ilgen, 1999), and many organizations use teams for many activities done by individuals in the past (Boyett & Conn, 1992; Katzenbach & Smith, 1993). The team participants, in many cases, provide their own resources for the achievement of their goals. Small-group interaction, conducted in face-to-face environments, was originally investigated by Bales (1950). During more than fifty years of small-group research, Bales’ Interaction Process Analysis (IPA) model has been one of the fundamental models used by researchers for analysis of group interactions. Nowadays, collaborative systems have caused a drastic change in the way people focus work and shared information, especially at a distance; therefore there is a need to adjust Bales’ IPA model to the 21st century and its types of communication media, specifically to the computer-mediated environment.

The research main goal is to track and explain the differences between Bales’ traditional group interaction observations and our computer-mediated group interaction observations: is there any difference? And if so, what can explain them? In other words, does the media change the way people interact?

Another set of questions deal with the interaction between the computer-mediated group members: Is the social part of the group work characterized by positive or by negative phrases? Is the task part of the group work characterized by asking questions or by giving answers?

Powell, Piccoli, & Ives (2004) stated that virtual team design has so far been treated as an afterthought by virtual team researches. Investigation of team structure in the virtual environment holds significant promise for research and practice (Powell, Piccoli, & Ives, 2004). Shwarts-Asher, Ahituv & Etzion (2008) have shown that virtual teams with swift structure were
more successful than traditional teams. Their findings raise the question of the impact of the group structure on the group member interaction, rather than the group output: Does division of labor, hierarchy and work process affect the traditional group interaction? Do our structure characteristics affect the computer-mediated group interaction?

This research contributes to a better understanding of computer-mediated group member interaction in hope of improving the group work in the computer-mediated world.

2. Background

Interaction in computer-mediated groups

Computer-mediated groups are becoming increasingly prevalent as businesses bring geographically dispersed members together to achieve a common goal. Majchrzak et al. (2004) stated that it isn't necessary any more to bring team members together to get their best work: In fact, they can be even more productive if they stay separated and do all their collaborating virtually; when carefully managed, the clash of perspectives led to fundamental solutions, turning distance and diversity into a competitive advantage.

Although there has been more than a decade of literature on computer-mediated communication, the research has been unclear as to whether it is an effective replacement for face-to-face collaboration. Empirical findings indicate that asynchronous collaboration is as effective as face-to-face collaboration in terms of learning, quality of solution, solution content, and satisfaction with the solution quality. However, participants were significantly less satisfied with the asynchronous learning experience, both in terms of the group interaction process and the quality of group discussions (Ocker & Yaverbaum, 1999).

Researchers investigating computer-mediated groups offered some explanations for the differences between computer-mediated groups and face to face groups. One explanation refer to the different perceptions of the group members: Webster & Wong (2008) found that local members of teams report different perceptions of local and remote members - More positive perceptions of their local than their remote members; Pissarra & Jesuino (2005) claimed that anonymity generated more satisfaction among the group members; Staples & Webster (2007) suggested that differential outcomes for traditional and technology-supported virtual teams evolve from self-efficacy differences; Another explanation refer to the different setting of the computer-mediated groups, such as frequency and distance (Cramton & Webber, 1999), lack of feedback and information about team processes (Geister, Konradt & Hertel, 2006), the difficulty in sharing information (Thompson & Coovert, 2003) and the distance communication tools as a limiting technology (Straus & McGrath, 1994). In terms of group outcome measures, researchers consent that groups using face-to-face channel outperform groups using computer mediated communication (Barkhi, Jacob & Pirkul, 1999, Denton, 2006; Potter & Balthazard, 2002).

Despite the wide spread of computer-mediated groups, little is known about Computer-mediated group processes. Much of computer-mediated group research fails to examine variations in computer-mediated group characteristics that may affect team communication behaviors (Timmerman & Scott, 2006). Branson, Clausen & Siung (2008) claimed that the social processes associated with effective team work are different in face-to-face and computer-mediated teams. These differences affect the ability of groups of people to successfully form a team that can function effectively. The social context of computer-mediated groups is one of the major explanations of why computer-mediated groups produce negative outcomes: computer-mediated groups have weaker team identity (Bouas & Arrow, 1996), the fact that computer-mediated group members are not familiar with one another (Gruenfeld et al., 1996), have less affection to one another (Weisband & Atwater, 1999) and a weaker social ties (Warkentin, Sayeed & Hightower, 1997). Strong social ties in computer-mediated groups can be achieved but will take longer time than in face-to-face groups (Burke & Chidambarram, 1996).

In order to learn how group members interact with one another, one can track the feedback they give each other. Watts & Lee (1999) laboratory experiment findings indicates that participants distorted negative information less, i.e., were more accurate and honest, when they used computer-mediated communication than face-to-face or telephone communication. They concluded that delivering (and receiving) timely and accurate negative information is critical for performance improvement.

Whitworth, Gallepe & McQueen (2000) suggested that individuals in groups construct cognitions regarding the task (purpose), other people (relationships), and the group (identity), and these drive
the interaction. Three core psychological processes follow: resolving task information, relating to others and representing the group. This gives three types of influence: informational, personal and normative, and three group purposes: task resolution, interpersonal relationships and group unity. They conclude that there is no "best" type of group interaction support, because there is no best process.

This section has presented computer-mediated groups as a growing phenomenon and the need for further social research of the different social processes of face-to-face and computer-mediated groups. The following section will introduce a specific theoretical method for measuring social and task processes.

### Social and task processes

The previous section ended with Whitworth, Gallupe & McQueen (2000) model of three psychological processes in groups: resolving task information, relating to others and representing the group. A well known method to measure two of their processes (task and people) is Bales (1950) Interaction Process Analysis (IPA). Bales' IPA is a method for analyzing the "systems of human interaction" in, originally, small face-to-face groups. The heart of the method is a technique of classifying behaviors act by act, as they occur, and a series of ways to analyze the data and obtain descriptive indices of group process. The IPA consists of 12 complementary-paired group processes; these are further subdivided into four major functions, describing communications issues or problems, as shown in Table 1.

<table>
<thead>
<tr>
<th>Function</th>
<th>Process</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social-Emotional Area: Positive Reaction</td>
<td>1. Shows solidarity: raises other's status, gives help, rewards</td>
</tr>
<tr>
<td></td>
<td>2. Shows tension release: jokes, laughs, shows satisfaction</td>
</tr>
<tr>
<td></td>
<td>3. Agrees: shows passive acceptance, understands, concurs, complies</td>
</tr>
<tr>
<td>Task Attempted Answers</td>
<td>4. Gives suggestion: supplies direction, implying autonomy for other</td>
</tr>
<tr>
<td></td>
<td>5. Gives opinion: supplies evaluation, analysis, expresses feeling, wish</td>
</tr>
<tr>
<td></td>
<td>6. Gives orientation: supplies information, repeats, clarifies, confirms</td>
</tr>
<tr>
<td>Task Questions</td>
<td>7. Asks for orientation: asks for information repetition, confirmation</td>
</tr>
<tr>
<td></td>
<td>8. Asks for opinion: asks for evaluation, expression of feeling</td>
</tr>
<tr>
<td></td>
<td>9. Asks for suggestion: asks for direction, possible action</td>
</tr>
<tr>
<td>Social-Emotional Area: Negative Reactions</td>
<td>10. Disagrees: shows passive rejection, formality, withdraws help</td>
</tr>
<tr>
<td></td>
<td>11. Shows tension: asks for help, withdraws</td>
</tr>
</tbody>
</table>

A recent study conducted by Hooff & Ridder (2004), although using different semantic terms, showed that there is a positive correlation between knowledge collecting and knowledge donating - the more knowledge a person collects, the more he or she is willing to donate knowledge to others. If we consider "asking questions" as "knowledge collecting", and "giving answers" as "knowledge donating", there is a relation between two (out of four) Bales' major functions - asking questions and giving answers.

Is it possible that the interaction functions can be influenced by external variables such as group structure? Hackman (1987) suggests that team output is influenced by team design through its impact on processes. In light of the fact that we will attempt to find a connection between Bales' functions and group structure, the next section will describe the theoretical aspects of structural group characteristics.

### Structural group characteristics

Integration between computer-mediated communication and group structural characteristics raises the question: “Has the virtual era put an end to team structure?” Leavitt (1996) claims that the rapid changes impose organizations to relax structures. Hackman (2002), on the other hand, predicts that team structure will always exist and managers will continue to be bothered by team design. Three salient structures characteristic were studied in previous research: Division of Labor, Hierarchy and Work Process. We will review these issues separately.

Division of Labor - The division of labor does not have a direct influence on team performance, but has an indirect influence, by means of perceived efficiency and team coordination (Strijbos et al., 2004), and is a stronger predication variable than individual characteristics (Ahuja, Galletta & Carley, 2003). The use of expertise assists in reducing errors (Potter & Balthazard, 2002a) and function diversity is important in achieving team efficiency (Bunderson & Sutcliffe, 2002). A team that is structurally diverse is one that its members have different positions or tasks and are distributed in different branches, can be exposed to unique information. In this manner, sharing unique external information elevates performance (Cummings, 2004).

Hierarchy - In order to explain the importance of the
hierarchy in integrative groups, Maier (1967) compares the group to a starfish and the leader of the group to the starfish's central nervous system. When individuals act as an organized unit, they become a higher type of organization - a single whole organism. Even when there is no formal division of labor, the role of the leader is divided between team members (Johnson et al., 2002). When there is a formal leader, status labels have a strong effect on team members (Weisband, Schneider & Connolly, 1995). But a series of studies has shown that more importantly, effective virtual leadership is dependent on the ability to communicate (Kayworth & Leidner, 2001/2002; Tyran, Tyran & Shepherd, 2003; Kim, Hiltz & Turoff, 2002). In practice, leaders send more messages (and longer ones) than others (Yoo & Alavi, 2004).

Work Process - In large teams meeting procedures are better known and there is better technology coordination then in small groups (Bradner, Mark & Hertel, 2002). Studies show that successful teams focus: on the task (Hofner, 1996), on structured goals (Huang et al., 2003) and on the development of routine (DeSanctis, Wright & Jiang, 2001). Successful teams also take a lot of time to understand the process and contents of the work (Iacono & Weisband, 1997; Ocker & Fjermestad, 2000), especially in the initial stages (Hause et al., 2001). Not only does the medium limit the team's ability to coordinate information (Graetz et al., 1998), virtual teams spend a great deal of time understanding how to execute the task (Lebie, Rhoades & McGrath, 1996), and team meeting that it's members are distant physically take longer time than face-to-face meetings (Siegel et al., 1986).

Coordination process are related positively to performance and satisfaction (Powell, Piccoli & Ives, 2004), and become more significant as time passes (Burke & Chidambaram, 1995).

This section reviewed three salient structures characteristic: Division of Labor, Hierarchy and Work Process. This was the last block of the background foundation we laid out. In the next section a laboratory experiment will be presented. The aim of the experiment was to examine the influence of group structure on group interaction functions, and whether the "rules of the game" are different when computer-mediated groups are involved.

3. The study

A laboratory experiment that was performed in order to answer three research questions: 1. Is there a difference between Bales' traditional (face-to-face) group interaction and computer-mediated group interaction? ; 2. What is the difference between computer-mediated group interaction and face-to-face group interaction? ; and finally: 3. What is the effect (if any) of group structure on group interaction and can group structure be manipulated in order to enhance the group interaction?

An experiment was designed, in which a team task was given to 150 undergraduate students in an academic college. The subjects, who were grouped into teams, had to share information in order to complete the task.

Subjects were assigned to groups of three. Each group was given a task that takes approximately 30 minutes to complete. The research design is a 2x2 Between Subjects Factorial Design: the factors are type of communication (computer-mediated vs. face-to-face) and group structure (structured vs. unstructured). The research design includes a total of four experimental conditions (see Table 2). Each condition was implemented on 12-13 teams, thus the experiment included 150 subjects (4 conditions * 12-13 teams * 3 subjects).

<table>
<thead>
<tr>
<th>Communication Type Level</th>
<th>Structural Level</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>Face-to-face-unstructured group</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>Face-to-face-structured group</td>
</tr>
<tr>
<td>3</td>
<td>0</td>
<td>Computer-mediated unstructured group</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>Computer-mediated structured group</td>
</tr>
</tbody>
</table>

Table 2: Experimental Conditions

Procedure

Subjects were invited in groups of three to discussions (computer-mediated or to face-to-face) that were conducted using MSN-Messenger or face-to-face communication correspondingly. The process of the unstructured condition of the experiment includes an intellective task. Each group member received a discrete piece of information, and only the aggregation of all the pieces of information revealed the whole "picture" and led to the correct solution. The structured condition of the experiment included also a preliminary manipulation, namely: instructions in writing to the group members asking them to nominate a chairperson who will be in charge of assembling the information, and to appoint a spokesperson and an information coordinator for the team. In addition, a recommended
work procedure was suggested to the group members. This preliminary manipulation was not present in the non-structured condition.

**Operationalization of the Task and Social Processes Variables**

A textual (or audio) recording was saved for each Computer-mediated (or face-to-face) discussion. Task and social processes was measured by content analysis: The analysis from each discussion, included the number of positive phrases, the number of negative phrases, the number of question phrases, and the number of answer phrases, in parallel to Bales (1950) model. In order to use reliable measures, the phrases' counting was done separately by two independent judges. The two judgment analyses were compared, and in a case of different decision (concerning the phrase category), a new agreed decision was taken. Four processes variables were calculated out of the phrases' counting correspondingly: adjusted positive phrases (positive phrases percentage among total phrases of the discussion); adjusted negative phrases (negative phrases percentage among total phrases of the discussion); adjusted asking phrases (questions phrases percentage among total phrases of the discussion), and; adjusted giving phrases (answers phrases percentage among total phrases of the discussion).

Table 3 presents a summary of the Means and SD's of all the processes variables (original = #, adjusted = %), above the experiment condition (Means and SD's by the independent variables are described in the following section).

<table>
<thead>
<tr>
<th>Positive phrases</th>
<th>Negative phrases</th>
<th>Asking phrases</th>
<th>Giving phrases</th>
<th>Total phrases</th>
</tr>
</thead>
<tbody>
<tr>
<td>M</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
</tr>
<tr>
<td>53.12</td>
<td>42.21</td>
<td>17.08</td>
<td>6.10</td>
<td></td>
</tr>
<tr>
<td>20.94</td>
<td>19.53</td>
<td>7.42</td>
<td>6.78</td>
<td></td>
</tr>
<tr>
<td>59.30</td>
<td>34.13</td>
<td>21.57</td>
<td>5.03</td>
<td></td>
</tr>
<tr>
<td>149.38</td>
<td>83.22</td>
<td>53.92</td>
<td>8.03</td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Means and SD's of All the processes Variables (Overall N=50)

4. Findings

Fifty experiments where preformed among undergraduate students in an academic college. Each one of the fifty groups included three participants, a total of 150 participants. The mean age of the participants was 25.79 years old (SD = 3.94). Among the participants, there were 89 males and 61 females. No significant differences were found among the teams in mean age ($F = 0.67$, $p = .56$), Breslow-Day test showed that there were no gender ratio differences among the experimental cells ($\chi^2 = 0.76$, $p = .38$).

A manipulation check demonstrated that two structure characteristics (hierarchy and division of labor) are well manipulated in the experiment group. However, most of the group members in the control groups admitted that they had an organized work process, even if they where not given specific instructions to do so.

All of the processes variables were tested for normality in each of the experimental cells by a Kolmogorov-Smirnov test. The normality assumption was not rejected.

Deviation of the phrases proportion mean (adjusted for total phrases number) from the expected proportion percentage mean by Bales observation was performed using One Sample T-test, for assessing the effects of the independent variable (Communication type) on the processes variables. Assessing the effects of structure was irrelevant, since Bales original observation did not take structure into account. Table 4 presents a summary of Means and SD's of the processes variables by communication type for unstructured group only compared to Bales' observation.

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<table>
<thead>
<tr>
<th>Bales' observation</th>
<th>Computer-mediated</th>
<th>Face-to-face</th>
</tr>
</thead>
<tbody>
<tr>
<td>(#)</td>
<td>%</td>
<td>M</td>
</tr>
<tr>
<td>Positive phrases</td>
<td>14.08</td>
<td>22.08</td>
</tr>
<tr>
<td>Negative phrases</td>
<td>14.08</td>
<td>8.99</td>
</tr>
<tr>
<td>Asking phrases</td>
<td>9.7</td>
<td>37.23</td>
</tr>
<tr>
<td>Giving phrases</td>
<td>56.4</td>
<td>99.00</td>
</tr>
<tr>
<td>Total</td>
<td>100.00</td>
<td>172.3</td>
</tr>
</tbody>
</table>

Table 4: Means and SD's of All the processes Variables by Communication type for Unstructured group only

The T-tests indicate that computer-mediated unstructured groups discussions were less positive than Bales' traditional face-to-face groups discussions ($T = -5.95$, $p < .001$), less negative than Bales' group discussions ($T = -4.76$, $p < .001$); included more proportion of questions ($T = 9.16$, $p < .001$), and; included the same proportion of answers.

Face-to-face unstructured groups discussions positivity proportion was not different from Bales' traditional face-to-face group discussions; less negative
than Bales' group discussions ($T = -6.89, p < .001$); included more proportion of questions ($T = 7.02, p < .001$), and; included the same proportion of answers as Bales' group discussions.

Two Way Univariate ANOVA was performed for assessing the effects of the independent variables (Communication type and Structure) on the adjusted processes variables. The ANOVA indicates that computer-mediated group discussions were less positive than face-to-face group discussions. In other words, a main effect of Communication type on Positive phrases was found ($F_{1,46} = 17.75, p < .001$, $\eta^2 = 0.27$). On the other hand, structured group discussions were more positive than unstructured group discussions, meaning that a main effect of structure on positive phrases was also found ($F_{1,46} = 3.83, p = .05$, $\eta^2 = 0.07$). An interaction effect on positive phrases was not found. Neither Communication type, nor Structure main (and interaction) effects were found on the other three processes variables.

5. Discussion

Computer-mediated unstructured group discussions and face-to-face unstructured group discussions were both: 1. Less negative than Bales' group discussions; 2. Included more proportion of questions than Bales' group discussions, and; 3. included the same proportion of answers as Bales' group discussions. The similarity between computer-mediated and face-to-face unstructured group discussions, and the discussions differences from Bales' observations, can be explained by the differences between the current experiment and Bales' experiment. For example, the use of different tasks and settings, the cultural differences between the participants, and above all, the time difference of more than fifty years between the two studies. Fifty years is a time difference that can, by no doubt, influence peoples mentality and their discussion orientation.

However, these differences can not explain the gap between the positive level of the computer-mediated and face-to-face unstructured group discussions. If one would consider Bales' group discussions positive level (20.5%) as a "universal" positive level of discussions (our face-to-face unstructured group discussions positive level was not significantly different), then the significant lower positive level of the computer-mediated unstructured group discussions can be explained by its communication type only. In other words, computer mediation reduces the positive level of the discussion.

The virtuality comparison yield the same significant effect: The social part of the computer-mediated group's discussion is less positive than the social part of the face-to-face group's discussion. This evidence is also consistent with previous studies, such as Cramton & Webber (2005) that points out the technology tools limitation of information, and the increase in hostility and aggression of the communicators.

The structure effect seems to partially overcome the above presented virtuality disadvantage, since a main effect of structure on positive phrases was found: structured group discussions were more positive than unstructured group discussions. This finding indicates that structure can manipulated in order to reduce the virtuality influence on the positive level of the discussion.

Although a structure main effect was found, further research attention should be given to the structure characteristics. Only two structure characteristics were manipulated successfully (division of labor and hierarchy). Most of the group members, in the control group, admitted that they had an organized work process, although they where not given specific instructions to do so. Therefore, the structure characteristics that had an actual impact on the discussion were division of labor and hierarchy, and not work process (which was carried out anyway by the group members).

6. Conclusions

Computer-mediated groups’ discussion is a common way of working nowadays, and with the growing use of internet applications and firms' globalization it will expand in the future. The motivation for this study was to examine the impact of e-infrastructure on the work place environment and to meet some of its challenges, hoping to contribute a new theoretical and practical solution to the wide adoption of e-infrastructure across organizations.

Our findings indicate, like some previous studies, that computer-mediated group discussion orientation is less positive than face-to-face group discussion orientation. We have offered a partial solution - a structure manipulation – which raises the positive level of the group discussion, thus overcoming some of the virtuality disadvantages.

An examination of the manipulation reveals that the improvement is due to the division of labor and hierarchy, and less because of work process that takes place anyway (even without our manipulation). It is
likely that future studies in these directions will assist in improving computer-mediated group interaction processes.

7. References


