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Collaborating effectively is essential in getting work done. Regardless of physical location, being able to effectively communicate ideas and tasks to one another is essential in completing successful work. The objective of the study is to observe conflict and conflict management techniques and see how they affect a group's ability to produce good work. The study is a content analysis of video and audio produced by a separate study conducted by researchers at the University of North Carolina at Chapel Hill. The UNC study focused on the relationship between the lab environment (face to face vs. remote) of a scientific experiment and the quality of the lab reports produced. The tapes from the UNC study were coded according to a coding system devised to capture types of conflict and types of conflict management/resolution techniques. Descriptive statistics taken from the coding were compared to lab grades to infer possible affects that conflict and conflict management/resolution may have on the final lab grades.

Headings:

Collaboration

Conflict

Conflict Resolution

THE ROLE OF CONFLICT AND CONFLICT MANAGEMENT/RESOLUTION IN
FACE TO FACE AND REMOTE COLLABORATION: A CONTENT ANALYSIS OF
A CONTROLLED EXPERIMENT

by
Andrew L Phillips

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Deborah Barreau

The Role of Conflict and Conflict Management/Resolution in Face to Face and Remote Collaboration: A Content Analysis of a Controlled Experiment

The evolution in technology over the last decade has improved the way humans communicate remotely. In the past, remote communication meant using the telephone, sending a fax, writing a letter, or traveling, often at great expense. However, the technology boom of the past decade has brought us e-mail, instant messaging, and NetMeeting at commonly affordable prices. Sharing not just voices, but documents, images and other artifacts during remote collaboration has been made much simpler and convenient. But has this new way to collaborate produced work as good as or even better than working face-to-face?

This is the research question in a study of the effectiveness of remote scientific collaboratories (Sonnenwald, Whitton, & Maglaughlin, 2003). The study investigated whether similar scientific work done face-to-face (FtF) results in worse, equal, or better results when done remotely by the same people. Using the data collected from this study, the objective of this new study is to compare the role of conflict and conflict resolution between working face-to-face and working remotely, in the context of scientific work.

The collaboration study focused on the ability of undergrad students to complete lab reports in both a FtF and remote context. The students were required to use a computer with basic word processing software and a remote microscope as a part of the lab experiment. The microscope, called the nanoManipulator, could be controlled from a console, which the participants shared in the FtF environment. In the remote collaboratory, students have the ability to control the nanoManipulator from their

consoles. In addition to the nanoManipulator, the students in the collaboratory used Microsoft's NetMeeting and the telephone to complete the lab report. Their effectiveness was measured by the grades received on the lab reports. Other sources of data included surveys and interviews with students.

The purpose of this study is to test if there is a relationship between conflict and end results under the two conditions, FtF and remote. The main focus is on the presence and type of conflict and how they impact, if at all, scientific outcomes. The study also examines the way the conflict is managed and how that may have affected the final results. The question that drives the study is: *does the amount and/or type of conflict, and subsequent conflict management, affect the quality of work in computer-mediated remote scientific collaboration as opposed to face-to-face scientific collaboration, in particular when conducting natural science experiments?*

Literature Review

Overview of Conflict

This study focuses on conflict within small groups. The exact purpose of small groups can vary, but usually a group's main goal is either to resolve some sort of issue, or to produce some sort of output. In this context, conflict can play one of two roles. It can be a disruptive, negative force that causes arguing, taking sides, and even fighting among group members. But conflict can also spark innovation and "out of the box" thinking. As a positive force, conflict can "stimulate change, motivate problem solving activity, and compel the group to focus, think through, and articulate a problem clearly and logically" (Laber, 1997, p. 40). Thus conflict can either result in groups being more productive and more successful, or it can create a hostile environment where trust is gone

and productivity is low. But what causes conflict, and how can it be manipulated towards the more positive outcomes?

There is no clear source for conflict; it is very situational. For example, Fisher (1980) identifies doubt as the main source of conflict. Whether it is the relevance of the information presented, or the way in which a group handles and collects this information, individuals can and will question its importance or role in the group process. But there is a more human element that is missing from this source. Sometimes, conflict is caused by human emotions such as envy or greed (Simmel, 1955). These emotions may result in conflict that is unrelated to the task at hand. For example, the leadership structure of a group can be a source of conflict because an individual does not think the people in the leadership roles are competent (Patton & Giffin, 1978). In summary, sources of conflict may come from many different individual, group, or organizational factors (Dace, 1992). Though the source can be ambiguous, recognizing the source can help in dealing with the conflict in a productive manner.

Responses to conflict can vary. Negative responses to conflict include antagonizing other members, withdrawing from the group, or even berating other group members (Bales, 1950, p. 51). These actions are usually a result of members who voice concerns and disagreements in a manner that is seen as hostile or offensive. These responses, in turn, cause other group members to become overly hostile, embarrassed, and anxious. Members that become emotionally involved can personalize the conflict, making it harder to concentrate on the issue (Patton & Giffin, 1978). Taking issues personally brings discussions beyond the informational level to a level where individuals may feel threatened or inferior (Kowitz & Knutson, 1980). They feel that they must

fight for their points so not to lose credibility, thereby closing out other people's opinions and alternate courses of action. As a result, individuals become less willing to participate in a constructive manner, and the group becomes polarized. It becomes bogged down in power struggles, taking sides, and other conflict issues that waste time and resources that should be used to achieve group goals (Kowitz & Knutson, 1980).

As conflict escalates, the effectiveness and productiveness of group members typically lowers. Leaders and members of the group are resigned to manage the disruptive conflict instead of proceeding forward (Laber, 1997). Group members may begin to make decisions that are more centered to avoid conflict than to effectively address the issues at hand (Fisher, 1980; Poole, Holmes, & Desanctis, 1991). Final decisions go from the criteria of being "the best way for everyone" to "the best way that placates those disruptive individuals." Group meetings may begin to look more like group therapy sessions. However, as disruptive as conflict can be, it is not inherently bad. When approached correctly and in a respectful, informational manner, conflict can actually be very beneficial to groups.

If groups never disagreed, why would they even be necessary? This question points to the fact that issues raised in groups are what makes a group effective. As Robert Laber states, conflict "makes committee participants aware of an issue's inherent problems and implications" (Laber, 1997, p. 40). Without conflict, the groups may suffer from "groupthink" and resulting decisions could suffer from bias and suppress important relevant issues (Fisher, 1980; Laber, 1997). By raising concerns and differences, group members seek more discussion which will bring more information, more ideas, and more

opinions to the group process. The information generation that conflict can bring is a huge benefit for the group process (Kowitz & Knutson, 1980).

Another effect conflict may have that can be either positive or negative is the observation that Beisecker made that “group members tend to concentrate greater on those issues (subject of conflict) in order to bring about solutions” (Fisher, 1980, p. 239). [It’s best to use the original source when possible.] What this observation is stating is that conflict can actually cause more work and more concentration to be done on particular issues. This can be a positive factor because more areas of the issue can be addressed and the resolution can be very complete. However, if the issue is not important, or the amount of time to complete the resolution is outrageously long, then the conflict has caused a waste of a very valuable resource, time, that could have been used on other issues.

The working definition of conflict must be general enough to identify both its good and bad aspects. The following is the working definition of conflict that will be used in this study:

Conflict: an instance in group interaction where the differences in beliefs or attitudes or actions come to light. These instances can be brought in both constructive and negative ways. Problems with technology and other materials could also be classified as instances of conflict.

In particular, this study focuses on instances of conflict that emerge due to differences regarding work goals and technology used to achieve work goals.

Types of Conflict

The focus of this study is examining conflict within a small group, as opposed to within an individual or between groups. Though individual conflict can give rise to intra-

group conflict, the study will focus on individual personalities of group members. As stated before, the focus is how the individual acts as a member of the group.

The research literature on conflict indicates that in a problem solving group, several different types of conflict may emerge. One type is procedural conflict. The problem, conducting a natural science experiment and documenting the experiment and results in a lab report, presented to participants in this study involves creating a strategy and systematically proceeding through required steps. There may be debate on how exactly to implement the strategy, and/or the steps required may be open to discussion. The disagreement that emerges from the discussion of strategy to solve the problem is procedural conflict (Kowitz & Knutson, 1980). An example could be a discussion whether to write the final lab report while conducting the experiment, or just taking quick notes and compiling the report at the end of the experiment. Another example is a discussion on how to carry out individual tasks. For example, if one member is attempting to measure something and there is a constant debate on whether the task is being done correctly, that is an example of procedural conflict. An important distinction of this type of conflict is its focus on the strategy around the task, not on the information discovered while completing the task. That type of conflict will be designated as informational.

Informational conflict “occurs when members disagree about the substance of group discussion” (Kowitz & Knutson, 1980, p. 169). As opposed to procedural conflict, informational conflict is when the group members disagree about the content of information that emerges during their work. For example, in this study, if the two participants (working remotely) both get different measurements for the same image on

the nanoManipulator system, they are having a disagreement about a fact (the actual measurements of the image). Informational conflict, though, is not limited to hard facts. Disagreements about interpretations and opinions based on the data collected are also classified as informational. So a discussion of relevance about the size of the image to the overall conclusion could contain some informational conflict.

Sometimes, conflict can be classified as just plain irrelevant. When personalities are attacked or discussions become derogatory, relationship conflict has appeared. This type of conflict is classified as relationship conflict because it acts on a different, more personal level than other types of conflict (Poole et al., 1991; Kowitz & Knutson, 1980). It is negative and usually the result of some personality clash, or because of other external factors. An example would be a participant lashing out at a partner because they are taking too long to accomplish a task. The big difference between relationship conflict and the previous two is that its contribution to the team is always negative. No new ideas or new approaches will come out of relationship conflict, only fighting and argument.

The fourth type of conflict is specifically outlined for the purposes of this study. This conflict is known as technology conflict. Technology is used quite extensively in this experiment. The use of the nanoManipulator, Microsoft's NetMeeting, Microsoft Word, telephones, and cameras are all examples of technology used in the experiment. The two ways conflict can occur with technology can either be from not knowing how to properly use the technology, or the technology stops working. This type of conflict can be recognized by extensively questioning how to use a piece of technology, or by the need for outside help to resolve problems. Because of the dependence on technology in

this experiment, the amount of technology conflict could be a significant factor in the group's success.

The Phases of Conflict Formation

Now that conflict has been defined and several types have been defined, a closer examination of the conflict interaction process is necessary. In their article "Phases of Conflict in Small Group Development," Ellis and Fisher (1975) describe three phases of conflict interaction.

The first phase is described as the interpersonal conflict phase. This phase "results from individual differences among the personalities of the group" (Ellis et al., 1975, p. 251). At this point in the group process, individuals in a group still view themselves as individual members as opposed to a member of a team. Because of this individual outlook and the fact it is still early in the group process, this phase may include procedural conflict as the strategy for completing the group's goal, e.g., a natural science experiment, begins to form. If individuals become apprehensive, or do not start to integrate into the group process, relationship conflict could also emerge. If group members get bogged down in managing relationship conflict, then group members won't get that sense of unity that is needed to succeed. As Patton and Giffin (1978) states, "only when members feel comfortable can conflict safely emerge" (p. 80).

The confrontation conflict phase is identified by an increased level of interaction and the testing of ideas (Ellis & Fisher, 1975 251). The members start feeling more like a group and they start "buying in" to the idea that the process can work (Fisher, 1980). This phase signals the beginning of really getting into the task the group is assigned to do. Procedural conflict may still be seen, but the conflict that should start to develop is

informational. Idea generation is a by product of this phase, which means the conflict is taking a positive effect and the group dynamics are getting better.


If the group reaches the third phase, then the group has really achieved a good synergy. The third phase is called the substantive phase and it is characterized by the positive discussion of ideas and the fact that all conflict is related to the issues at hand (Ellis & Fisher, 1975 251). No relationship conflict is found in this phase, and informational conflict should be the only type of conflict to be constant through this phase. However, progressing to this phase is not a natural progression. Only with proper leadership and proper management of the conflict can a group successfully navigate through these stages (Ellis & Fisher, 1975).

Conflict Management and Resolution

The second dimension of the study focuses on the reactions of group members to conflict. The terms “conflict management” and “conflict resolution” are used interchangeably in most conflict literature. However, some articles make a distinction between the two. They take the approach that “conflict resolution” is based on the notion that conflict is essentially negative and its point is to end the conflict, not solve the main issue (Kottler, 1994). “Conflict management” is, however, based on the fact conflict can be positive and thus directs conflict to constructive dialogue (Nemeth & Owens, 1996; Rybak & Brown, 1997; Tjsovold, 1991).

Managing the participants’ behavior in relation to conflict is imperative in the group process because it has the power to make conflict a positive force in the group environment. Probably the most important factor in determining whether conflict can be managed in a beneficial way is how members approach the situation (Fisher, 1980).

Table 1: Conflict Management and Resolution Strategies and Tactics

	Strategy (Sillars, 1980, p. 188)	Objective (Sillars, 1980, p. 188)	Example Actions and Tactics
<p>Conflict Resolution</p>  <p>Conflict Management</p>	Passive Indirect	Resolve conflict without confronting it directly	<p>Changing the subject (Dace, 1992)</p> <p>Joking about the situation (Dace, 1992)</p> <p>Agreeing just to agree (Dace, 1992)</p>
	Distributive	Resolve conflict by seeking concession from group members	<p>Concealing information (Poole et al., 1991)</p> <p>Threatening other members (Sillars, 1980)</p> <p>Coercing other members (Sillars, 1980)</p> <p>Suggesting to vote (Zornoza, 2002)</p> <p>Persuading with concessions (Sillars, 1980)</p>
	Integrative	Resolve conflict through discussions and logical reasoning (no concessions sought)	<p>Exchanging information (Poole et al., 1991)</p> <p>Considering alternative viewpoints (Sillars, 1980)</p> <p>Presenting logical reasoning (Dace, 1992)</p> <p>Clarifying issues, suggestions, etc... (Dace, 1992)</p>

Some groups develop very effective work practices, working as a cohesive unit, constructively striving towards group goals. Other groups descend into the realm of bickering and standoffs, causing no goals to be accomplished and the group to fail in its tasks. So, it is entirely possible that the deciding factor in whether a group succeeds or fails is in its ability to manage conflict in a constructive manner.

Research has identified a number of conflict resolution and conflict management tactics. Synthesizing the research provides a more comprehensive understanding of actions typical of conflict resolution and management tactics (see Table 1).

Types of Conflict Management/Resolution

In the conflict literature, three types of conflict management/resolution strategies have appeared most frequently. The three strategies are passive indirect, distributive, and integrated (Dace, 1992; Zornoza, 2002; Poole et al., 1991). Two of the three strategies tend to follow more of the conflict management track, but the third will depend on the situation.

Passive indirect is also known as “avoidance behavior” (Poole et al., 1991). This strategy is inherently a conflict resolution strategy. The goal of this strategy is to smooth over the conflict by avoiding the subject. Typical behaviors include avoiding the issue, changing the subject, joking, and submissive actions (Sillars, 1980). The point of passive indirect is to get the conflict resolved, even at the expense of the goal of the group. Therefore, passive indirect is a very ineffective way of managing conflict because it sacrifices the productivity of the group in return for harmony.

The second strategy is labeled as distributive. Patton and Giffin (1978) describe a distributive strategy as a strategy where one person gains at another’s expense. Actions

that can result from this type of strategy are typically negotiation tactics. Requesting, demanding, threatening, and persuading are just some examples of this type of strategy in action (Sillars, 1980). This strategy, however, cannot be immediately labeled as either conflict management or conflict resolution. Tactics such as insulting and demanding imply that coercion is being done through negative tactics. However, if one uses logic and well thought arguments relevant to the issues to persuade someone to buy-in to his idea, then that would be viewed as being productive. The way this strategy is used will determine whether or not conflict management or conflict resolution is being used.

The final strategy this study will observe is the integrative strategy. This strategy is characterized by the participants having an open mind about all ideas and the discussion of the ideas is constructive and not personal (Sillars, 1980). Also, no concessions are sought when participating in this strategy. Analytical remarks are a key sign that this strategy is being utilized (Poole et al., 1991). Because of its emphasis on both issues of the main problem and the creation of an environment for the free flowing of ideas, the integrative strategy is labeled as a conflict management strategy.

Of special note, because of the inclusion of technology as a source of conflict, none of these strategies may apply to the breakdown of technology. If there is a technical problem such as a computer system failure, the obvious resolution is to have it fixed by the researchers. In other words, some types of conflict may not necessarily have a management/resolution strategy that fits one of the mentioned three.

Collaboration (FtF and Remote)

The third dimension of the study is collaboration, more specifically the differences between remote and FtF collaboration. The main discussion in the literature

is between two different lines of thinking. Some researchers propose that remote collaboration will never be as effective as FtF because of it lacks implicit and informative artifacts and cues. Other researchers propose that technology and the human ability to devise workarounds will lead to just as effective work.

Opponents of remote collaboration claim that it will never be as effective as FtF because of the absence of too many implicit/interpreted actions. One example is the concept of spatiality. Spatiality refers to the ability to use objects or mannerisms as indexes of action. An example is a flip chart being used as a discussion piece (involves pointing to a chart to refer to an idea). With this artifact “participants working face-to-face seldom feel disoriented or without context” as opposed to remote collaboration participants (Olson & Olson, 2000, pg. 8).

Proponents argue that the proper use of technology and the adoption of new technology can allow for groups to bridge these gaps. Research done by Walther and Burgoon indicate that over time, computer mediated communication starts to exhibit similar behaviors as FtF groups, even with the lack of social cues (informal interactions such as joking around and such). They also argue that the absence of some social cues may even increase productivity (Walther & Burgoon, 1992). However, there seems to be more literature against the effectiveness of remote collaboration than for it.

Interestingly, some of the opponents will agree that similar work can be done both FtF and remotely. However, they are quick to point out that the additional overhead involved in the remote work makes it a much more tedious and not a very beneficial venture (Olson & Olson, 2000).

The purpose of this study is to investigate conflict and conflict management/resolution in the context of FtF and remote collaboration. Thus, conflict and conflict management/resolution are the dimensions that are the main focus of the experimental/coding aspect of the study. The collaboration aspect is, of course, present, but it is not the primary focus of the study.

The Sonnenwald Experiment

The content analysis for this study is based on transcripts, video, audio, and other data collected during research on the effectiveness of a scientific collaboratory. The study was undertaken by researchers Diane Sonnenwald, Mary Whitton, and Kelly Maglaughlin at the University of North Carolina at Chapel Hill (Sonnenwald et al, 2003).

The purpose of the study was to experimentally evaluate the effectiveness of a scientific collaboratory, comparing scientific work done remotely using the collaboratory system to traditional face to face scientific work. The stated goals of the study included “providing insights regarding the efficacy of scientific collaborators, increasing our understanding of collaborative scientific work processes and mediated by technology, and informing the design of collaboratory technology” (Sonnenwald et al., 2003, p. 3). Based on the collaboration literature, the researchers hypothesized three outcomes:

H1: Study participants will be less effective collaborating remotely than collaborating face to face.

H2: Study participants will report more difficulty collaborating remotely than collaborating face –to –face.

H3: Study participants will report they are more likely to adopt the system after using it face-to-face than remotely.

The study enlisted upper-level undergraduate natural science students. They were assigned a partner for the purpose of completing two natural science experiments, including writing lab reports that documented the natural science experiment procedure and outcomes. One experiment was completed while working FtF using a single collaborative system, and the other completed using two identical scientific collaborative systems in different locations. The collaborative system provided a 3-D visualization and haptic interface to an atomic force microscope as well as off-the-shelf software for video-conferencing, application and file sharing, word processing and data analysis. The study participants received training on the system before each session.

An important point to note is that the ordering of the lab reports was consistent throughout the groups, regardless of whether it was a FtF or remote session. In other words, the first session's lab report had half of the groups completing it in a FtF environment while the other half completed it in a remote environment. This is called a "mixed design."

The researchers collected data from each group, in particular data regarding the group's task performance, individuals' perceptions of the experiment, and individuals' attitude regarding adoption of the collaborative system. Respectively, the measurements for each were the lab report grades, post-interviews, and questionnaires. In their analysis, the order of the task (FtF or remote first) was taken into account during data analysis.

Though the study resulted in no statistically significant results (none of the hypotheses could be statistically disproven), the data analysis yielded some interesting trends and implications. The data showed that the order of the experiments could potentially impact the results. It suggested that by doing remote collaboration first, it “may have a positive effect on scientific outcomes in this context” (Sonnenwald et al., 2003, p. 15). This was not what the literature had suggested, and helps to disprove the second hypothesis.

Probably the most important results were based on data collected from the interviews, surveys, and questionnaire. They provided good feedback and observations from the participants that can be used to design future laboratories and research projects. The interviews and surveys brought out the fact that workarounds for the remote collaboration were employed. Further research can be done on these workarounds and how they can be integrated into the remote system. As for perceptions of the system, the questionnaire showed that certain perceptions of the collaborative system (complexity, relative advantage, etc...) had not changed throughout the course of the experiment. This serves to attempt to disprove the third hypothesis of the study.

The study is the first published experimental evaluation of a scientific collaborative system, and data collected from the original study is being used in this study because it provides an unique opportunity to investigate conflict and conflict management in scientific collaboration.

Methodology

Coding

This study is a content and observational analysis of data already collected from the Sonnenwald experiment discussed above. However, unlike a typical content analysis which uses books and other written material, this content analysis focuses on the analysis of audio and visual recordings. Transcripts of the group sessions will be the main resource in the study.

The transcripts from pairs of study participants conducting a natural science experiment working FtF and remotely will be the basis for the coding, though, the audio will also be listened to while reading through the transcripts to search for any conflict that the writing does not convey. This is an attempt to pick up any non-written cues such as tone of voice or pace of conversation.

Coding will be done in 1 minute intervals. This time interval equals the one described in the TEMPO group interaction analysis system. The designers chose this interval based on previous observations of group interaction (Futoran, Kelly, & McGrath, 1989).

Labeling strategies and actions as conflict resolution or conflict management requires observing participants and their actions. As mentioned before, the conflict literature noted a difference between the management and the resolution of conflict. For the purposes of this study, the coding system for conflict management/resolution will concentrate on the strategy used. In particular, tactics will be observed and coded. As discussed previously, tactics have been identified as contributing to a passive-indirect, distributive or integrative strategy. A secondary analysis of the data and the context in

which the tactics emerged will be used to determine if the strategy contributed to conflict resolution or management.

The secondary analysis will involve in examining both the strategy the participant uses to resolve conflict and the type of conflict that it is solving. The strategy used is a good indicator of whether the resulting actions are management or resolution, but it is not the only factor (Dace, 1992). For example, attempting to persuade someone would be labeled as a distributive strategy. Persuading with clear logical arguments would be seen as conflict management. However, another distributive strategy such as coercion would be probably seen as more of a conflict resolution strategy because of the use of force rather than logic.

It also may not be possible to label a resolution strategy for certain conflicts. For example, if the conflict is a technical problem, the resolution may not fit any of the strategies. However, technical problems aren't just because something broke, it could stem from a misunderstanding of how to use some of the technology. Therefore, strategies such as problem solving may come to light.

Coding Schema

Identification of Types of Conflict

Acts of conflict will be recorded as:

- Procedural (P)
- Informational (In)
- Relationship (R)
- Technology (T)

This coding scheme was developed from research focusing on conflict in the small group process literature. For an explanation of these four types of conflict, please

see the “Types of Conflict” section. Detail definitions and examples of data for each code can be found in the Appendix (Figure 1).

Identification of Conflict Management/Resolution

Consequent strategies for resolution/management of the conflict will be recorded as:

- Distributive (D)
- Passive-indirect (PI)
- Integrative (I)

Figure 1 goes into more detail for the three types of strategies that will be coded and examples of each. The coding guidelines are primarily based on research conducted by Sillars (1980), Dace (1992), and Poole, Holmes, & Desanctis (1991). For more information on the three strategies, please review the “Types of Conflict Management/Resolution” section.

Measuring inter-coder agreement

Due to resource constraints, the coding was done by only one researcher. However, two other researchers were asked to use the coding system in order to test its reliability. Using the results of the two researchers, an inter-observer agreement test was conducted before any coding took place. The purpose of running this test was to validate the coding system, making it more effective as a measurement of conflict and identifying the correct types of conflict and conflict management/resolutions. The test was based on the model presented by Robson (1993).

Cohen’s Kappa is a concordance measure which corrects for chance agreement. The two researchers were given the same observations to code (1 set of FtF and 1 set of remote), and two Cohen’s Kappas were calculated. For the FtF observations, the Kappa

was found to be in the “excellent” range according to the “rules of thumb” outlined in Robson (Robson, 1993). The remote observations produced a lower Kappa, but it was still classified in the “good” range. The complete results can be found in the Table 2 in the Appendix section.

From conversations with the researchers, the coding system was slightly revised to clear up some areas of confusion. One of the major points was to emphasize the distinction between procedural and informational conflict more in the coding system explanation. This was a general area of confusion and the definitions of each were clarified so that the final coder may fully understand the difference.

Another major point of interest is the use of the word “No.” The researchers discussed that the word “No” or other negative type comments were immediately seen as conflict. After discussing the issue, the distinction between conflict and clarification was noted. Clarification is not the act of disagreement, but of correcting someone when they are making an obvious error. Clarification was very evident when users had problems with technology. An example was trying to find a function in the Microsoft Word program. This brought out the need for the final coder to be careful to consider more than negative comments when coding conflict.

Group Selection

Because of the time required to thoroughly code the data, data from 4 groups were selected for analysis in this study. The groups selected were not random, but were based on their grades (i.e., task performance) in the original study. A chart with more information can be found in the Appendix (Table 3), and the following is the verbal explanation of why these certain groups were chosen.

Group 7: Group 7 participated in the FtF lab first and did not do well relative to other groups in the study. They then proceeded to do below the average in the remote lab. They represent the group that did not do well in either lab, but started with the FtF lab.

Group 10: Group 10 participated in the remote lab first and did well relative to the other groups in the study. They then proceeded to do above the average in the FtF lab. They represent the group that did well in both labs, but started with the remote lab.

Group 21: Group 21 participated in the remote lab first and did not do well relative to the other groups in the study. They then proceeded to do below the average in the FtF lab. They represent the group that did not do well in either lab, but started with the remote lab.

Group 24: Group 24 participated in the FtF lab first and did well relative to the other groups in the study. They then proceeded to do above the average in the remote lab. They represent the group that did well in both labs, but started with the FtF lab.

The groups were comprised of upper-level undergraduate natural science students from Research I universities. Their fields of study included: biology, biochemistry, chemistry, mathematics, and chemical engineering.

Hypothesis

Conflict can have a variety of affects on the results of group collaboration.

However, based on the conflict literature, the type of conflict and the way the conflict is handled may determine the quality of these results. Therefore, the following hypothesis will serve as a basis of analysis of the results of the study:

H1: Groups who experienced a “healthy” amount of procedural and informational conflict will have better results.

H2: Groups utilizing high amounts conflict management techniques will do better than those relying on conflict resolution techniques.

H3: Groups working remotely will experience more conflict than those working FtF.

Hypotheses 1 and 2 are targeted at the relationship between conflict/conflict handling techniques and the final results. Hypothesis 1 is based on the notion that procedural and informational conflict can lead to better results. As discussed in the literature, conflict has the ability to bring out different ideas and different opinions on both how to accomplish a task and how to decipher information. The assumption is that a reasonable amount of each conflict will generate new ideas and create informative discussion among the group. These ideas and discussions will create results that are well thought out and with few errors. However, the amount experienced is key. That is why the ambiguous word “healthy” is used in the hypothesis. Healthy, in this context, is determined by the observer. If the procedural and informational conflict becomes so obtrusive that the group production is hurt, then the amount of conflict is having a negative affect on the results. The observer will need to note this when proving or disproving the hypothesis.

Hypothesis 2 concentrates on the way all conflict is handled. All conflict literature agreed that the way conflict is handled will play a major role in how it affects the group’s productivity. The labeling of conflict resolution as a negative approach indicates that groups who utilize such techniques will have worse results than those using conflict management techniques. Hypothesis 2 will serve as the basis of analyzing this phenomenon in this study.

Unlike the first two hypotheses, Hypothesis 3 is not concerned with conflict/conflict handling as it relates to results, but how it relates to the environment.

Because of the lack of social cues and the spatial difference, some collaboration literature argues that remote collaboration will not be as effective as FtF collaboration. Instead of measuring effectiveness, this hypothesis will test to see if there is a difference in conflict level. Based on this literature, including the Olson and Olson study, the hypothesis will assume that more conflict will occur in the remote sessions (Olson & Olson, 2000).

Table 4: Coding Results for Report 1

Group ID	Condition	Grade	Conflict: Procedural	Conflict: Informational	Conflict: Relationship	Conflict: Technology	Total Conflict	CR/CM: Distributive	CR/CM: Passive- indirect	CR/CM: Integrative	Conflict Resolution	Conflict Management
7	FTF	42	6	7	0	6	19	0	0	14	0	14
10	Remote	80	2	8	1	5	16	0	5	9	5	9
21	Remote	55	7	14	0	7	28	0	4	5	4	5
24	FTF	84	2	9	0	2	13	0	3	8	3	8

Figure 2: Conflict Occurrences for Lab Session 1

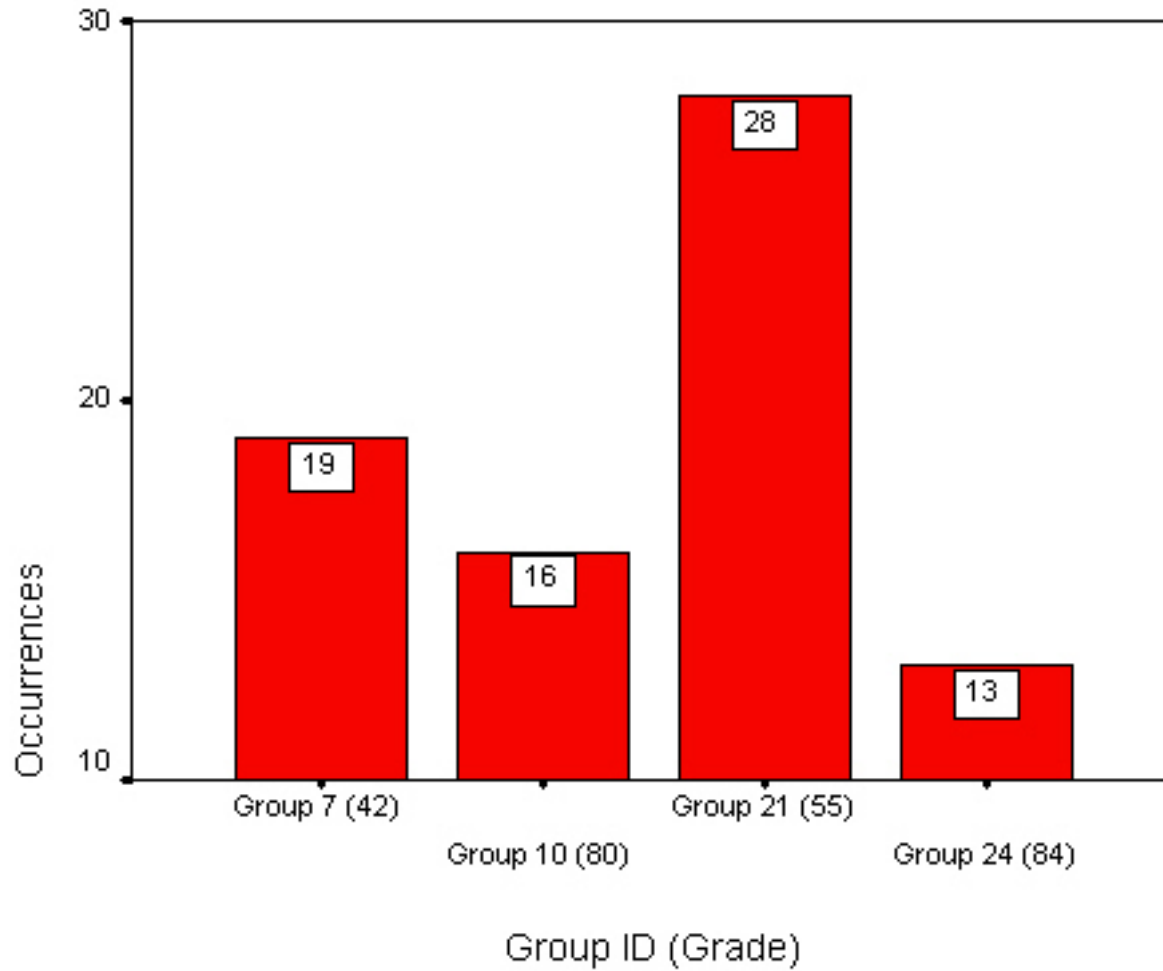


Table 5: Report 1 Descriptive Statistics

	Minimum	Maximum	Total	Mean	Std. Deviation
Conflict: Procedural	2	7	17	4.25	2.630
Conflict: Informational	7	14	38	9.50	3.109
Conflict: Relationship	0	1	1	.25	.500
Conflict: Technology	2	7	20	5.00	2.160
CR/CM: Distributive	0	0	0	.00	.000
CR/CM: Passive-indirect	0	5	12	3.00	2.160
CR/CM: Integrative	5	14	36	9.00	3.742
Conflict Resolution	0	5	12	3.00	2.160
Conflict Management	5	14	36	9.00	3.742

Figure 3: Conflict Breakdown for Report 1

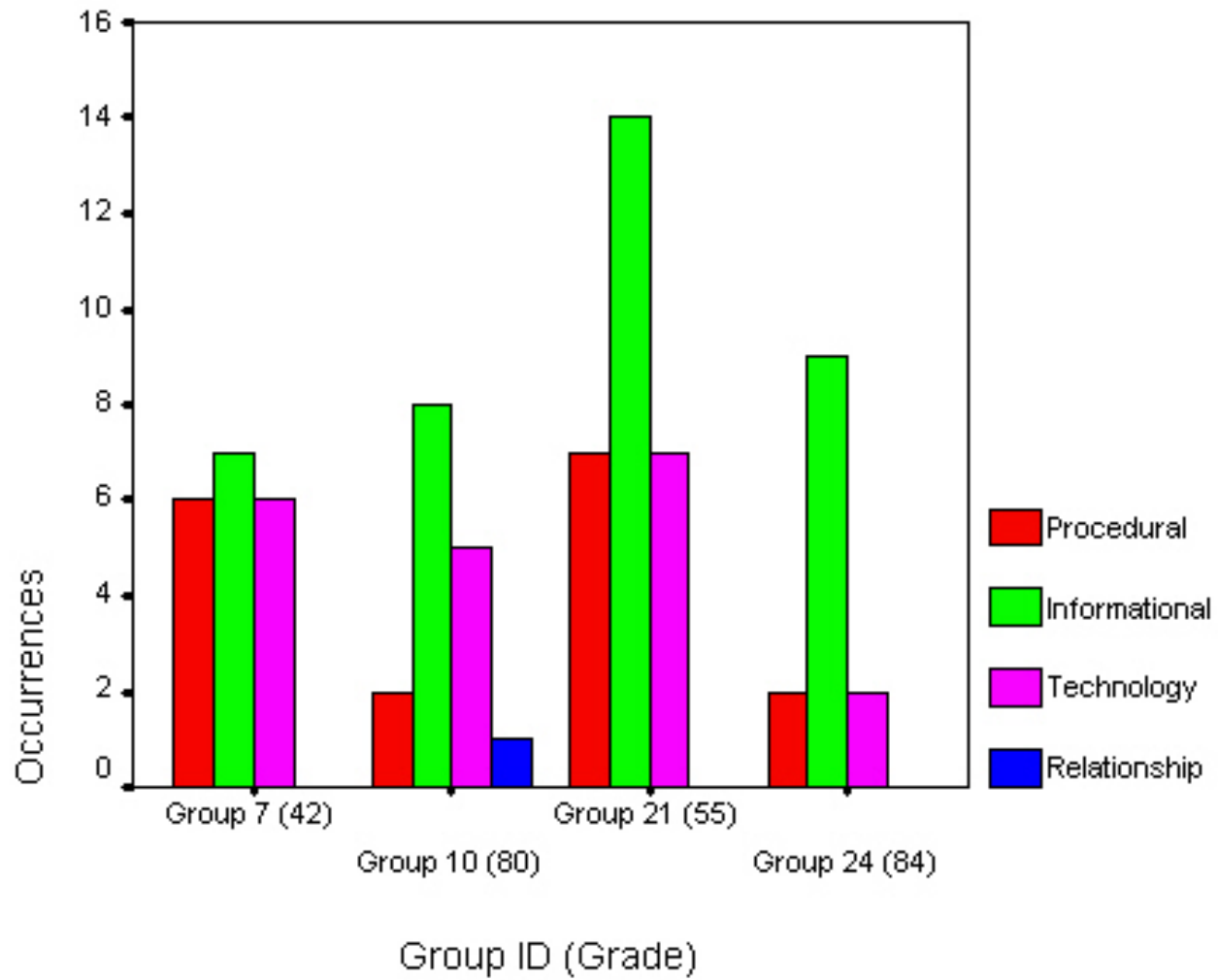


Figure 4: Conflict Management/Resolution Breakdown for Lab Session 1

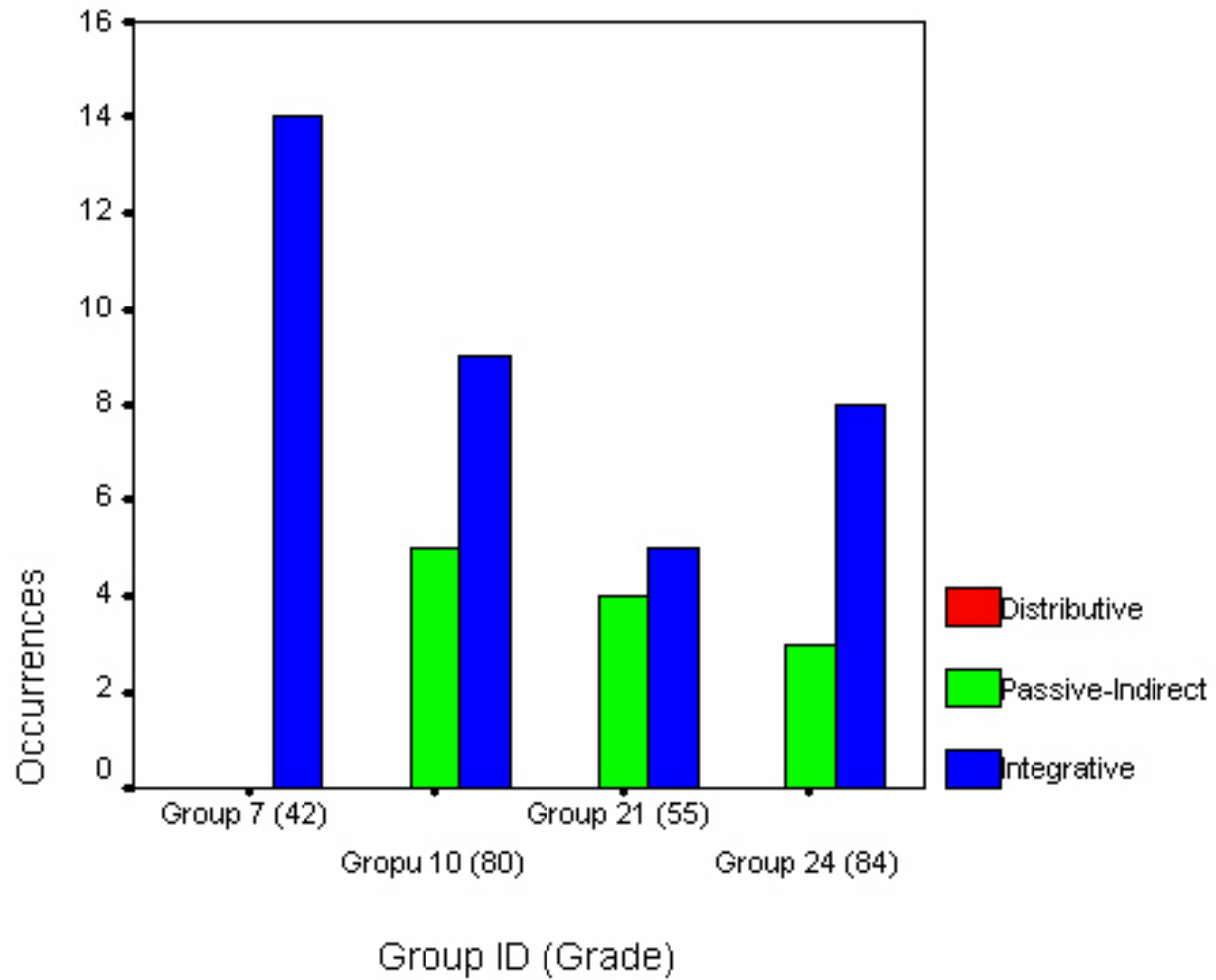
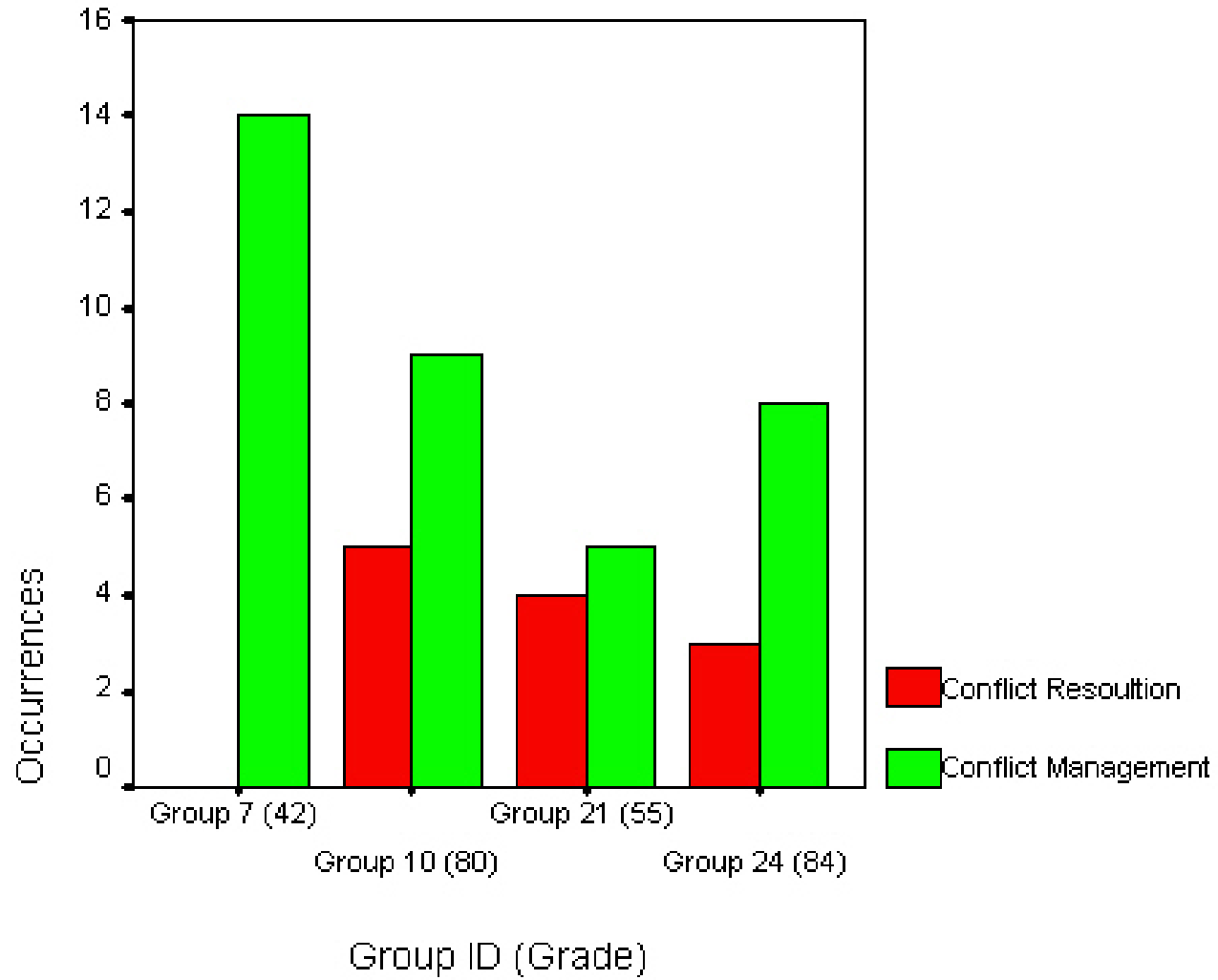


Figure 5: Conflict Management/Resolution Summary for Lab Session 1



Results and Analysis

Lab Session 1 Analysis

Lab session 1 was the first time the groups worked together. The average amount of overall conflict experienced for the entire session was 19 instances (Coding breakdown for all groups can be found in Table 4). Figure 2 shows the amount of conflict experienced for each group. The most occurrences of conflict in a group were 28 (group 21), while the least amount of occurrences in a group was 13 (group 24). Comparing these numbers and lab report grades, the two lowest scoring groups experienced the most conflict.

The breakdown of the types of conflict can be found in Table 5 and Figure 3. Informational conflict was the most prevalent among all groups (occurring 38 times), while relationship conflict only occurred once. Figure 3 also indicates that the groups seemed to experience about the same amount of procedural conflict as technology conflict.

Table 5, Figure 4, and Figure 5 show the breakdown of the conflict resolution and management techniques. All groups showed a propensity to try to manage the conflict in a manner that would help the team, and no group showed signs of distributive behavior. This behavior indicates that the members, when faced with conflict, acted in an integrative fashion. The passive-indirect cases were all almost all observed to be “agree to agree” instances, which seemed to be aimed at moving the group along.

In addition to being coded as integrative or passive-indirect, Table 4 and Table 5 show that each case of passive-indirect conflict handling was coded as conflict resolution, while each case of integrative conflict handling was coded as conflict management. The

“agree to agree” reactions are a negative response to the conflict. They seek to avoid it and move on without confronting the conflict. Because of this negative reaction to the conflict, it was labeled as conflict resolution. The integrative approach, on the other hand, is inherently a conflict management technique. The integrative behavior demonstrated by the groups involved constructive discussions and reasoning. By addressing the conflict directly in this positive, open manner, the instances were recorded as conflict management.

The following descriptions of the each group will allow for a better analysis of why some of the groups performed better than the others.

Group 7 Observations and Discussion (FtF; Low Performance)

This group really worked well together. The tone they set was one of open communication and friendliness. The partners created this atmosphere with a good amount of “side comments.” One group member was especially entertaining with comments like “I’m having a brain stall,” “Now what have I done,” and “Good grief....” In the context they were used, the statements were very light hearted and brought an ease to the group. This atmosphere probably prevented the formation of any relationship conflict, while encouraging positive informational and procedural conflict (Figure 3). As stated before, only when members feel comfortable will positive idea sharing evolve.

Another factor in achieving this open atmosphere was that the partners always sought the other’s opinion. “What do you think” and “so let’s talk about this” showed that the members were committed to working together to solve the issues. By encouraging one another to contribute and share ideas, the group continued to create a tone of openness and sharing.

Because of the openness of the group, it may be assumed less conflict should have occurred in this group than others. However, the results indicate that the group experienced slightly higher conflict than two of the other groups. This can be explained by the way the group clarified and justified their points as they went.

Like the other groups, this group spent some time clarifying and justifying their opinions and conclusions. This justification is important in the context of conflict because when it is done in a logical way, it may have served as a proactive force against conflict. By justifying his/her stance on procedural or informational issues, a group member has already given solid reasons for his/her decision. The partner then may quickly agree to them (“Yeah, sounds good”), and move on. This behavior was seen frequently at the beginning of the session. The group discussed possible steps and procedures to complete the tasks, and because each member justified their opinions, most were accepted readily.

This justification appeared to also lead to good informational discussion. The rest of the session saw several instances of this behavior along the informational lines. When drawing a conclusion, a partner would carefully explain the logic behind it. The following discussion would be a series of questions if clarification was needed. This was not recorded as conflict unless the partner added an opinion or disagreed.

So, what the results and observations indicate are that even with an open, information sharing atmosphere, conflict may emerge. However, the members’ actions of justifying and clarifying as they discuss help minimize conflict without resorting to negative conflict resolution techniques.

Surprisingly, the final grade for this group was very poor. This result does not make much sense since the group seemed to work well together and ideas were shared. With such a high level of conflict management techniques (Figure 5), it would be expected that the grade would have been better. However, the main reason the grade was so low is that the group did not finish all of the questions in the time allotted. The observer on the tapes indicated it was not their fault, but no explanation was really given. Some of the technical problems during the session required extensive time to correct, but some of the longer discussions between the partners may have also caused the group not to finish in time.

This result seemingly helps to disprove H1. As seen in Figure 3, the amount of conflict experienced by this group was moderate. However, due to a situation out of their control (according to the moderators), they were not able to finish all aspects of the lab report. Therefore, this group would not be a good source of data to prove or disprove any of the hypotheses.

Group 10 Observations and Discussion (Remote; High Performance)

Several instances of technical conflict were observed in this remote session (Figure 3). The use of Microsoft's NetMeeting and jointly sharing the nanoManipulator added an extra level of complexity to the lab report, so a greater amount of technical problems, when compared to the FTF report, were to be expected. Most of the technical conflicts were solved with help from the experiment observers. The partners were able to work through some of the problems themselves, which was coded as an example of integrative conflict management.

The tone of the experiment was very light, and the participants were friendly to each other. They seemed to get along very well and no tension between the two was ever seen throughout the session.

The dynamic that emerged from the group was that of a leader and follower. One of the members consistently read the task descriptions to the other and proceeded to think out loud. He clearly took a role of facilitating the discussion and made his opinion known. Instead of adding to the discussion, his partner basically agreed to everything he said. The leader, however, frequently checked with his partner to get her approval, which she almost always gave. So, the opportunity to critique was clearly given but rarely used. This dynamic led to a relatively small amount of conflict between the two. This can be seen by the amount of conflict recorded in the session (Figure 2) when compared to the other groups.

This same dynamic was also seen in the conflict resolution/management strategies of the group. An interactive approach was used for most conflicts, with one member asking for input from the other (Figure 4). However, even when asking for input, the first suggestion was always taken and the group moved on. Because of these actions, it became difficult to tell if either member began to agree just to move on, thus making it a passive indirect type of conflict resolution. Figure 4 and Figure 5 show that this group experienced the highest amount of conflict resolution (passive-indirect) of all the groups in lab session 1. Despite the high amount of conflict resolution, the group did very well on its report. This can be attributed to the already mentioned observation that the first suggestions were taken readily by the other member. These suggestions may have been very good, which caused the second group member to readily accept them. Once again,

the difficulty in determining whether the agreement was genuine or not is difficult to decipher.

There are several reasons why this agreement dynamic may have emerged. One could be that the tasks in the lab were too straightforward. Some of the questions were based on numbers, or very simple tasks to perform. In other words, the content did not lead itself to very much open discussion. Discussions on content were happening between the groups, but the discussions would not be characterized as being very “deep.” The discussions spawned from the content were mostly disagreements about calculations and not really about the meaning behind the numbers. Because no real discussion of the content ever took place, there was never any opportunity for conflict to emerge. A critical exchange of ideas is where conflict breeds. Without discussion, the opinion of the leader is taken as fact and the group moves on. The lack of discussion also made it difficult to tell whether the subservient member really agreed with the other, or if she was simply agreeing to move on with the experiment.

Another explanation of the dynamic could be the amount of scientific knowledge one partner had over the other. One group member, who was also the “leader,” did seem to exhibit more knowledge of the subject. By being the first to suggest possible solutions and by sharing his ideas, it could be assumed that he was just more knowledgeable. With this perception, the other group member may have been more hesitant to share ideas, and even more inclined to agree to the ideas he was suggesting. This type of behavior would only contribute to the agreement dynamic.

The way the members split up the work seemed to reduce the possibility of negative conflict. It is reasonable to assume that a member taking a subservient role may

start to feel that they are not contributing or that they are not really involved in the experiment. However, the group did a good job of splitting the type of work. In one case, the leader used the nanoManipulator and dictated results to the other member for her to record. For another task, the leader took the dictation and his partner conducted the experiment. This strategy of splitting up the work probably led to less relationship type conflict because both members had the feeling that they contributed. In addition, the strategy may have also have given the members new learning opportunities. By taking different roles, each member was able to control the observation and data gathering tool (nanoManipulator), allowing them to contribute in different ways. For example, if one member of the group took all of the dictation, then there is not even the opportunity to contribute to the group. There is no access to the data gathering, observation tools, so the one member has no way of adding to the discussions because there is no way to find new information. By rotating the positions, each member had the opportunity to take the role as the primary data collector, allowing them to be the source of new data and new discussion.

This strategy did lead to some more technical conflict, however. Because a member who had become familiar using nanoManipulator had to pass the task to the partner who had not used it as much, the partner usually needed some help to get started. Evidence of this can be heard in their conversations as the one member has to explain in a step by step fashion to the other on how to properly use the nanoManipulator.

Group 21 Observations and Analysis (Remote; Low Performance)

Figure 2 shows that group 21 experienced the most overall conflict of all the groups in lab session 1. In particular, they experienced the most informational,

procedural, and technical conflict for this session (Table 4). It would be expected that with so much informational and procedural conflict that their results would be better. However, the group's results indicate otherwise. This group serves as an example of what happens when too much discussion leads to negative results as mentioned in hypothesis H1.

The high amount of procedural conflict appears to be mainly due to the group's inability to successfully complete the tasks required to gather data. The group consistently challenged the procedures they were doing and got caught up so much in carrying out the data collection tasks that they failed to finish all the data analysis in the allotted time. At one point, a discussion on how to properly take a measurement took over 15 minutes (some technical conflict was also attributed to the same instance). Even deciding when to save the sections of the lab report spawned conflict. This high amount of procedural conflict contributed to the inability of the group to finish all of the tasks, which ultimately led to a low score.

The amount of clarification on the questions also cost the group valuable time. Though clarification is not considered the same as conflict, it was too significant to be ignored. The group did a good job of communicating openly with each other, but the lack of strong will from both members appeared to hurt group productivity. The group really needed some assertiveness in decision making to move along. "Maybe" and "I think" were the indicators of the lack of assertiveness by both groups. However, it should be noted that other groups also used similar comments and may have displayed some non assertive behavior. The difference, though, is that someone in the other groups

presented reasonable guesses. The guesses were discussed briefly or agreed to, and then the group moved on. This group never had someone to take that role.

The lack of a decision maker seemed to give rise to most of the procedural conflict. Instead of making an assumption and moving along, the group was bogged down in too much discussion (both informational and procedural). The informational conflict may have been caused by lack of scientific knowledge on the part of the group members, but other groups did not seem to have more scientific knowledge. Yet, the other groups did not experience the same amount of conflict (Figure 2), nor did they have a problem finishing all of the tasks.

Similar to other groups, the math exercises were responsible for a significant amount of informational conflict. This group really had problems agreeing on answers and neither could easily explain their calculations. The remoteness may have caused the members problems when trying to explain what they did. The resolution seemed to be more just to agree and move on (passive indirect approach).

Confusion and clarification were the norms of this group. The partners never really seemed to be comfortable working with each other. Common statements used by both members were: “what are you doing now,” “I don’t understand why...,” and “I don’t know.” This atmosphere is what led to high amounts of both informational and procedural conflict.

The group also did not appear to a good job of handling the conflict. As Figures 3 and Figure 5 shows, the group used conflict resolution strategies (passive-indirect) almost as much as conflict management (integrative). This indicates that the group was more

focused on keeping harmony and not trying to offend one another, as opposed to openly discussing all of the conflict.

It should be noted that the total amount of conflict noted for the group (28 instances) is much higher than all the conflict management/resolution strategies (9 instances). Some of these differences can be attributed to technical conflict, but some are just instances where the conflict that occurred seemed to not be acknowledged. This marks a deficiency in the coding system and the issue is discussed in the “Limitations of the Study” section. However, this type of avoidance could be seen as a conflict resolution technique, though it doesn’t exactly meet the requirements of any specific type. Even though it is not noted in the metrics of the study, this type of behavior also showed a lack of effort on the part of the group to try to manage the conflict in a beneficial manner.

The environment of the group may have affects on the conflict level. As seen in Figure 3, this group experienced slightly more technical conflict than any other group. This may not have been as much as a factor as the larger amount of informational conflict, but it still may have affected their grade.

Group 24 Observations and Discussion (FtF; High Performance)

The tone of the experiment was light and the two partners were friendly to each other. There was not as much joking and laughter as some of the other groups, but it did not affect the atmosphere of the session.

A reoccurring issue in all the groups, including this one, is the lack of discussion that is taking place. All sessions had long pauses for typing and constant agreeing behavior between the group members occurred. In this group, the members took turns

being the “yes man.” Constant agreement implies some passive indirect occurrences of conflict resolution, but those are difficult to determine.

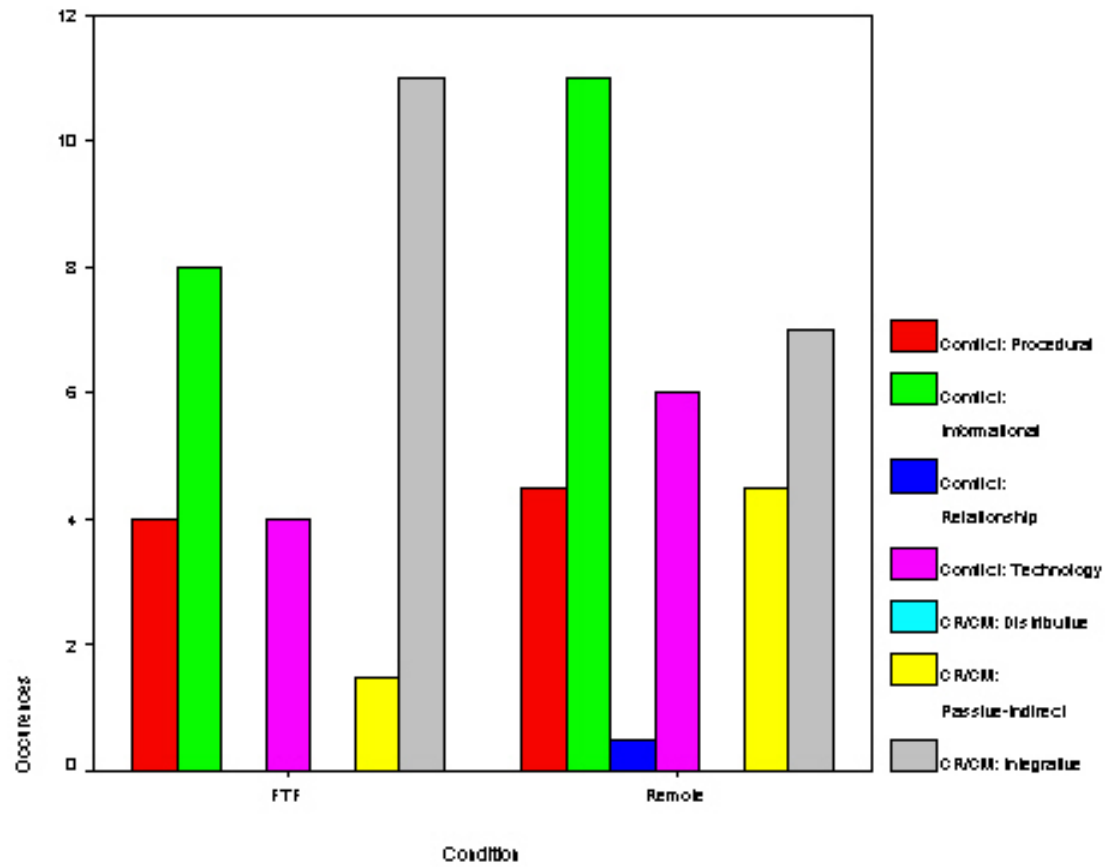
This trend is troubling because speculation about problems is very apparent. Members make statements such as “I think” and “this kinda makes sense” that imply doubt. Instead of challenging the statements or even making comments, the response is “ok” or “sure”. Now, this could be because the partner expects the answer to materialize later, but the ease at which speculation is being accepted is alarming.

There could be several reasons for this, but the very nature of the lab sessions is probably the most responsible for the lack of discussion. Because the issue has been observed in all the groups, it is discussed more thoroughly in the “Limitations of the Study” section.

As mentioned in the previous section, the members took turns agreeing with the other. This dynamic was similar to group 10’s leader/follower dynamic, but the leadership role in this experiment session switched more. Each participant at different points led the discussion of a question and proposed solutions (which were usually accepted).

The group had very few problems with the technical side of the experiment. The only real problems involved using the nanoManipulator, and the moderator usually stepped in. Overall, the technical conflict experienced was low (Figure 3).

Figure 6: FTF vs. Remote Comparison for Report 1



The informational conflict from this group was characterized by uncertainty statements. Statements like “are you sure” were clear indications that there was some uncertainty in the information presented. The response was usually a clear step though of the logic used for the assertion (integrative conflict management). The partners really did a good job of backing their points the few times they were challenged. A good example was one of the members drawing pictures in order to illustrate her point to the other. If more of this type of conflict existed, it would be interesting to see if all the explanations continued to be as thorough.

Analysis of FtF vs. Remote Conflict for Lab Session 1

The group analysis had some examples of issues based on condition. Figure 6 gives a breakdown of all aspects of the study in relation to the environment. The results are inconclusive. The total amount of conflict for the remote groups was 44 occurrences while the total amount for the FtF groups was 29 (Table 3). However, when looking at the individual groups, a remote group experienced the most conflict (group 21), while a FtF group experienced the second most (group 7). So, in terms of total conflict experienced by the remote groups vs. the FtF groups, the numbers support H3. However, taking each group separately, the numbers do not support H3.

When breaking down the numbers by type of conflict, there is less support for H3. In each category, there is no case where the remote groups were the 2 highest in amount of conflict that occurred (Relationship conflict did have a 3-way tie for second). Group 21 had the highest amount of conflict in each category except relationship, while group 10 only finished above third in one category. The one category that group 10 did finish

above third was relationship, but it experienced only 1 occurrence (the other three groups experienced 0 occurrences).

The higher amount of total technical conflict in the remote sessions may be due to the extra amount of technology present. The FtF groups do not have to use the programs in “shared states,” which was a main reason for the higher instances of technical conflict. These states occurred as both members attempted to view or edit work jointly. The observers could be heard on several occasions saying “are you in shared state” as technical problems persisted.

The total amount of informational conflict was also higher in the remote sessions. One of the main reasons for this type of conflict was the members jointly doing math. In the FtF environment, the group members used artifacts like their computer screen or scratch paper to work and show calculations. Because of their proximity, discussion of the problems was minimized because they could just refer to the artifact. However, in the remote environment, the problems needed to be discussed openly. Without the aid of the artifacts, the members were forced to talk out loud about the step by step procedures for calculation. Because of the open discussion, informational conflict was recorded more frequently.

There was a greater amount of total integrative conflict management observed in the FtF session than in the remote session (Figure 6). One possible reason is the communication medium. In FtF, the partners simply can speak and gesture to each other when confusion arises. In many cases the partner will conduct a step by step explanation that may include using artifacts. Similar reactions were also seen in the remote session. One member would explain carefully their logic behind a statement and they would

discuss. However, communicating through the phone may have frustrated some members from openly discussing every issue. Because FtF was much simpler to bring up smaller issues, more informational conflict could occur.

This frustration with the remote environment could also explain with more passive-indirect instances were observed. Not wanting to get into a prolonged discussion, a group member may just agree to move on with the study rather than discussing through the phone. This may be why groups 10 and 21 displayed the most occurrences of passive-indirect behavior (group 24 was close, only 1 occurrences away from group 21 and 2 occurrences from group 10).

As stated before, the numbers are inconclusive in their support for H3. If the total amount of conflict experienced is the criteria, then the numbers do support H3. It is troubling thought, that group 21 had the most conflict in each category, while the other remote group did not, may indicate there were more factors other than the environment affecting group 21. So in a group by group comparison, the numbers do not support H3 because the remote groups never were the top two groups to experience the most conflict.

Table 6: Coding Results for Report 2

Group ID	Condition	Grade	Conflict: Procedural	Conflict: Informational	Conflict: Relationship	Conflict: Technology	Total Conflict	CR/CM: Distributive	CR/CM: Passive-indirect	CR/CM: Integrative	Conflict Resolution	Conflict Management
7	Remote	77	7	11	0	12	30	0	0	16	0	16
10	FTF	98	5	4	0	13	22	0	4	7	4	7
21	FTF	70	5	7	0	2	14	0	0	9	0	9
24	Remote	85	3	6	0	4	13	0	1	8	1	8

Figure 7: Conflict Occurrences for Lab Session 2

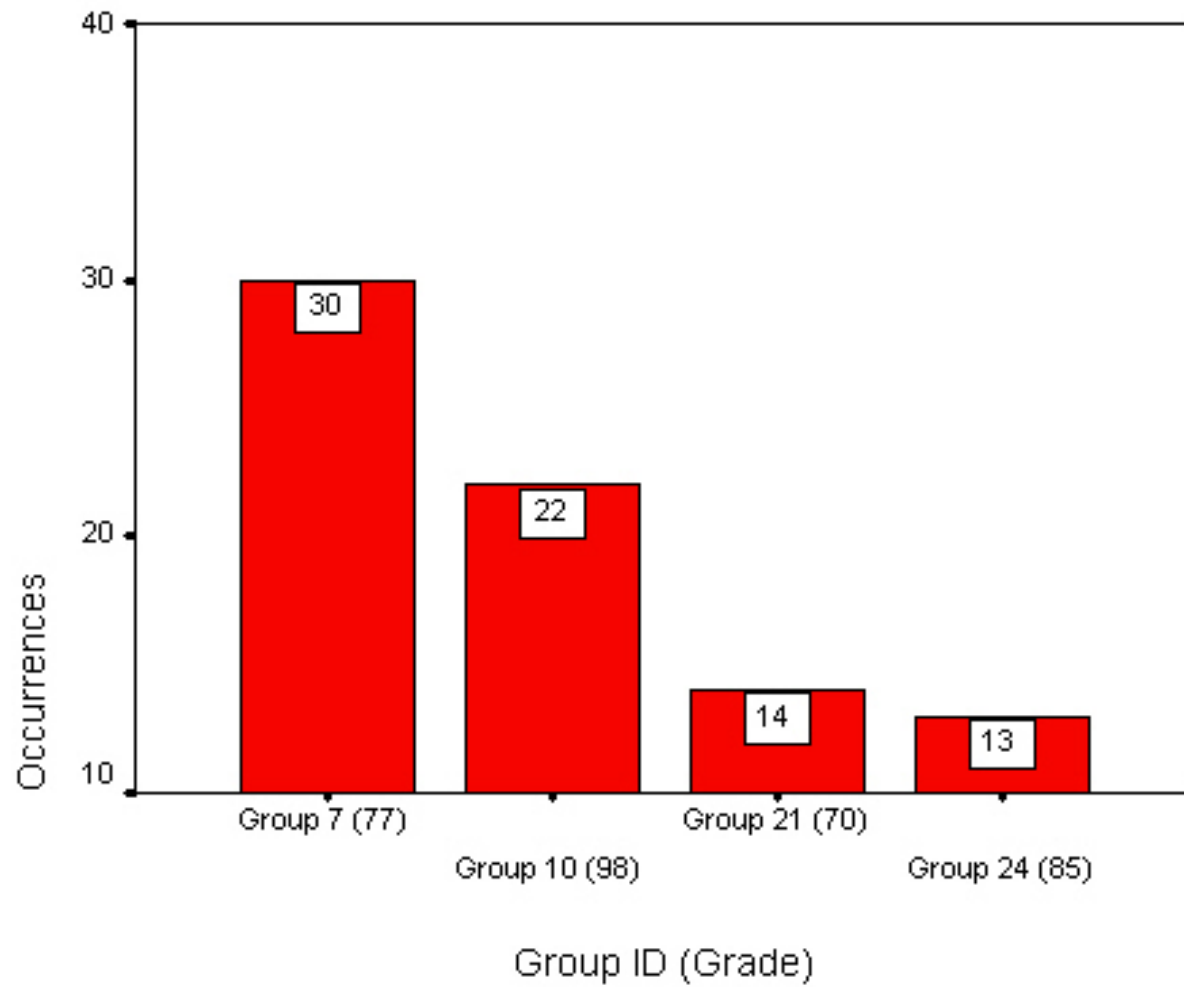


Table 7: Report 2 Descriptive Statistics

	Minimum	Maximum	Sum	Mean	Std. Deviation
Conflict: Procedural	3	7	20	5.00	1.633
Conflict: Informational	4	11	28	7.00	2.944
Conflict: Relationship	0	0	0	.00	.000
Conflict: Technology	2	13	31	7.75	5.560
CR/CM: Distributive	0	0	0	.00	.000
CR/CM: Passive-indirect	0	4	5	1.25	1.893
CR/CM: Integrative	7	16	40	10.00	4.082
Conflict Resolution	0	4	5	1.25	1.893
Conflict Management	7	16	40	10.00	4.082

Figure 8: Conflict Breakdown for Report 2

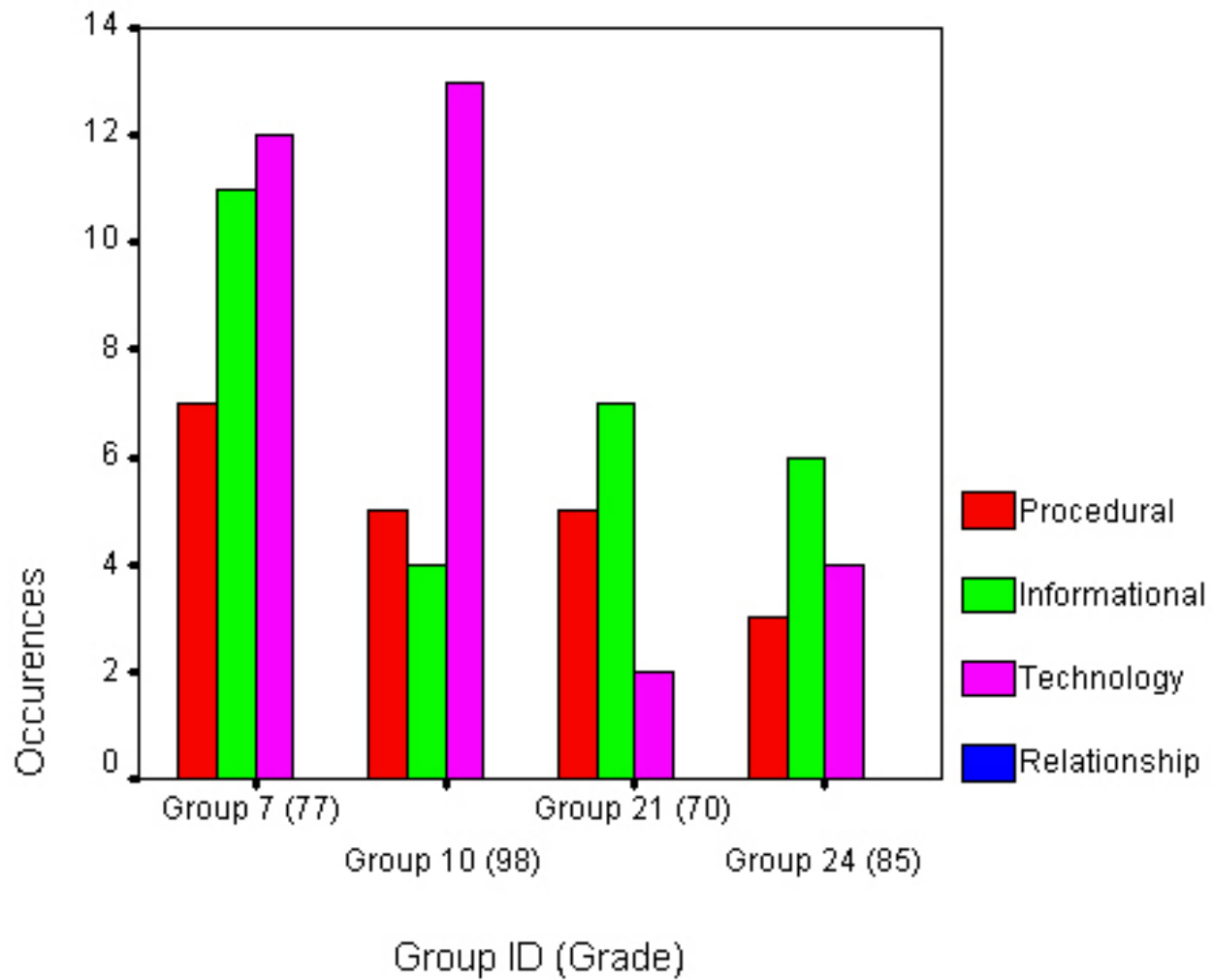


Figure 9: Conflict Management/Resolution Breakdown for Lab Session 2

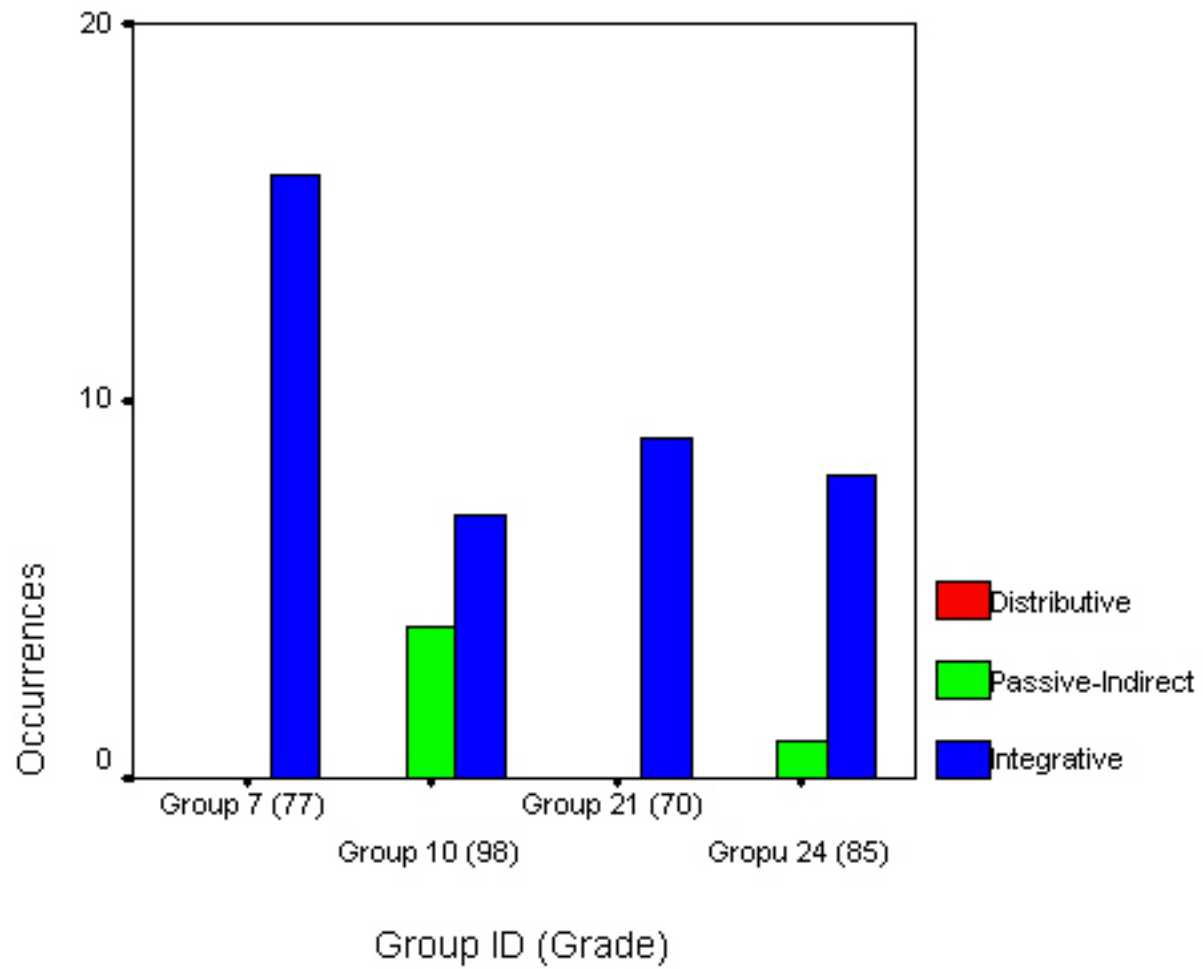
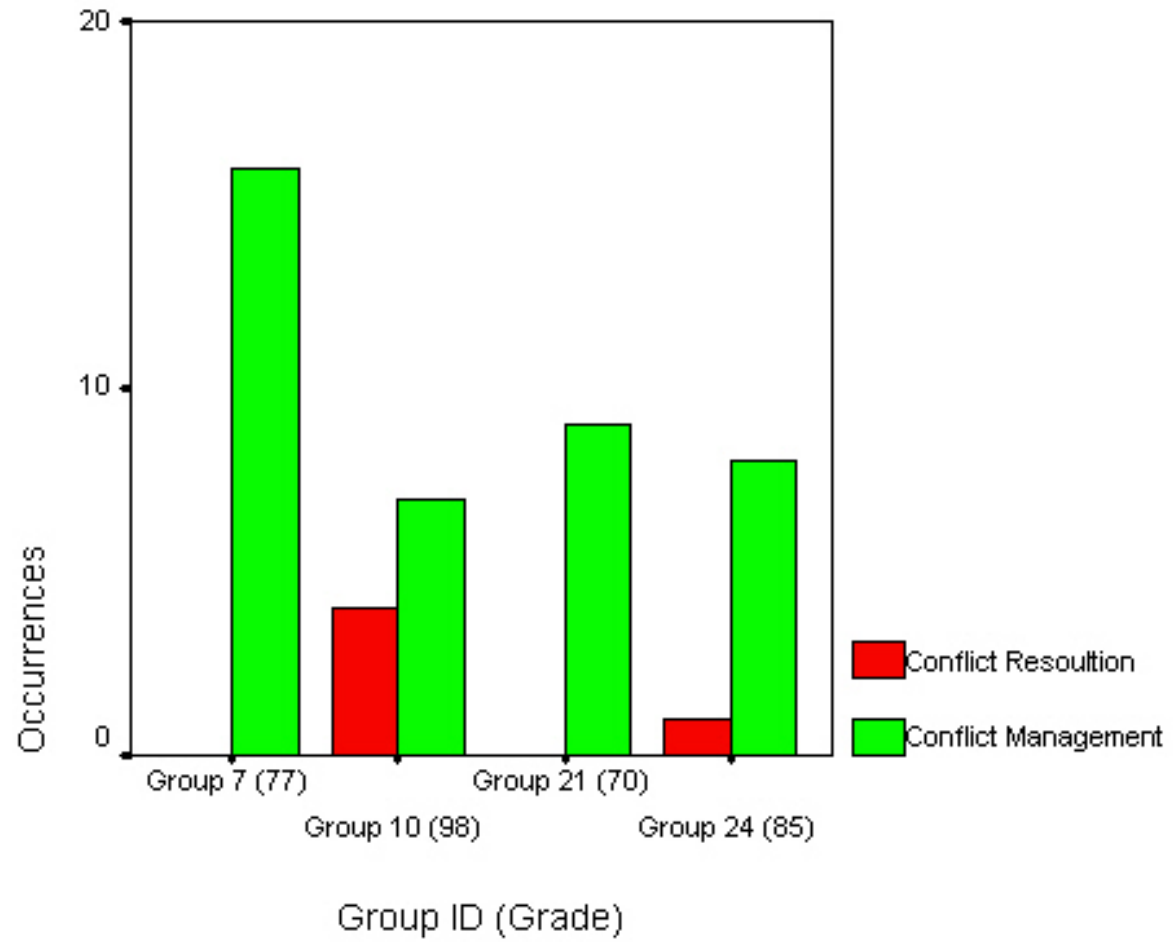


Figure 10: Conflict Management/Resolution Summary for Report 2



Lab Session 2 Analysis

The same group worked together during lab session 2. The average amount of overall conflict experienced for the report 2 was 19.7 instances (coding breakdown for all groups can be found in Table 6). Figure 7 shows the amount of conflict experienced for each group. The most occurrences of conflict in one group were 30 (group 7), while the least amount of occurrences in a group was 13 (group 24). The amount of overall conflict and the final results do not have an obvious correlation as they did for report 1. The breakdown and analysis will give reasons for the performance.

The breakdown of the types of conflict can be found in Table 7 and Figure 8. Though, like in report 1, informational conflict is high (7), technology conflict had the highest average (7.75). This can be explained because two of the groups (7 and 10) experienced an exceptional amount of technical conflict when compared to the other two (21 and 24). The informational conflict, on the other hand, seems to be more evenly dispersed with only group 7 experiencing a significantly higher level. Relationship conflict was not recorded for any of the groups, and procedural conflict on average (5.0) was observed at a slightly greater rate on average than report 1 on average (4.25).

Table 7, Figure 9, and Figure 10 show the breakdown of the conflict resolution and management techniques. As seen in lab session 1, all groups showed a propensity to try to manage the conflict in a manner that would help the team. In fact, two groups were observed to having no instances of conflict resolution. Ironically, these were the two lowest performing groups. Reasons detailing each group's performance are discussed in the following sections.

Group 7 Observations and Discussion (Remote; Low Performance)

The group mimicked much of the same behavior it showed in the earlier FtF session. This was especially seen in the tasks section. They discussed each task very openly and both members put in good amounts of input. As in the earlier remote session, their conclusions and views were challenged and they effectively worked through the problems in an integrative fashion. There was some more informational conflict than in the earlier FtF (Table 5 and Table 7), but this may be attributed to the difficulty of the tasks in this session.

This session experienced a large amount of partner agreement with the phrase “Yeah.” This has been seen in all groups but an example that is typical can be seen in the Appendix (Figure 11).

The tone of the session was much like the earlier FtF session. The partners quipped with “side comments” that lightened the mood and verbalized some frustration. This frustration may have led to some more informational conflict, but did not lead to any relationship conflict. The working relationship seemed effective because both partners actively encouraged each other throughout the session.

The technology problems experienced in this session had an impact on the procedural level. There was a lot of discussion involving having to backtrack with some of the drawings and nanoManipulator tasks. This was because the nanoManipulator shut down unexpectedly and some work had to be redone. One of the group members seemed to have an especially hard time with the technical equipment. It became frustrating for her and even at one point stated “I’m going to sit tight and not touch anything until you tell me too.” This was out of frustration with the equipment, not with her partner. This

large amount of technical conflict probably resulted in the groups below average marks for the experiment.

Group 10 Observations and Discussion (FtF; High Performance)

The overall tone in this session was very much like the group's earlier remote session. The partners joked with each other on several occasions and light laughter was prevalent throughout the session. This laughter was mostly resulting from slight mistakes and the joking. Some of the joking was attributed to some light conflict on some points, but most of it seemed to be just a personalizing force between the two partners.

As in the remote session, the same group member emerged as the leader. One indication was that he always was the first to comment on possible solutions to the problems. However, the reason this was an indication was more because of his partner's response. She commonly used phrases such as "Yeah" and "Sure" that may be seen as instances of passive-indirect behavior (agreeing just to agree). Her agreement never seemed to be unfounded, but her lack of adding to most of the discussions made her look like a "yes person." Her actions may indicate an unwillingness to challenge the leader, leading to less conflict.

When the group discussed minor details, it appears that one usually just differed to the other without much discussion. This behavior was also seen in the earlier remote session. Some of these cases were coded as passive-indirect because it seemed that the agreement was not entirely genuine, but rather a means to proceed.

Most of the discussion centered on the math calculations needed in this session. The members discussed the math results much more than the ones in the previous lab session. This may be due to their proximity to each other. The remote lab did not see an

excess amount of discussion about the math because of the inconvenience of discussing math calculations remotely. For example, the technology did not support the use of mathematical symbols. However, because the members were now together, they could both look at the calculations that were written down on paper.

Not all of the math discussion, though, was recorded as informational conflict. Some of it was not coded as informational because it could be attributed to miscalculation. Miscalculation can sometimes be simply corrected and the group can move on. However, if the discussion is prolonged, a resolution strategy may be appropriate. In all of the informational conflicts due to math, a clear integrative process was used. One group member would step through the calculation and carefully explain how the results were reached. Because of the management process needed to resolve the misunderstanding, the math discussion was recorded as informational conflict.

Technical problems also occurred in this session of the lab, and at a higher frequency than in the earlier remote session. This was unusual because the amount of technology had decreased (no collaboration software). This seemed to be a result of an increased amount of problems with the nanoManipulator. In resolving the technical conflicts, not all of the technical problems were solved by the 3 possible resolution strategies. As in the remote session, the session observers were needed in some cases to help out with technical issues, or the members worked together to solve them.

Group 21 Observations and Discussion (FtF; Low Performance)

This group demonstrated many of the same tendencies as in the earlier remote session. Both members had problems understanding the tasks, but one member in particular really seemed to struggle. At one point, both her partner and the moderators

were trying to explain a task to her. Her attitude was not necessarily negative, but remarks such as “I’ll have to think about it” showed an inability to understand the content, therefore, not allowing her to contribute to the group.

But how did the one partner’s limitations affect the conflict level? It may be expected that if her frustration level increased, some relationship conflict could emerge. At some points, even the other group member seemed to be frustrated at her inability to understand the task. However, no relationship conflict developed. Instead, the group member who was experiencing the difficulty just wanted clarification of answers and accepted them. Because she never disagreed, no conflict of any type was recorded.

The steps required to complete the tasks were discussed very heavily at the beginning of the experiment, much more than seen in the other groups. The high level of discussion, though, did not lead to high amounts of procedural conflict. The partners were very open and agreed frequently on the steps. This discussion of procedure was also seen in the earlier remote session, but more conflict emerged than in the FtF. This may be attributed to the fact they were in proximity to each other and could explain themselves easier than in the remote condition.

Group 24 Observations and Discussion (Remote; High Performance)

The most interesting observation was that both members of the group seemed to talk an equal amount. As opposed to their first lab, both members gave more input on the tasks and neither seemed to dominate any conversation. However, this did not seem to produce any more conflict than seen previously (Figure 2 and Figure 7). They tended to agree just as much as before with most of the conflict emerging when doing calculations (similar to what group 10 experienced in the same lab).

Surprisingly, the tone of this group was much friendlier and lighter than in the earlier FtF session. The distance between them should probably act as more of a depersonalizing factor (social cues are harder to detect), but the distance seemed to make them both more comfortable with each other. Joking was especially seen as the members attempted to draw pictures using the collaboration tools. This added level of comfort kept the tone very friendly and appeared to prevent any relationship conflict from happening.

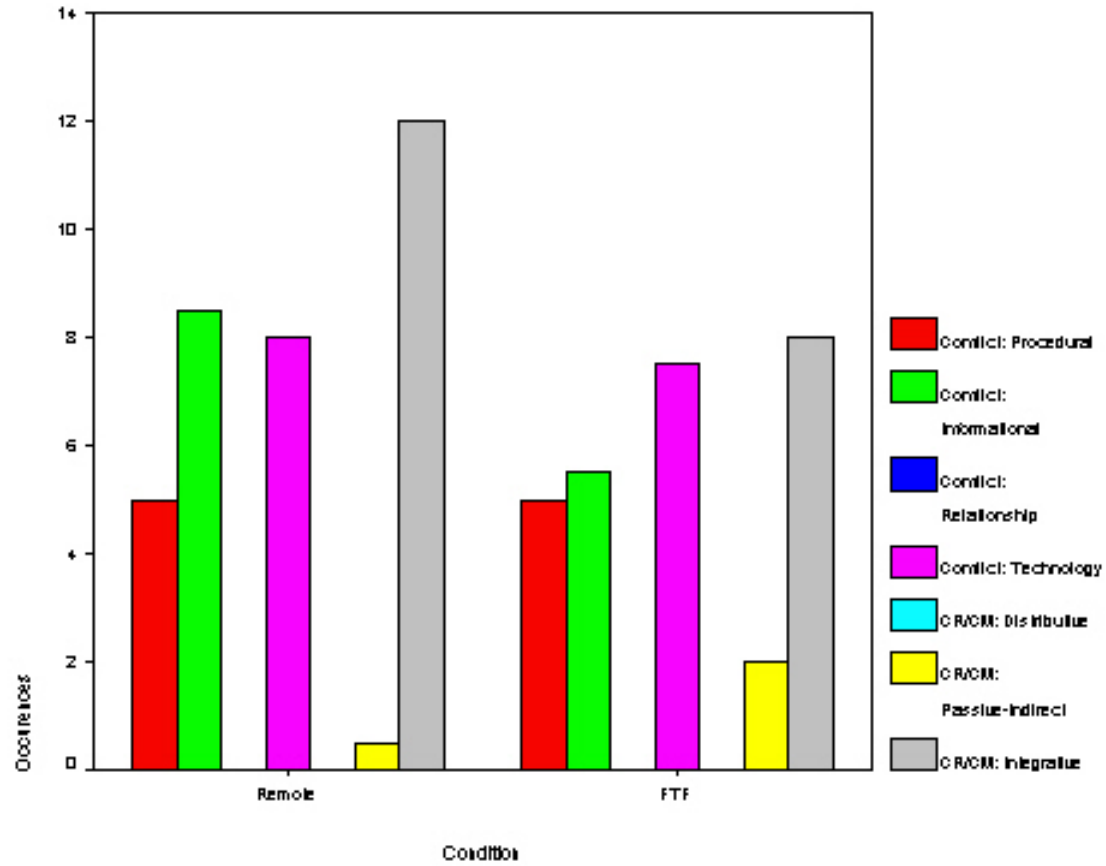
A technique used by this group that appeared to be very effective was the use of positive reinforcement. Several times, the partners complemented each other on their work. Phrases such as “good job,” “you’re doing great,” or “perfect” served to commend the work being done. This appears to give both partners the feeling that they are actively contributing to the tasks. It also helps drive the positive atmosphere created. A positive atmosphere does not necessarily prevent all conflict. In fact, this type of atmosphere should actually promote some conflict because the partners feel that their ideas can be shared without ridicule. In this case, though, the atmosphere did not seem to produce any more conflict than seen in the other groups.

There were several instances of the integrative approach to conflict management. It should be noted that the signs of this type of management were slightly different from the defined way. For example, when one partner questioned what the other is stating, an instance of informational conflict has happened. Sometimes instead of walking his partner through his point (traditional integrative approach), he encourages his partner to reexamine the question or the calculations. So, the one partner does not show or walk though how they got to the answer, rather, he has his partner redo or reread the problem

in order to get to the proper conclusion. In each case, the partner in error did realize their mistake and reached a similar conclusion.

This was very common in the math calculation section of this experiment, and this type of behavior was also seen in group 10. However, because group 24 completed this problem remotely, it was easier to request a reexamination/recalculation than to attempt to explain in a step by step fashion with the collaboration tools. Group 10 completed this experiment FtF, so they had a shared notebook where explanations could be walked through much easier. This type of resolution could be viewed as an act of clarification, but because there was communication between the partners in a positive, helping manner, the acts were coded as integrative.

Figure 12: FTF vs. Remote Comparison for Report 2



Analysis of FtF vs. Remote Conflict for Lab Session 2

Figure 12 gives a breakdown of all aspects of the study in relation to the environment. The results are very similar to what was seen in the analysis from lab session 1. The remote groups experienced total conflict levels equal to or greater than those in the FtF environment. However, as in the lab session 1, the remote groups did not rank first and second in total conflict or any of the individual conflict categories (Table 5). This session also did not provide any significant evidence of H3.

Even though the conflict occurrences were similar to session 1, the management/resolution occurrences differed. The remote groups in session 2 experienced more integrative acts of conflict management than the FtF groups. This was not expected because of the perceived communication issues in the remote session. As mentioned earlier, without social cues and artifacts, people may have more trouble communicating and explaining problems. This trouble would lead to a tendency to only debate those issues seen as important, while accepting other issues readily. This was not the case, however, for this report.

Lab Session 1 saw the remote groups experiencing passive-indirect conflict handling. In session 2, however, only one of the remote groups used the passive-indirect approach. Because the sample is so small, it may be assumed that characteristics of the group members may override the affects of the environment. For example, group 10 displayed the highest level of passive-indirect behavior in both reports. The group and its dynamic may just favor the passive indirect approach because of the high level of agreement from one member to the other.

Overall Analysis and Discussion

Unfortunately, the sample size for this study is too small to reach any statistically significant results. However, but looking at the numbers and observations, some inferences towards the hypothesis can be made.

Both reports showed indications that moderate amounts of conflict can lead to good results. The two high performing groups in report 1 and report 2 experienced about the same levels of procedural conflict and informational conflict (Table 4 and Table 6). This seemingly proves H1 as being correct. However, report 2 also showed a low performing group to have similar numbers. This is a case where a more thorough study may help prove or disprove H1.

Figures 4 and 9 show the amount of conflict resolution and conflict management each group exhibited. These findings seem to disprove H2. In fact, in report 2, the group who had the best grade also had the highest occurrences of conflict resolution techniques. One reason for this could be that the all of the conflict resolution instances were seen as “agree just to agree” instances. In this case, the resolution strategy may hamper “out of the box” thinking. But when the scope of the ideas and thinking is so limited (lab report), then this may not produce any negative results. The partners ideas that are the subject of the resolution strategy may also turn out to be always correct. If they are always correct, the grade should be higher.

H3 was discussed in the last section of each analysis section. Neither of the lab reports can validate the assertion made in H3. The amount of overall total conflict was higher in the remote sessions in both reports, but that total was a result of one group having a very large amount of conflict. When examining the results on a group by group basis, no remote group finished first and second in conflict occurrences in any conflict

category (including total conflict). The small amount of groups in the study really affects the ability to determine whether H3 is valid. A greater sample would help in determining this hypothesis (as it would the rest).

Limitations of the Study

One of the main issues of the study was whether scientific lab reports are a proper vehicle in testing conflict in small groups. The lab reports present a problem because they are very direct on the proper procedures for performing the experiment, and their solutions may require extensive mathematical calculation.

As stated previously, procedural conflicts are disagreements regarding the strategy to solve a problem or complete a task. Because of the structured nature of lab reports, there is little room to discuss strategy. The only real questioning of strategy that came up is whether to do the steps in a different order (if possible), or whether to write the report as the group proceeds through the steps, or to take notes and compile at the end.

Math is traditionally not an area where a lot of discussion of results can happen. Recalculation can solve most mathematical conflicts, which can be seen as an integrative resolution strategy if the participants explain the problems as they step through it. However, this brings up the point of clarification versus true conflict. Making a mathematical mistake should not be seen as conflict because it is an “absolute” mistake. There is no room for discussion. Disagreeing about what the numbers say, though, may be a very good example of informational conflict.

Discerning whether math difficulties were really conflict was a big challenge in this study. One indicator that was used was whether a clear form of conflict

resolution/management emerged after prolonged discussion. If so, the math difficulty was labeled as conflict because the disruption was seen as serious enough for a resolution/management strategy. The minor difficulties were usually solved much quicker and with much less discussion. To help with this distinction in the future, making sure the questions really concentrate on the meaning behind the numbers rather than just the quantifiable results.

Both of these characteristics of lab reports have the ability to produce conflict and the subsequent resolution strategies, but a more open ended problem may lead to more discussion of strategy and possible solutions. An experiment that involved planning, designing, and implementing a solution would serve as a much better setup to study conflict and how it is handled because there is much more room for discussion and the “brainstorming”

Another major limitation of the study was the amount of groups chosen to code. Because of time constraints, only 4 groups were chosen. The sample is too small to properly run a statistical analysis based on the conflict coding, eliminating statistically significant findings.

The amount of speculation in the consequent conflict strategies in the coding system is probably too high. The reason for this is that the coding relies on inferring internal thoughts and feelings of individuals. Without interviewing members about certain events, it may not be possible to determine if they were disclosing information in order to have an advantage in a situation. This could be the deciding factor between coding an event as distributive or integrative. Having follow-up interviews or questionnaires may help rectify the situation.

A deficiency in the coding system also created some problems while coding the data. The coding system really did not have a code for when the conflict experienced was totally ignored. This seems to be a passive-indirect type of behavior, but because the limitation was realized too late, only notes of this type of behavior were recorded. Therefore, this behavior is not seen in the coding system, but will be recorded in the discussion so that it will not be left out.

Conclusion

The main question to ask in this study is *why even look at conflict?* The reason a conflict analysis is beneficial is it examines a recognized factor in the effectiveness (or ineffectiveness) of group process. As Patton and Giffin (1978) stated “Group conflict may either bring out the best in a group or literally tear the group apart” (p. 86). The study can give insights in how groups may effectively deal and plan for conflict in a remote collaboration situation.

Because remote collaboration can use a great amount of technology, it’s important to see how that affects conflict level. Does all of this new technology actually create more issues than it solves? In other words, is it a source of negative conflict? Identifying sources of negative and positive conflict is a side goal of this study, but an important one. If sources of negative conflict can be identified, then work can be done to prevent the negative conflict from happening. This could mean changing the technology used, or educating the users to watch for it.

Along the same lines, conflict management techniques can also be observed. Which management style works best? Which leads to more problems? Are some styles

more suited to a certain type of conflict? Conflict management techniques that prove to be effective can be recorded and noted for future user education and tool improvement.

One commonly overlooked significance of a study is its ability to generate interest and topics for further study. Because of time constraints, this study is only taking a small sample of a larger study, but further researchers could conduct a more thorough content analysis of the data. Further studies in remote collaboration can also make conflict the central aspect of the study. Adding conflict catalysts or altering test conditions to specifically create conflict may produce more insight into its role in the remote collaboration process.

Stepping back from concentrating solely on conflict, there is the potential that the study could give more insights into general human behavior. Do people feel more empowered now that they have a computer to hide behind? More assertive of their opinions? How do humans feel about not talking FtF, getting those implicit cues that facial and body expressions give? This is the human-computer interaction aspect to the study. Any new observations could contribute to this growing body of work.

As stated in the introduction, remote collaboration is being used more widely because of better remote tools and because of its cost effectiveness in a business environment. This makes the work of this study significant because of its timeliness. This topic currently is of great interest and growing. Because of this, the study is very relevant and has more of a chance to make an impact in society.

Finally, the limitations and problems with the study have been noted above. However, the real contribution of this study is that it can aide in the design of another study that can capitalize on this one's shortcomings. Creating the correct environment,

choosing the right questions to ask, and looking for certain types of behavior have all have been addressed in this study. Further researchers can take this data and observations and create a study that is better suited to learn more about how conflict and its resolution affects the productivity of groups.

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Appendix

Figure 1: Notes for the Coding System

- 1) Coding will be done in 1 minute intervals.
- 2) Acts of conflict will be recorded as:
 - Procedural (P)
 - Disagreement with previously proposed strategies for approaching the task or previous contributions to keep the task moving to the next step (Kowitz & Knutson, 1980).
 - Disagreements while carrying out the tasks. Not content centered, but process centered.
 - Example in Figure 13.
 - Informational (In)
 - Disagreement or direct rejection of previously proposed task solutions or ideas (Kowitz & Knutson, 1980).
 - Content centered discussions rather than process centered.
 - Example in Figure 14.
 - Relationship (R)
 - Negative interpersonal comments (Poole et al., 1991; Kowitz & Knutson, 1980).
 - Example in Figure 15.
 - Technology (T)
 - General problems with using equipment and tools.
 - Example in Figure 16.
- 3) Consequent strategies for resolution/management of the conflict will be recorded as:
 - Distributive (D): Seeking concessions from other parties; parties pursue own interest without regards to others; conceal information; behave competitively; closed attitude; closed minded to other suggestions
 - Tactics (Sillars, 1980)
 1. Threatening other members (Sillars, 1980)
 2. Coercing other members (Sillars, 1980)
 3. Suggesting to vote (Zornoza, 2002)
 4. Persuading with concessions (Sillars, 1980)
 - Passive-indirect (Pi): parties seek to flee or smooth over conflict; disagreement is not openly discussed.
 - Tactics (Sillars, 1980)
 1. Changing the subject (Dace, 1992)
 2. Joking about the situation (Dace, 1992)
 3. Agreeing just to agree (Dace, 1992)
 4. Example in Figure 15.

- Integrative (I): parties attempt to work with each other; disclosive behavior is used
 - Tactics (Sillars, 1980)
 1. Exchanging information (Poole et al., 1991)
 2. Considering alternative viewpoints (Sillars, 1980)
 3. Presenting logical reasoning (Dace, 1992)
 4. Clarifying issues, suggestions, etc... (Dace, 1992)
 5. Example in Figure 14.
- 4) The coding environment can be seen in Figure 17.

Table 2: Calculation of Kohen's Kappa for inter-coding agreement

FtF

		Observer 2							
		P	In	R	T	D	Pi	I	
Observer 1	P	4	0	0	0	0	0	0	4
	In	0	0	0	0	0	0	0	0
	R	0	0	0	0	0	0	0	0
	T	1	0	0	0	0	0	0	1
	D	0	0	0	0	1	0	0	1
	Pi	0	0	0	0	0	0	1	1
	I	0	0	0	0	0	0	3	3
		5	0	0	0	1	0	4	10

Kappa = 0.786623

REMOTE

		Observer 2							
		P	In	R	T	D	Pi	I	
Observer 1	P	3	0	0	1	0	0	0	4
	In	0	0	0	1	0	0	0	1
	R	0	0	0	0	0	0	0	0
	T	0	0	0	6	0	0	1	7
	D	0	0	0	0	0	0	0	0
	Pi	0	0	0	0	0	0	4	4
	I	0	0	0	0	0	0	4	4
		3	0	0	8	0	0	9	20

Kappa = 0.646322

Figure 11: “Yeah” example

Member 1: Yeah. I mean like if it were Clay-Dough, not only would it stretch in the motion that you were trying to move it, but probably be. . . it would no longer be a perfect cylinder. It would have like an indentation in the fiber where your finger was or whatever.

Member 2: Yeah.

Member 1: So, it might be. . . . You could try to. . . underneath the picture where you have the tip, on the circle, on the very left?

Member 2: Yeah.

Member 1: We could put another figure under that with the tip causing a deformity in the circle's. . . .

Member 2: Yeah.

Member 1: Or do you not know what I mean, because I can do it and then you can see what I'm talking about.

Member 2: Yeah.

Member 1: OK.

Member 2: Yeah. Try that.

Member 1: OK. Let's see. I need. Other Shapes. Did you . . . let's see. Did you use these lines to make the V for the tip?

Member 2: Ah, yeah. Yeah. I just used the line tool like right next to the Other Shapes.

Explanation: This conversation is a representative example of the use of the work “yeah” in agreement. It is difficult to tell at times whether the agreement is genuine or a result of a more passive-indirect approach (agreeing just to agree). This particular example appears to be genuine because of the extensive conversation.

Figure 13: Example of Procedural Conflict resolved with Observer help

Observer: I think you'll find if you want to pause it or wait until Daniel catches up. . . just you guys work it out.

Member 1: OK. Well, um. . .I might. . .um. . . .

Member 2: Oh, yeah. Do the shared state. Yeah.

Member 1: OK. I'm going to pause it, Daniel. Is that all right with you?

Member 2: Oh, yeah. That's fine.

Member 1: 'Cause this is also, it just in my private state, it's paused at 218.

Member 2: Oh, that's. . .

Member 1: What's yours doing right now?

Member 2: Um. . . . Well, I'm still setting up the colormap and everything.

Member 1: OK. Well I'm going to set that up too. I'm going to do that right now.

Observer: You guys might want to go ahead and read all the directions on that page.

Member 2: OK. That's a good idea.

Explanation: This illustrates some confusion by a group member on the tasks needed to start the experiment. The conflict occurs as Member 1 tries to figure out what she needs to do while interacting with Member 2. This situation is ultimately resolved by the moderator making suggestions and the group members following it.

Figure 14: Example of Informational Conflict resolved by Integrative fashion.

Member 1: Right, and then go down to the next one. OK, so there is a . . . there were originally, like one, two pieces, I guess. Because this one wasn't there. That means that's going to be resolution of two separate pieces, original piece or pieces, as far as I can tell. Well, no. . .

Member 2: I think it's just one piece, to be honest with you. I mean. . .

Member 1: Because there's a break here. . . a break here. Appears to be a break there.

Member 2: Right.

Member 1: So in effect you're adding two pieces to the original number we were drawing.

Member 2: OK. Then we could say that, "At the . . .in the manipulation area."

Member 1: Oh, right.

Member 2: Yeah, because that way it's not confusing.

Member 1: Oh, well, OK, then there's Yeah, you've added a piece. We've broken off one piece. (Pause-typing) Yeah, cause there were originally five pieces and then we broke that into one, two, three, four, five, six--yeah, there were seven. So you're adding a total of two new pieces to it.

Explanation: The 2 group members are in disagreement over the number of pieces of fiber. This is an example of Informational conflict. The management strategy is Integrative because there is a clear attempt to solve the conflict by openly discussing the issue. There is no apparent disclosive behavior being used.

Figure 15: Example of Relationship resolved by Passive-Indirect fashion.

Member 1: Uh-oh.

Member 2: Uh-oh, you killed it!

Member 1: I know!

Member 2: That was good. It died.

Observer: Yeah, lay that down. You could just. . . .

Member 1: You thought you were going to be the one to break it.

Member 2: Smooth move.

Observer: use the button next to Touch Services and reset.

Member 2: Ah, it sure does.

Explanation: Though this conversation happened in a joking style, the “Smooth move” comment can be seen as a negative interpersonal comment. The comment goes ignored and the group continues (passive-indirect).

Figure 16: Example of Technical Conflict resolved with Observer help

Member 1: Um. . . . well I think it would be good to. . . I don't know what happened to my NanoManipulator. It's gone.

Observer 1: Hey, <Observer 2>?

Observer 2: Yes.

Observer 1: While she was working over on Word, looking Word, I was just sitting here watching, and her NanoManipulator turned itself off. Just disappeared.

Daniel: Just the image or the program?

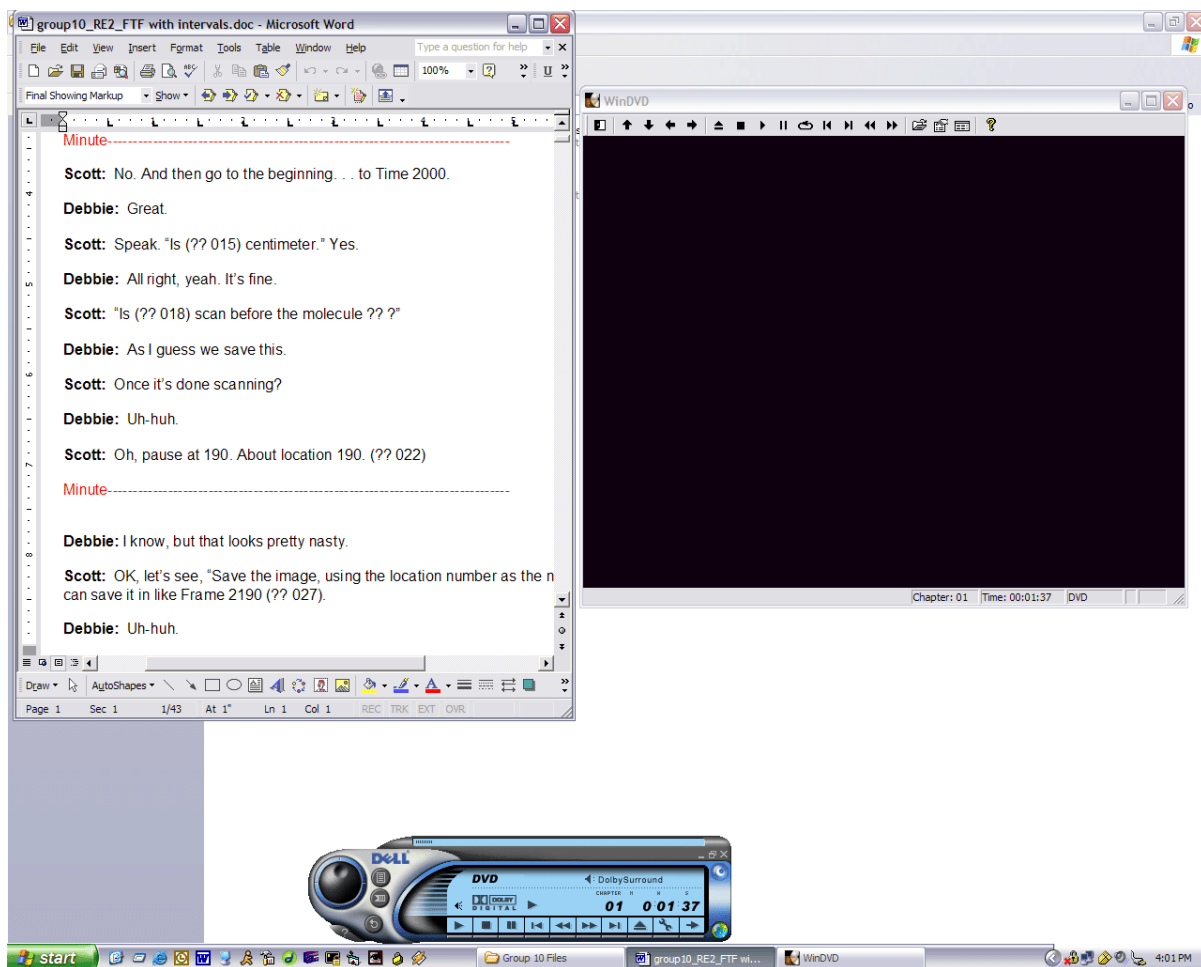
Observer 1: The whole sh. . . .

Member 1: The whole thing.

Observer 1: The whole shooting match. The only thing left is Phantom.

Explanation: Technical problems took many forms, but this is an example of the most obvious. The system fails and the moderators are called in for their expertise.

Figure 17: Coding Environment



Note: The black screen is the DVD play

Table 3: Sonnenwald Study Summary

	Group	Cond	Lab Session 1		Lab Session 2	
			Grade	Comparison to Mean	Grade	Comparison to Mean
Group Results	7	FTF first	0.42	-0.28	0.77	-0.04
	10	Remote first	0.80	0.10	0.98	0.17
	21	Remote first	0.55	-0.15	0.70	-0.11
	24	FTF first	0.84	0.14	0.85	0.04
Overall Results	Mean		0.70	0.00	0.81	0.00
	Median		0.73	0.03	0.82	0.01
	S.D.		0.13	0.13	0.12	0.12
	Max		0.88	0.18	0.98	0.17
	Min		0.42	-0.28	0.56	-0.31

Notes: Groups 10 and 24 both performed above average in both studies.
 Groups 7 and 21 performed below average in both studies.