

## **ABSTRACT**

MORRIS, LYNNAE CAROL. Power and Status within Small Groups: An Analysis of Students' Verbal and Nonverbal Behavior and Responses to One Another. (Under the direction of Glenda Carter and Eric Wiebe.)

The purpose of this research has been to determine the influence of verbal and nonverbal behavior on power and status within small groups. The interactions which took place within five small groups of students in a middle school spatial reasoning elective were analyzed. Verbal responses to requests for help were analyzed using sequential analysis techniques. Results indicated that the identity of the student asking a question or requesting help in some form or another is a better predictor of whether he/she will receive help than the type of questions he/she asks. Nonverbal behavior was analyzed for social gestures, body language, and shifts in possession of tools. Each nonverbal act was coded as either "positive" (encouraging participation) or "negative" (discouraging participation); and, the researchers found that in groups in which there was unequal participation and less "help" provided among peers (according to the verbal analysis results) there tended to be more "negative" nonverbal behavior demonstrated than in groups in which "shared talk time" and "helping behavior" were common characteristics of the norm. The combined results from the analyses of the verbal and nonverbal behavior of students within small groups were then reviewed through the conflict, power, status perspective of small group interactions in order to determine some common characteristics of high functioning (collaborative) and low functioning (non-collaborative) groups. Some common characteristics of the higher functioning groups include: few instances of conflict, shared "talk time" and decision making, inclusive leadership, frequent use of encouraging social gestures and body language,

and more sharing of tools than seizing. Some shared traits among the lower functioning groups include: frequent occurrences of interpersonal conflict, a focus on process (rather than content), persuasive or alienating leadership, unequal participation and power, frequent use of discouraging social gestures and body language, and more seizing of tools than sharing. While “functionality” was easily defined, labeling groups according to this characteristic proved to be a more difficult task. Although there was clearly a “highest functioning” and a “lowest functioning” group among the five, the other three groups fell somewhere in between these two, along a continuum of group functioning.

Power and Status within Small Groups:  
An Analysis of Students' Verbal and Nonverbal  
Behavior and Responses to One Another

by  
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## **BIOGRAPHY**

Lynnae Carol Morris was born, Lynnae Carol Flynn, on October 24, 1972, in Winston-Salem, NC, where she lived with her parents, Wayne and Linda Flynn for a little over 6 years, before moving to King, NC, where she would attend grades 1-12 and graduate at the top of her class from South Stokes High School in 1991. She was then awarded a NC Teaching Fellows' Scholarship to UNC-Chapel Hill, where she earned a degree in secondary science education in 1995.

Following her undergraduate studies, Lynnae worked at Sanderson High School in Raleigh, NC (as a biology and physical science teacher), for four years before going back to school full-time (while teaching labs and conducting university-funded research) at North Carolina State University in the fall of 1999. She earned a master's degree in science education in December of 2001, and immediately entered NCSU's doctoral program in science education in the spring of 2002. While speeding through her coursework, Lynnae made the decision to marry the love of her life, DeShannon Morris, on December 20, 2002; and, in November of the following year, they had their first child, a beautiful baby girl, Hannah Grace.

At the time of Hannah's arrival, Lynnae had basically completed her coursework; however, she had not begun to think about her dissertation, and had little time to do so with a new born baby. Therefore, the degree-seeking process seemed to come to a screeching halt and stayed there for a while. This served as a growing source of frustration for Lynnae, who had never been known as a "quitter." However, her new job as "wife" and "mommy" became top priority in her life, which slowed her down a bit in other areas (like school),

causing some to begin doubting that she would ever become “Dr. Morris.” Yet, she kept plugging away, slowly but surely, using countless late nights at home (after Hannah had fallen asleep) and many trips to her parents (where she could temporarily enjoy the benefits of 24-hour child care) to complete the dissertation process, one grueling step at a time.

In the meantime, Lynnae began to realize that relocating (a reality which faces many individuals seeking research-based professorships at universities) may not be realistic for her and her family any time in the near future, due to her husband’s job and other familial commitments. Therefore, she began to seek other opportunities in the world of education. One of her favorite experiences during her graduate studies was working with pre-service teachers, helping them to become the best instructors they could be before entering their own classrooms. Lynnae really enjoyed being back in the classroom, acting as an instructional leader, so she began exploring opportunities which would allow her to assume this role. As a result, in the fall of 2006 Lynnae entered the MSA (master’s of school administration) program (which prepares educators to become K-12 principals) at UNC-Chapel Hill as a NC Principal Fellow.

During the summer of 2007, DeShannon and Lynnae discovered that they would be giving birth to a second child sometime in February of 2008; and, in light of this new information, Lynnae knew (from past experience) that she needed to push harder than ever to finish the doctoral program at NCSU in time to graduate in December, before the baby arrives. Upon graduation, Lynnae plans to spend a few months settling into life as a mother of two (while finishing her year-long internship in school administration) before seeking employment in the summer.

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I would also like to thank all the extended family members and friends who have provided words of encouragement and inspiration throughout this process. There are too many of you to name, but you know who you are. Your phone calls, voicemails, and email messages always seemed to come at just exactly the right time, when I needed them the most.

Finally, I would like to thank my committee members for their wisdom and guidance, especially my co-chairs, Dr. Eric Wiebe and Dr. Glenda Carter. Dr. Wiebe, your insight and thought-provoking questions have kept me on my toes and helped to prepare me for the toughest of critics; and, Dr. Carter, your encouragement and amazing patience with me have taught me that there is much more to advising than providing edits and scheduling meetings. Your genuine concern for me and my family helped me to keep things in perspective, and I appreciate that more than words can say. I am not sure that I could have completed this process without you. Thank you.

## TABLE OF CONTENTS

LIST OF TABLES .....	viii
Chapter One: Introduction .....	1
The Case for Small Group Interaction.....	2
Red Flags Appear .....	3
Problem .....	4
Focus of this Study .....	5
Sequential Analysis .....	6
Nonverbal Communication .....	7
Research Questions.....	8
Chapter 2: A Review of the Literature .....	9
The Construction of Knowledge through Small Group Discourse: Constructivist Theory..	9
Social Constructivism.....	12
Knowledge Construction within Small Groups .....	14
Small Group Interactions: Group Dynamics.....	20
Helping Behavior.....	23
Coding Schemes .....	27
Sequential Analysis .....	32
Nonverbal Communication .....	35
Theoretical Perspectives on Small Group Research.....	48
Conflict, Power, Status Perspective.....	49
Support for Further Research on Small Groups.....	54
Chapter 3: Methodology .....	56
The Elective Course and its Participants .....	56
Data Collection and Selection .....	57
Pilot Study Results and Development of Dissertation Research Questions .....	58
Verbal Interaction Analysis .....	61
Lag Sequential Analysis: Peer Assistance Codes .....	63
Lag Sequential Analysis: Type of Request and Help Provided .....	65
Lag Sequential Analysis: Request Type and Response Type .....	66
Lag Sequential Analysis: Student Requesting Help and Help Provided .....	66
Examining Nonverbal Interactions.....	67
Establishing a Framework.....	67
Theoretical Lens .....	68
Secondary Research Questions .....	69
Nonverbal Interaction Coding and Analysis .....	69
Chapter 4: Analysis and Results .....	72
Level I Analysis: SAS analysis of verbal responses to requests for help.....	72



Question 1: What is the relationship between the kind of help a student requests and the type of help he/she receives?.....	73
Question 2: What is the relationship between the kind of help a student requests and the likelihood that he or she will receive help or not?.....	75
Question 3: Are the relationships discovered during the exploration of research questions 1 & 2 consistent between groups?.....	77
Question 4: Is there a relationship between the likelihood that a student will receive help when requested within a small group and the individual who is requesting help?..	79
Summary .....	82
Level II Analysis: Inventory and examination of the nonverbal behavior within each small group .....	82
“Positive” Social Gestures .....	84
“Negative” Social Gestures.....	85
“Negative” Body Language .....	86
Possession of Materials.....	87
Level III Analysis: Analysis of the overall behavior (verbal and nonverbal) within each small group using the conflict, power, status theoretical lens .....	88
Group One .....	89
Group Two .....	92
Group Three .....	93
Group Four.....	95
Group Five .....	97
Chapter 5: Discussion.....	99
Summary of results.....	99
Unanswered Questions .....	102
Limitations .....	103
Recommendations .....	104
Future Research.....	105
References.....	107
APPENDICES .....	116
Appendix A: Sample SAS Code .....	117
Appendix B: Sample SAS Output.....	119

## LIST OF TABLES

Table 1. Coding scheme for sequential analysis research questions.....	61
Table 2. Examples of interactions for each code .....	62
Table 3. Standardized residuals for lag0 = request; lag1 = specific type of response .....	74
Table 4. Standardized residuals for lag0 = request; lag1 = help/no help .....	76
Table 5. Standardized AE residuals for each group.....	77
Table 6. Standardized NO residuals for each group.....	78
Table 7. Standardized NOH residuals for CLQ and CRQ (whole class and each group).....	79
Table 8. Standardized help residuals for each student within each small group .....	81
Table 9. Frequency and breakdown of positive social gestures noted in each group .....	85
Table 10. Frequency and breakdown of negative social gestures noted in each group .....	86
Table 11. Frequency of negative body language and breakdown within each group .....	87
Table 12. Frequency of times materials were shared/seized noted in each group.....	87
Table 13. Frequency and percentage of sharing/seizing of materials by each individual.....	88

## Chapter One: Introduction

The notion that social interaction enhances student learning is widely accepted by the science education community. This concept is so widely accepted, in fact, that it is a key component of both the *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993) and the *National Science Education Standards* (National Research Council, 1996). According to *Benchmarks* (1993), “good communication is a two-way street. It is as important to receive information as to disseminate it, to understand other’s ideas as to have one’s own understood” (p. 295). The National Research Council explained that talking with peers about science experiences helps students develop meaning and understanding, allowing them to clarify the concepts and processes of science and make sense of the content.

The inclusion of social discourse as a key component of each of these sets of science education standards resulted from a plethora of research studies conducted during the late 1900’s, which generally reported positive results related to small group interaction. However, just before the turn of the century, Bianchini (1997) published a groundbreaking article which forced educators to begin reexamining the ways in which group work impacts learning. This study was the first of its kind to report individual differences in the learning outcomes achieved through small group interactions. Despite the fact that many researchers have revisited small groups in search of an “end all” solution, more research is still needed in this area to explain why some students are more successful in small group settings than others.

## ***The Case for Small Group Interaction***

The roots of influence in the move toward socially inclusive classrooms stem from the early work of Vygotsky and Piaget. According to Vygotsky, conversational theories of learning fit best into the constructivist framework that Piaget first laid when he explained that the learner is not passively subject to all sorts of influences, but rather, he actively contributes to the construction of his own universe (Atherton, 2004; Boeree, 1999; Droz & Rahmy, 1976; Furth, 1981). The emphasis from the perspective of this framework is on the learner as an active “maker of meanings,” in which he constructs meanings and understandings from social encounters. Vygotsky observed, while developing his theory of social constructivism, that when children were tested on tasks on their own, they rarely did as well as when they were working in collaboration with other individuals (Atherton, 2004).

An additional key piece of Vygotsky’s sociocultural framework of learning is his “zone of proximal development,” which is described by Bruner in Wertsch’s *Culture, Communication and Cognition* (1985). Bruner described this zone as the potential a child has for learning, which can be altered by arranging the environment such that the child can reach higher or more abstract ground through social interaction. Vygotsky believed that human learning requires social interaction as an antecedent (1978). This concept alone has served as the basis for many educators to shift their views about teaching, from the traditional paradigm of passing down information from teacher to student, to the more modern idea that the teacher (or someone else, such as a peer) should model and verbalize learning processes (or scaffold them) for the learner, allowing the learner to construct meaning through social experiences.

Once the social nature of learning was recognized, a push began for more interaction between students working within small groups. In one call for small group discourse, Lemke (1990) explained that students “learn a great deal from one another in the classroom. They mediate and translate for one another when the teacher’s language is unfamiliar. They support and facilitate each other’s learning in countless ways” (p. 78). As Courtney Cazden (2001) explained, until information presented within a lesson becomes detached from any authority, it is not likely to be internalized. It is more likely for students to actively struggle with new ideas, by rephrasing them and trying them out, when they are spoken by peers rather than by the teacher.

Enthusiasm for this perception of small group discourse as an effective teaching strategy steadily increased as researchers gathered evidence to support it (Jones & Carter, 1994; Peklaj & Vodopivec, 1999; Richmond & Striley, 1996; Roth & Bowen, 1995). Consequently, in the past two decades there has been an enormous surge in the use of this strategy within classrooms worldwide.

### **Red Flags Appear**

Despite the fact that most leaders in the field of educational research and practice do still, at present, whole-heartedly support allowing students to work together within small group settings in the classroom, there have been some interesting data reported that practitioners must consider before transforming curricular strategies. While the findings of most educational research in this arena largely support working in small groups, it has also been reported that student role-taking (Hogan, 1999; Richmond & Striley, 1996), the use of tools (Carter, Westbrook, & Thompkins, 1999; Jones et al., 2000), and group dynamics

(Hogan, Nastasi, & Pressley, 2000; Richmond & Striley, 1996; Webb, 1982, 1984a, 1991; Wegerif, Mercer, & Dawes, 1999) can influence the magnitude of success within such small groups.

As previously mentioned, one of the first studies to explicitly report troublesome information pertaining to the use of groupwork as an instructional strategy was conducted by Julie Bianchini (1997). She found that high status students, as defined by perceived academic ability and popularity, often have greater access to materials, as well as discourse within small groups. In addition, she found that those students who talk more learn more. This study suggested that “even under the best circumstances . . . groupwork can . . . fail to provide all students access to meaningful science learning” (p. 1062).

Bianchini’s work highlighted a key piece of understanding small groups and their effects, which had previously been overlooked by many educators. “Groupwork is not a magical solution to all that ails science education” (Bianchini, 1997, p. 1062). It is not simply the arrangement of classes into small groups that improves the learning process for children and increases conceptual understanding. Rather, there are specific kinds of experiences that students can have within small groups, which can easily influence the types of interactions that will occur and, thus, group members’ participation and benefit.

Therefore, as researchers, we must focus on identifying these experiences.

## **Problem**

Despite the fact that Bianchini’s research findings identified some serious issues which have yet to be absolutely resolved, most educational leaders still support small group discourse as an effective teaching strategy. After a brief wave of research reports warning

instructors of the possible problems which may result from the use of small groups, it seems as though this area of study has approached the point of saturation.

However, despite the fact that research in the area has decreased dramatically, the notion that social interaction enhances student learning remains as a key component of both the *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993) and the National Science Education Standards (National Research Council, 1996). This means that there is still a push for inclusion of social interaction within small groups in US classrooms today; and, this ongoing push for inquiry-based learning in small groups, paired with the lack of new research findings in this area, creates a hole that needs to be filled. Bianchini, along with several other educational researchers, have reported that the use of small group interactions may benefit some students more than others, and that it may even hinder some students' learning processes (Cohen & Lotan, 1995; Hogan, 1999; Webb, 1982, 1984a, 1991). The question of interest to most practitioners is why? Why are there individual differences in learning outcomes and achievement gains that result from group work? Why do these differences perpetually emerge? Is there some behavior or characteristic which the individuals who struggle within small groups share in common, or do the answers lie somewhere hidden in the behavior of the whole group? What is it that causes some students to do poorly within small group settings, while others seem to thrive?

### ***Focus of this Study***

The research in this study is two-fold. A two-part study has been conducted with a focus on examining the intricacies of small group dynamics. The first piece of the study builds on the seminal work conducted by Noreen Webb in the 1980's and early 1990's

(Webb, 1982, 1984a, 1984b, 1985, 1991; Webb, 1980a, 1980b, 1980c, 1980d), which dealt with help given and received within small groups, by examining this same topic using a tool with amazing potential – sequential analysis. This tool provides a means for examining the specific sequences of interactions preceding and following any request for help within a small group, in search of possible indicators of the type of help an individual may receive after communicating a request. The second component of the study is an examination of the nonverbal behavior within small groups, with a particular focus on how the unspoken interactions exchanged between group members seem to influence verbal participation and content.

### **Sequential Analysis**

Sequential analysis (the tool of choice for the first research focus) has been used in the past, almost exclusively, in the behavioral sciences. This tool allows researchers to examine the relationship between interactions, based on the order in which they occur. According to Bakeman and Gottman (1997), “sequential methods are tailor-made for the study of social interaction. . . [After all,] a defining characteristic of interaction is that it unfolds in time” (p. 1). In some cases researchers may be interested in actual time measurements, while other times the focus may simply be what events follow what; but, whatever the focus, Bakeman and Gottman (1997) argued that a sequential view offers the best possibility of “illuminating dynamic processes of social interaction” (p. 1). In a separate call for sequential analysis, Gottman and Roy (1990) stated that “anyone who has collected data over time and ignores time [has missed] an opportunity” (p. 3).



While the major mathematics for sequential analysis were actually derived between 1957 and 1962 (Miller, 1956), there were serious problems with the utility of many of the early analyses, as they dealt primarily with simple order of events. The questions of most researchers, in fact, are far more specific than questions of order, as they concern the dependency of events on one another. In addition, typical probabilistic methods (such as chi-squared tests) are often not used due to problems of not having enough data to employ such tests with confidence. So, within a decade, there emerged three key tools in sequential analysis which provide more insight into series of events: 1) log-linear and logit analysis, 2) time-series analysis, and 3) lag sequential analysis. This study employed the use of lag sequential analysis, which is discussed in greater detail within the methods section, to determine if there is a relationship between the way in which an individual requests help and whether or not he/she receives help, and if so, the type of help he/she receives within small group settings. In addition, within-group comparisons have been conducted, in order to identify any similarities or differences in responses to individuals within each group, and cross-group comparisons have been conducted, in order to identify any similarities or differences in sequential patterns of interactions between small groups.

### **Nonverbal Communication**

The second focus of this dissertation study is the nonverbal interactions which take place within small groups, and the influence of such behavior. While there have been numerous research articles published describing the various verbal interactions which may take place within small groups (Cazden, 2001; Hogan, 1999, Hogan et al., 2000; Johnson, 1981; Lemke, 1990; Mercer, 1996; Richmond & Striley, 1996; Webb, 1985), as well as a

recent surge of work related to nonverbal interactions which may take place within small groups (Goldin-Meadow, 1999, 2000; Roth & Lawless, 2002; Valenzano, Alibali, & Klatzky, 2002), there is a lack of research available which examines the relationship between the two, particularly how one may influence the other.

Nonverbal interactions include a wide array of movements, which may or may not communicate information to others. For the purposes of this study, kinesics (body language), hand gestures (both content-related, as well as those which appear to be social in nature) and the possession of, or access to, materials are each loosely classified as nonverbal interactions.

## **Research Questions**

There is clearly a need to explore new methods for analysis of small group interactions, in order to fully understand the impact of the dynamics which develop within these small groups. This dissertation employs two approaches to analysis in this area: 1) a sequential analysis of student responses to one another, and 2) an analysis of the nonverbal interactions and how they seem to influence the accompanying verbiage which takes place within small groups. In doing so, two research questions are addressed (respectively):

- 1- Do the sequential interactions between and among small group members differ, either within or between groups?
- 2- How does nonverbal communication influence the verbal interactions that take place within small groups?

## **Chapter 2: A Review of the Literature**

The rationale for the inclusion of small group activities in science classrooms can easily be unveiled through a careful analysis of literature on the construction of knowledge. This chapter begins with a review of constructivist teaching and learning practices. This is followed by a thorough description of the available research on the use of small groups, which has been established as an effective method of including constructivist practices in science classrooms. This section includes three subsections on the factors which may influence the effectiveness of individual small groups— verbal communication, nonverbal communication, and the use of tools. The subsequent section describes the interdisciplinary perspectives from which one should choose before beginning a study on small groups, followed by an in-depth description of one of these perspectives— the conflict, power, status perspective. This perspective provides a theory for the unfortunate problem which often presents itself in small group research— the creation or perpetuation of inequalities between students working together; and, finally, the latter portion of the chapter is dedicated to building a case for further research in the area of small group research using the conflict, power, status perspective as a basic framework.

### ***The Construction of Knowledge through Small Group Discourse: Constructivist Theory***

In recent years there has been a push for the use of constructivist teaching practices throughout the field of education. In fact, during the 1990's, in the United States alone, more than 400 national reports have called for the reform of science education, many of which

have mentioned the need for a philosophical shift within the field— from rote memorization to constructivism (Hurd, 1994). Constructivism is a pedagogical style in which a teacher initiates instruction by assessing students’ past experiences related to the subject and builds lessons based on students’ prior knowledge. Despite the fact that the work of child development experts, such as Piaget and Vygotsky, which provided the basis for this movement, has been published and available for decades, Tobin, Briscoe and Holman (1990) contended that many science educators have continued to teach according to the system in which “knowledge is piped from the full container of the teacher’s head to the empty vessels of the students’ heads” (p. 410).

According to Vygotsky (1962), “direct teaching of concepts is impossible and fruitless. . . [accomplishing] nothing but empty verbalism, a parrot-like repetition of words by the child, simulating knowledge of the corresponding concepts, but actually covering up a vacuum” (p. 83). Furthermore, Lorsch and Basolo (1997) reminded readers that “teachers cannot cause students to learn, knowledge is not a commodity that can be transferred from a teacher to students, and students cannot absorb knowledge” (p. 116). Nevertheless, the teaching and learning approach that has prevailed in science classrooms for years has invariably been dominated by practices based on such philosophies.

According to Piaget, the learner is not passively subject to all sorts of influences. Rather, he actively contributes to the construction of his own universes. This perspective supposes that people develop schemas (conceptual models) by either assimilating or accommodating new information, which can be explained as fitting information into existing schemas and altering existing schemas in order to accommodate new information,

respectively. In order for this assimilation and/or accommodation to be necessary, there must be a feeling of uncertainty or insecurity that Piaget referred to as disequilibrium (Atherton, 2004, p. 22; Boeree, 1999; Droz & Rahmy, 1976; Furth, 1981). This disequilibrium occurs when the environment presents a problem that the individual seeks to resolve that is outside of the individual's repertoire.

For example, an infant learns in his first few months of life how to grab his favorite toy (such as a rattle) and thrust it into his mouth. He has mastered that particular schema, so that when he is presented with a new object, for example Mommy's expensive bracelet, he easily transfers his "grab and thrust" schema to the new object, assimilating the new object into his existing schema, remaining in a state of equilibrium. However, when the same infant is presented with another, larger object (such as a beach ball), his existing "grab and thrust" schema will work poorly, creating a state of disequilibrium and forcing him to accommodate this old schema, perhaps changing it to "grab and drool," to fit the new object (Boeree, 1999). The equilibrium that occurs after assimilation and accommodation can be paralleled to Vygotsky's "internalization" of new information, which also requires a period of intellectual frustration in which the mind meets new ideas with opposition, until the focal points of the new ideas become clear and the knowledge is "internalized" (Kobayashi, 1994).

Marton and Tsui (2004) described the extremely important distinction between *discernment* and *being told* in the field of education in their book, *Classroom Discourse and the Space of Learning*. They explained that in order for the learner to truly understand a new concept, he must be given the opportunity to *discern* the information pertaining to that concept for himself. It is not sufficient for the learner to *be told* about the information.

Medical students, for example, may be advised to notice different features of their patients, such as lip color, skin moisture, the ease with which one breathes, etc. However, before they can follow this advice, they must experience these features for themselves, by seeing how they can vary. After all, noticing the color of a patient's lips would not be very meaningful if only one patient was provided for demonstration, or if all the patients' lips were the same color. The medical student must be provided with the experience of examining a number of patients in a variety of conditions in order to internalize the relationship of these features with their associated conditions.

The examples provided above emphasize the fact that the constructivist view of learning is based upon personal experiences and prior knowledge and that learning occurs naturally by doing rather than through rote learning and dogmatic instruction (Atherton, 2004). Using traditional teaching methods, such as lecturing and providing notes for students to copy, alone do not provide experiences nor tap into prior knowledge as is necessary for students to construct their own knowledge. Therefore, educators are faced with the challenge of discovering and implementing alternative teaching practices, in order for each student to achieve a personal understanding of new concepts.

### ***Social Constructivism***

Contemporary research in science education suggests that an effective strategy for implementing constructivism within daily pedagogy is to allow classroom discourse and/or social interaction among students. However, as Lemke (1990) describes below, traditional views on teaching and learning meet this theory with strong opposition.

Students learn a great deal from one another in the classroom. They mediate and translate for one another when the teacher's language is unfamiliar. They support and facilitate each other's learning in countless ways. Learning is not an essentially individual process in the classroom . . . Learning is essentially social. But the rule against side-talk is part of a general system of beliefs that ignores this. It presumes that each student learns as an isolated individual, even though part of a group.

If we know that classroom learning is an essentially social process, why are so many classroom rules formulated on the assumption that it is strictly an individual process? (pp. 78-79)

The origin of this controversy related to the learning process can also be traced back to the early philosophies of Piaget and Vygotsky. Piaget's work was primarily focused on the individual, whereas Vygotsky's work focused on the role of others in cognitive development (Tudge & Rogoff, 1989). Piaget did recognize that others could play an important role in cognitive development by creating cognitive conflict through disagreements about concepts, subsequently creating an opportunity for the individual to develop more complex cognitive constructions through the negotiation of concepts (Linn & Barbules, 1993). However, Piaget viewed social interaction as only one means of creating cognitive dissonance for an individual, and therefore did not deem it necessary for learning to occur. Vygotsky, on the other hand, according to Jones and Carter (1998) "viewed the child's social world as paramount to the learning process. . . [suggesting] that *all* higher mental functions originate as a direct result of interactions between and among individuals" (p. 263).

According to Vygotsky, conversational theories of learning fit best into the constructivist framework. The emphasis from the perspective of this framework is on the learner as an active "maker of meanings," in which the learner constructs meanings and understandings from social encounters. Vygotsky observed that when children were tested

on tasks on their own, they rarely did as well as when they were working in collaboration with other individuals (Atherton, 2004).

“The [emergence of an] increased popularity of groupwork as an instructional strategy paralleled the shift in educators’ focus from the individual (a Piagetian theoretical perspective) to the larger social context (a Vygotskian theoretical perspective)” (Jones & Carter, 1998, p. 262). Once the social nature of learning was recognized, described, and supported with evidence by contemporary researchers, educators realized the importance of mirroring what happens in the real world. After all, outside school, people are generally expected to turn to others for help in solving problems and are often rewarded for being successful at working in groups. In addition, educators began to recognize that students often achieve more in classes in which there is a positive social milieu than in one in which there is not (Lemke, 1990). As a result of these realizations, there has been a strong movement within recent years towards the inclusion of classroom discourse as an important educational strategy, as supported by published *Benchmarks for Literacy* and *National Science Education Standards* (American Association for the Advancement of Science, 1993; National Research Council, 1996).

### ***Knowledge Construction within Small Groups***

While classroom discourse is a great step forward in the movement toward constructivist-based teaching, there are some major difficulties presented when teaching through discourse in a large group setting of students. There are the obvious obstacles, such as making sure all students are listening and understanding the remarks of their peers and ensuring that the students stay on-topic during discourse. However, there is a deeper issue



concerning the students' perspective of the teacher as the authority on the subject being discussed. During authoritative discourse, such as a class discussion in which the teacher is asking most of the questions and rephrasing most of the answers, information can be memorized by students to be repeated in the future, on demand. However, until the information presented becomes detached from that authority, it is not likely to be internalized. It is more likely for students to actively struggle with new ideas, by rephrasing them and trying them out, when they are spoken by peers rather than by the teacher (Cazden, 2001). Vygotsky also argued that peers are often more effective than adults in assisting with the construction of meaning, as peers are more likely to be at similar developmental levels, or in the same zone of proximal development. This often allows students to assist one another by rewording an instructor's explanation so that it makes more sense, developmentally, to the student who is confused (Vygotsky, 1978).

Roth and Bowen (1995) examined the processes of interaction within an open-inquiry, small group learning environment during an ecological unit of study. Student conversations were documented and reviewed to gain a better understanding of how students negotiate answers to problems and conceptual understanding between and among themselves (without an authority-figure's participation involved in their small group interactions). The researchers developed an understanding of four particular aspects of the negotiations they observed during the analysis of transcripts and tapes:

- 1- Students worked through differences but had a common goal: to construct a convincing experiment, to find answers to their focus questions, and ultimately to receive a good grade on their assignment.
- 2- Issues emerged during negotiations that neither the participants nor the observers could have foreseen.
- 3- Student negotiations could not be understood from a winning-losing perspective, because students received no individual benefit for being “right.”
- 4- The students’ arguments were different from logical or scientific arguments that are often discussed in literature on rational discourse, but rather they negotiated through “natural,” spontaneous arguments when negotiating.

In essence, this study of “student-student interactions pervasively highlights the collaborative and interactionally accomplished sociocultural nature of learning” that can take place within small groups of students (Roth & Bowen, 1995, p. 121). As a result of publications such as this, which emphasize the ability of students to negotiate conceptual understandings among themselves, many educators have increased the amount of small group activities included in their daily instruction.

Research supports the notion that small group activities will improve the overall quality of instruction. Successful groups can promote enhanced reasoning skills, cognitive processing, perspective-taking and accommodation of others’ ideas, and acceptance and encouragement of others’ ideas. Many researchers in education, including Jones and Carter (1994), Peklaj and Vodopivec (1999) and Richmond and Striley (1996), have documented

positive correlations between working within small groups and students' understanding of concepts or achievement of some sort.

One of the greatest benefits of small group activities is the peer-teaching that naturally takes place as a result. Jones and Carter (1994) took a closer look at this phenomenon when they examined the social interactions within ability-grouped dyads of students constructing knowledge about levers and balance. The students observed within this study exhibited behavior that demonstrated a clear relationship between social interaction and conceptual growth. The verbal and nonverbal behaviors of 30 fifth-grade students, who were paired with other students based on achievement test scores, were examined in order to determine common characteristics of similarly grouped dyads. The low-low dyads were typically inattentive to instructions, unable to focus on the task, often competed for use of the laboratory materials, and were generally unable to construct meaning from activities. The high-high dyads tended to work cooperatively, stayed on task, and used effective verbalizations to validate concepts for one another during the activities. However, it was the high-low dyads that were of particular interest in this study.

Although the individual characteristics of the students within the high-low dyads were not different from those in the same-ability dyads, the types of interactions that took place within high-low groups differed significantly from the others. The high-achieving student often kept the low-achieving student focused and on-task by sharing equipment and through verbal encouragement. Furthermore, the high-ability students often verbalized their thinking processes, which seemed to enhance the low-ability students' understanding of the concepts related to the activities. In addition, the researchers who conducted this study

speculated that the high-ability students who were paired with low-ability peers actually benefited from verbalizing their conceptual understanding of levers, as it very possibly could have strengthened their own understanding of the concepts.

In another study, Peklaj and Vodopivec (1999) found learning in small groups to have positive effects on students' cognitive functioning. They used the CAMS model (O'Donnell & Dansereau, 1992) of student learning, which includes four levels of students' functioning: cognitive (C), affective (A), metacognitive (M) and social (S) as a theoretical framework for this study. In the experimental group of this study, which was comprised of 170 fifth grade students, work in small groups was introduced for one in four lessons. The control group, 203 fifth grade students, received the traditional way of teaching the same subjects; and, the data that they collected for assessment of growth within the four levels of functioning provided evidence that group work is positively correlated with greater gains in standardized achievement test scores than the students from the control group exhibited.

Richmond and Striley conducted a study which also examined the conceptual understanding of students working within small groups; however, they focused on the group as a whole, rather than individual students (1996). Within this study 24 students (16 boys and 8 girls) were placed into groups of 4 based on gender (2 or 3 boys and 1 or 2 girls per group) and GPA (arranged heterogeneously). These students were members of a pre-existing science course with an integrated curriculum in which real-life problems were investigated from a variety of scientific perspectives (biological, chemical, ecological and physical). The students were asked to design hypotheses and experiments, conduct the experiments, record results and draw conclusions about four basic concepts related to a simulated Cholera break-

out (1 diffusion, 2 enzyme digestion, 3- nutrient loss, and 4- oral rehydration therapy). In each case the students were asked to collaboratively construct an argument that linked the following pieces of information:

- the problem they were given to solve
- the hypothesis they were testing
- experimental techniques they developed
- the data they collected
- conclusions based on their interpretation of these data

In the first experiment, students were unable to construct sophisticated arguments of this sort. It was also noted that there were three points of difficulty for most groups during the beginning stages of the course: 1- differentiating between a problem and a hypothesis, 2- understanding the importance of control groups in the experimental design, and 3- distinguishing between observations/results and conclusions. However, by the end of the last experiment, the researchers noted that within most groups the levels of engagement rose throughout the course and “students’ arguments became both more sophisticated and better situated in an intellectual context” (Richmond & Striley, 1996, p. 855). While the findings of this study, as well as those which were previously discussed, largely support the use of small group interactions as an effective teaching strategy, it is imperative that teachers understand that the dynamics within individual groups can create varying learning outcomes for each group member.

### ***Small Group Interactions: Group Dynamics***

Richmond and Striley (1996) included a section within their article on collaborative problem solving in which they described the emergence of social roles within each 4-person group in their study. They identified these roles as leader, helper, and non-contributor (active or passive). Leaders were usually high-achievers who generated the action plan, coordinated assignments, and often acted as the liaison between the group members and the instructor.

They were further categorized as one of the following characteristic styles:

- **Inclusive leaders** – often asked for and encouraged group members' participation
- **Persuasive leaders** – usually presented their ideas and tried to convert other group members that challenged these ideas
- **Alienating leaders** – simply declared their views and disregarded the ideas of any others, removing themselves from any discussion within the group

Helpers basically acted in a cooperative fashion with the leader to formulate group plans and carry them out. Active non-contributors were often engaged in off-task behavior, sometimes ridiculing the other group members, and generally simply wanted to just “get by.” Passive non-contributors rarely engaged in any interaction with any other group members and usually copied their work from others once the assignment was completed.

The researchers noticed some key differences among the levels of discourse that took place within each group which seemed to be strongly correlated with the group leader's style. In those groups in which there was an inclusive leader, engagement appeared to be

substantial, as indicated by the nature and extent of the discussion and the number of individuals who participated in each discussion. In those groups in which there was a persuasive leader, engagement was substantial for the leader, but rarely for anyone else. In fact, most of the engagement by other group members in these groups arose from procedural issues rather than contextual matters. In groups in which there was an alienating leader, the majority of time was spent off-task, and there was a low level of engagement throughout the course of each task.

Kathleen Hogan also conducted a study in which she examined the sociocognitive roles that developed during small group discourse in a science class dealing with the nature of matter (1999). She collected data from 24 eighth-grade students in eight mixed-ability groups within four classrooms throughout a 12-week period. Samples of the students' discourse were analyzed using ethnographic interaction analysis procedures (Erickson, 1992; Jordan & Henderson, 1995) that allowed her to identify eight prominent sociocognitive roles and the general characteristics associated with each one. Students who assumed four of these roles generally promoted reasoning processes within their groups. Hogan's labels for these four roles were as follows:

- **promoter of reflection** - identified work which needed reevaluation and improvement
- **contributor of content** - generally had prior knowledge of the subject being studied and shared it with group members when it was pivotal to the group's progress

- **creative model builder** – often developed highly original ideas based on imaginative use of prior lab experiences
- **mediator of group interactions and ideas** – often acted as the peacemaker during any conflicts between group members and offered verbal support to students who were ridiculed or ignored

Students who assumed the other four of these roles generally inhibited reasoning processes within their groups. Hogan's labels for these four roles were as follows:

- **promoter of acrimony** – oftentimes hostile and repeatedly attacked others' ideas
- **promoter of distraction** – constantly made light of group tasks through silly or off-task behavior
- **promoter of simple task completion** – often recorded non-discussed or partly discussed ideas that many times missed the point of the assignment
- **reticent participant** – made very few verbal contributions

While Hogan did find that students sometimes shifted slightly from one role to another, for the most part, the roles students assumed were assumed very early in the study and remained relatively stable throughout the 12-week period. Furthermore, she found that there was little correlation between the intellectual engagement of groups and the group members' prior achievement levels. "The highest achievers were not necessarily the best collaborative thinkers or the most reflective, curious or participatory group members,"



highlighting the complexities involved in the analysis of learning in sociocognitive contexts (Hogan, 1999, p. 875).

### **Helping Behavior**

In 1982, Noreen Webb conducted a meta-analysis which was aimed at identifying the factors that best predict the types of interactions which will occur within small groups (Webb, 1982). This review focused on three key aspects of small group learning: 1- the relationship between interaction and achievement, 2- cognitive processes and social-emotional mechanisms that link interaction and achievement, and 3- individual, group and reward structure characteristics that predict interaction within small groups. Before beginning the study, Webb developed a model which summarizes the relationship between hypothesized characteristics which affect interactions within small groups and the mechanisms that bridge the gap between interaction and achievement. Therefore, the model consisted of three key components: input characteristics, interaction, and achievement. Examples of input characteristics included individual ability, ability and racial composition of the group, and group and individual reward structure. Components of interaction which were factored in included group helping, giving help, receiving help, off-task behavior and passive behavior.

This review of literature allowed Webb to draw several conclusions dealing with the relationship between interaction and achievement. The most common interaction variable examined in studies aimed at relating interaction and achievement is helping behavior. The majority of findings about this relationship indicate that there is a positive relationship between the two. However, there are some studies that indicate contradictory findings, for

example, Slavin, et al (1985) found that achievement corresponded not with helping behavior, but rather to on-task behavior. In this study, students instructed to work with others helped each other more, but they also remained on task less and showed lower achievement than those who were instructed to work individually. Webb addressed this discrepancy within her meta-analysis by suggesting an alternate interpretation to Slavin's, which questions the link between cooperation and performance: perhaps, the positive effects of helping behavior on achievement were simply overshadowed by the negative effects of passive or off-task behavior within Slavin's study.

To further support this theory, Webb described three studies which reported a positive relationship between giving help and achievement. Peterson and Janicki (1979) and Peterson, Janicki, and Swing (1981) reported correlations between .24 and .29 ( $p < .05$ ). In the third study discussed, a significant relationship between giving explanations and achievement (holding ability level constant) demonstrated that students who *gave* explanations of how to complete tasks to their peers showed higher achievement levels than students who chose not to actively engage in any interaction (Webb, 1980a). In Webb's study, explaining how to perform algebraic manipulations was positively correlated with achievement (partial  $r$  controlling for ability = .39,  $p < .05$ ). This significant partial correlation, controlling for ability, helps clarify the previously questioned direction of the relationship between giving help and achievement. Prior to these findings, many educators would argue that interaction (or giving help) is *a function* of ability level (or achievement); however, these findings suggest that interaction actually *influences* achievement.

Webb further examined this relationship between giving help and achievement by examining studies which distinguished between specific types of help given and received within small group interactions. In a series of studies she conducted herself (Webb, 1980a, 1980b, 1980c, 1980d), she revealed that the effectiveness of help received by students within small groups depends on 1) the nature of the help received and 2) the student behavior that elicited the help (Webb, 1980c). According to Webb's findings, when students who asked for help received explanations about a particular task, they learned how to complete it on their own. However, when they received either no response from the group or simply a restated solution, with no explanation, they did not learn to complete the task on their own. The results indicated that there was a positive relationship between receiving help and achievement (partial  $r$  controlling for ability = .21,  $p < .05$ ), whereas there was a negative relationship between receiving restated solutions without explanations and achievement (partial  $r$  controlling for ability = -.44,  $p < .01$ ) (Webb, 1980b).

Recognizing the importance of peer assistance within small groups, Webb and Farivar (1994) designed and implemented a semester-long program focused on the development of students' explaining skills. Analyses of student interactions and learning in the program showed that a simple demonstration of how to solve a problem is not always sufficient for learning, especially for students who need help. These results are aligned with the other research which shows an inconsistent relationship between receiving help and learning outcomes (Webb, 1991; Webb, 1989).

In order to understand this inconsistent relationship, Webb and Farivar (1994) conducted further analyses based on Vedder's (1985) hypothesis that peer assistance is most

effective when the student who receives help has the opportunity to use the explanation to solve a problem or carry out a task for himself/herself. Carrying out this further activity may benefit the learner in a number of ways. Chi (2000) hypothesized that it allows students to generate self-explanations which help them to internalize principles and repair imperfect mental models. Furthermore, Webb and Farivar (1994) found that making mistakes while attempting to solve problems after receiving help helped to make others aware of the student's misconceptions; whereas, without such information, group members rely primarily on students' own admissions of understanding (e.g. "I got it"), which are often inaccurate (Shavelson, Webb, Stasz, & McArthur, 1988).

To test Vedder's hypotheses, Webb, Trooper, and Fall (1995) analyzed peer assistance and follow-up activity. These analyses confirmed Vedder's prediction that follow-up practice (after receiving an explanation) most strongly predicts achievement. However, Webb and her colleagues (1995) also reiterated the importance of receiving help, as without help, there would be no follow-up behavior.

The results of another study added to these findings, indicating that receiving help is effective only when given in response to a student request. In this study, there was a near-zero correlation between frequency of help given and achievement (when there was no differentiation between solicited and unsolicited help), while there was a significant positive relationship between receiving help in response to a question and achievement ( $r = .19$ ,  $p < .05$ ) (Webb, 1980a). Results of this series of studies further indicated that not receiving help in response to a question, seems to be most detrimental, resulting in a strong negative

relationship with achievement in two instances—  $r = -.53$ ,  $p < .001$  (Webb, 1980a), and  $r = -.55$ ,  $p < .001$ , (Webb, 1980b).

In addition to Webb's work on giving and receiving help within small groups, Louise Cherry Wilkinson conducted a pair of studies, using a group of second and third grade students, in which she investigated the characteristics of requests students made within small groups. She examined the relationship between these characteristics and the likelihood that such a request would receive an appropriate response. Using log-linear analysis methods, she found that requests were more likely to receive appropriate responses if they 1) were for information rather than for action, 2) were of a direct form, 3) were revised (after the initial attempt, if no response was granted) (Wilkinson & Calculator, 1982; Wilkinson & Spinelli, 1983).

### **Coding Schemes**

Whatever the cause, research does indicate that there is a wide variety in the kinds of interactions and levels of discourse demonstrated by small groups in experimental settings. In a follow-up study to the Hogan's (1999a) study which was previously discussed, Hogan, Nastasi and Pressley (2000) analyzed the interactions that took place within the same transcripts they had previously examined. In this study, the researchers used a series of analysis steps including coding modes of discourse, types of statements, creating discourse maps, discerning interaction patterns, creating conceptual proposition maps, judging reasoning complexity and relating group patterns of interaction to the level of reasoning complexity they achieved. Interaction sequences were defined as units of dialogue that begin when a speaker makes a conceptual or metacognitive statement or poses a question or query

and end when a speaker steps back from the flow of the interaction by posing a new question or query or by refocusing the discussion. Level of focus is key in distinguishing between sequences. An interaction sequence, by definition, must include interactions by at least 2 individuals. The researchers coded each of the sequences as one of the following types:

- **Consensual** – These sequences consisted of one speaker contributing all the group's substantive statements and other speakers responding to the initiating speaker by a) simply agreeing with the statement, b) passively acknowledging the statement, c) actively accepting what was said, thereby encouraging the initiating speaker to continue, or d) repeating the preceding statement verbatim.
- **Responsive** – These sequences consisted of both questions and responses of at least two speakers. Although the roles of the speakers differed, both were equally responsible for contributing to the substance of the discussion.
- **Elaborative** – In these sequences, all of the speakers contributed substantive statements to the discussion (as in responsive sequences). However, these sequences were generally longer than responsive sequences as they consisted of co-constructive additions (links to prior ideas), corrections, or disagreements with prior statements.
- **Nonconceptual** – These sequences consisted of off-task talk which was not prolonged enough to consider an entire off-task discussion (usually 2-4 speaking turns).

After interaction sequences had been coded, the total number of consensual, responsive, and elaborative sequences for each group was calculated along with percentages of each type of sequence. These percentages were then compared to the level of reasoning (low, medium or high) that each of the groups achieved. There was little variation between groups in percentages of consensual sequences (low reasoning groups = 20%, medium and high reasoning groups 21% each). However, the percentage of responsive interaction sequences decreased as reasoning level of the group increased (low reasoning = 47%, medium reasoning = 29%, high reasoning = 15%); and, the percentage of elaborative responses increased as reasoning level of the group increased (low reasoning = 33%, medium reasoning = 50%, high reasoning = 64%). These results indicate that the most productive pattern of interaction was elaborative, which makes sense, as it would seem that when students build on one another's contributions (as elaborative sequences were defined) the sophistication of the reasoning would increase.

In another study of interactions, Wegerif, Mercer and Dawes (1999) examined the effects of "exploratory talk" within small groups on group and individual, non-verbal reasoning test scores. Within this article, Mercer typified three kinds of talk which may occur within small groups. These kinds of talk include:

- **disputational talk** – characterized by disagreement and individual decision-making
- **cumulative talk** – characterized by repetitions, confirmations, and elaborations

- **exploratory talk** – characterized by challenges and counter-challenges in which reasoning is more visible in the talk

Within his article, Mercer identified “exploratory talk” as the kind of talk within small groups which is most likely to produce group gains in conceptual understanding.

During the study, 64 eight- and nine-year old children (in 4 classes) were taught “exploratory talk” as described by Mercer himself (1996) through the use of an intervention program developed explicitly for teaching the rules of such discourse (Dawes, 1997). These ground rules for discourse within small groups included the following:

- 1- all relevant information is shared
- 2- the group seeks to reach agreement
- 3- the group takes responsibility for decisions
- 4- reasons are expected
- 5- challenges are acceptable
- 6- alternatives are discussed before a decision is taken
- 7- all in the group are encouraged to speak by other group members

Before and after this intervention, in which the ground rules were taught, the children within the target group of 64, as well as 64 other children in a control group comprised of 3 classes, were divided into mixed-ability groups of 3 and asked to solve the Raven’s Standard Progressive Matrices (SPM) within their small groups. They were also given Raven’s



Coloured Progressive Matrices (CPM), as individuals before and after the program (Raven, Court, & Raven, 1995). The Raven's Matrices are standard reasoning tests that are often used in psychological evaluations of children.

The researchers in this study selected the target group that had achieved the greatest pre-/post-intervention change in group score on the Raven's SPM test to be the focus group of the study. The scores on the SPM were converted to the same scale as the CPM for comparison of group scores with the individual scores. In the pre-intervention tests, the group score was lower than the highest individual score; but, in the post-intervention tests, the group score was higher than the highest individual score in the group. This finding suggests that the significant improvement in group score following the intervention can not simply be accounted for by a significant improvement in the level of reasoning of one individual, but rather this group improvement is a product of a change in the way the group reasoned together.

The results of Mercer's study on exploratory talk (as well as those of the Hogan, et al 2000 study) suggested a key piece of understanding small group discourse and its benefits. It is not simply the arrangement of classes into small groups that improves the learning process for children and increases conceptual understanding. Rather, there are specific kinds of "talk" or sequences of interactions that can occur within small groups that can create such benefits; and, it is essential for educators to be able to identify such interactions and see that a greater percentage of such interactions occur within *all* small groups – not simply a few exceptional ones. In order to do this, however, it is essential that the kinds of "talk" within groups which seem to promote conceptual understanding be broken down and examined

further. What is it about the sequences of interactions within “exploratory talk” that is different than those within other kinds of talk; and, does it matter who says what? While many coding schemes and methods of analysis have been used in the past for examining small group interactions, there is one tool – sequential analysis, previously used primarily in the behavioral sciences, which holds great promise for corroborating and extending all previously published findings in this area of research.

### **Sequential Analysis**

Sequential analysis is an innovative tool which allows a researcher studying a given sequence of events to determine the likelihood that there is a relationship between any particular dyad of events. John Gottman conducted a study (1979), which demonstrated the power of this tool. The purpose of the study was to examine differences between the ways satisfied and dissatisfied couples try to resolve important current issues about which they disagree. During the initial analysis of transcripts of couples’ conversations, which was not a sequential analysis, the discovery was that there were no significant differences in the relative frequencies with which satisfied and dissatisfied couples used metacommunication (communication about communication). However, a sequential analysis revealed dramatic differences between the way metacommunication was used by the two groups. For satisfied couples, metacommunication functioned as a repair mechanism, as it was usually followed by an agreement by the partner. For example,

Partner 1: You’re interrupting me.

Partner 2: Sorry, what were you saying?

However, for dissatisfied couples, metacommunication was usually followed by a counter-metacommunication, rather than an agreement, which typically led to an indefinite spiral of negatively presented metacommunication that was difficult to exit once entered. For example:

Partner 1: You're interrupting me.

Partner 2: I wouldn't have to, if I could get a word in edgewise.

Partner 1: Oh, now I talk too much, is that it?

Partner 2: You could say that you do rattle on and on about nothing. . .

and so on, and so on. . .

While the fact that the sequential analysis revealed differences in the couples' communication that the initial analysis did not should be reason enough to employ it, it is important to note also that the sequential analysis revealed patterns of interaction that were never even considered in the original study on metacommunication. The implication of this second point is that sequential analysis is good for *generating* theory as well as for *testing* theory (Gottman & Roy, 1990).

Although the common use of sequential analysis is a relatively new phenomenon, its history dates back for quite some time. It was in a seminal paper by George Miller in 1956 that sequential analysis processes were first introduced, in the most basic form, into the behavioral sciences. In this paper, Miller presented data related to individuals' ability to recall sequences of information bits. He also introduced basic methods of recoding binary sequences of numbers in order to increase the span of immediate memory recall of such numbers; and, he noted, more importantly, that "recoding [in general] is an extremely

powerful weapon for increasing the amount of information that we can deal with” (p. 94). In addition, he argued that these probabilistic methods would enhance research in a number of arenas, such as social psychology, linguistics, anthropology, etc; and, he summarized by suggesting that he anticipated “that we [would] find a very orderly set of relations describing what [then seemed] an uncharted wilderness of individual differences” (p. 96).

Miller’s paper was written in the postwar context of the work of Norbert Wiener and Claude Shannon, who were already concerned with change and dependent data. Before World War II, Wiener had been involved in research on neurons, in which he used time-series models to predict behavior of neural networks; and, during the war, he began working on a gun that could track and anticipate its target, which required the employment of a form of “forecasting” based on assumptions about the past behavior of the target. Shannon was also involved in a war-related project, in which he was assigned the task of decoding secret messages and cracking codes; and, what he discovered about the importance of redundancy within these secret messages is paramount in the understanding of sequential analysis, as “the anatomy of the redundancy in any code is the central subject of sequential analysis” (Gottman & Roy, 1990, p. 10).

As previously stated, sequential analysis has, in the past, been used primarily in the behavioral sciences. In addition, its primary use within this field has been to examine sequences of verbal interactions between individuals. However, it is worth noting that there are also many *nonverbal* interactions which take place within small groups, both simultaneously with the verbiage and alone, which influence small group dynamics as

well. In fact, many researchers believe that it is impossible to fully comprehend the meaning of what individuals are saying simply by analyzing their speech, as spoken language and body language are dependent upon each other (Birdwhistell, 1971). Therefore, it is essential to observe and examine *both* verbal *and* nonverbal interactions when examining small groups, as each of these contribute to the magnitude of success that an individual group experiences.

### **Nonverbal Communication**

Nonverbal communication (more commonly referred to as “body language”) has several characteristics in common with verbal language. While spoken language consists of words, sentences, and punctuation, body language consists of gestures (“words”), logical clusters of gestures (“sentences”), and pauses or postures (“punctuation”). Similar to the vocabulary of spoken language, each gesture may have several meanings, which only make sense when clustered together (like the words of a sentence). Most researchers agree that verbal communication is used to relay information from one person to another, and that nonverbal communication generally serves the purpose of negotiating interpersonal attitudes. While the mouth and vocal cords are used for speech, the entire body is used for conversation.

Despite the similarities between spoken and unspoken language, there are certain distinctions between words and body movements (Hamlin, 1988).

- Words must only be translated mentally into meaning, whereas nonverbal language is absorbed instinctively. The meaning of body language is *felt* rather than *thought* about.
- Words can be controlled through practice and training, whereas body language is involuntary and spontaneous. Therefore, the messages conveyed by body language are generally more genuine.
- Words express concrete ideas, whereas body language needs interpretation.
- While words exist in abundance, making it convenient to describe and explain things with their use, it is impossible to fully understand the depth of feelings through the use of words alone. However, body language expresses feelings more directly, evoking an immediate response.
- Words separate individuals by nationality (where different languages are used), education and social status, whereas body language can serve to unite individuals, as it is universally understood, for the most part.

Verbal and nonverbal languages together create a dual dialogue. When congruent and consistent, they strengthen meaning in communication. However, when they are contradictory, greater attention is given to the nonverbal (Hartley, 1993). This phenomenon can be illustrated best through an example. Imagine a busy boss shuffling and sorting papers while simultaneously checking voicemail and e-mail messages when a troubled subordinate enters the office and blurts out a problem. The boss continues what he is doing without so much as a glance toward the subordinate, who suddenly stops speaking, as if to see if the

boss would even notice. The boss then mutters an uninterested, “Continue . . . I’m listening,” without ever pausing his work or looking at his employee. In this situation, the subordinate would almost assuredly feel as though his boss was disinterested in his problem, as is indicated by the nonverbal cues being sent. As is illustrated by this example, nonverbal communication can be very powerful, and therefore warrants a closer examination within small groups; but, before beginning such a study, the range of behaviors considered to fall into the category of body language should be defined and behaviors of interest described.

Nonverbal communication may be transmitted through a wide array of varying behaviors. Lewis (1998) distinguished between four main types of body movements used for the purposes of nonverbal communication. They are as follows:

- **emblems** – acts that have direct verbal translation and may substitute for words (for example, thumbs up or down, beckoning with a crooked index finger, or even rude gestures, such as an extended middle finger). These are sometimes culture specific and rarely used in normal conversation. They are most often used in situations during which there is a need for a message to be communicated more quickly than can be done through speech or when a message needs to be sent silently.
- **Illustrators** – movements, usually of the hands, which are used to demonstrate what is being verbalized (for example, pointing to oneself when making a personal reference or making a shape with the hands which matches that of

something being discussed). These movements are more closely related to speech than emblems, as they are typically used to clarify something that is being said.

- **Regulators** – movements that serve as subtle indicators which serve to control the flow of conversation between individuals (for example, head nods, eye contact, and shifts in body position). Because of their subtlety, they can often lead to miscommunication and inappropriate responses.
- **Self-touching** – body-focused movements (for example, touching the fingers to the nose or the lips) which are usually done so unconsciously and usually indicate negative attitudes such as shame or fear.

Lewis continued by explaining that these kinds of body movements form a language of their own; however, in isolation, this language is very difficult, and sometimes impossible, to comprehend. He explained that most body movements take on significance only when considered along with other elements of the interaction process. He further explained that, “the medium of body language is, of course, the body” (Lewis, 1998, p. 31) and that body language can include reflexive or non-reflexive movement of any part or all of the body, which is used in communicating a message to others. He includes the following range of actions as key aspects of nonverbal communication:

- facial expressions
- gestures (hand and arm movements)
- body movements (head nods, shifts in posture and orientation of body)



- visual orientation (eye contact, in particular)
- spatial behavior (proximity, positions)
- appearance
- non-verbal vocalizations

In addition to the types of body language listed, some researchers also include the “fringe areas” that fall into the visual as research foci. For the purposes of this study, the researchers have defined the access to materials needed for group assignments (or lack thereof) as part of this “fringe area,” and labeled it as a point of interest, along with body movement and gesticulation. Therefore, a closer examination of the literature related to body movements, gestures, and the use of tools will be conducted.

## **Body Movements**

Body movements encompass a variety of behaviors, including shifts in posture or body orientation, as well as any movement of any body part, excluding the hands and arms (these movements are more specifically classified as gestures). Within small group interactions in a classroom setting, in which students are seated at desks, the most visible body movements are head movements, shifts in posture, and changes in body orientation.

Many head movements fall into clear categories with universally accepted meanings, the two most widely used being the up-and-down nod (“yes”) and the side-to-side shake (“no”). Both of these are presumed to be innate movements, present in infants (Lewis, 1998). Other head movements demonstrate a number of different feelings. For example, small head nods indicate continuing attention, while larger nods are indicative of agreement.

Charles Darwin noticed in his work that all animals, including man, tend to tilt their heads to the side slightly upon hearing something of interest. Similarly, when members of a group or audience are listening to a speaker, a slight tilt of the head indicates interest in the subject being discussed. On the contrary, a straight forward orientation of the head typically indicated that a listener has taken a neutral or disinterested position in the topic (or he is indicating “information overload”). Furthermore, in one-to-one encounters, head tilts (especially when accompanied by a hand-to-chin gesture) indicate a positive response, while a downward tilt indicates that the listener has taken a negative, or possibly even judgmental, stance (Lewis, 1998).

In addition to head movements, shifts in posture, such as leans forward or backward, are easily detected and readily interpreted in most cases. A number of scholars have researched forward leans, and many have reported that such posture communicates stronger rapport with other participants in a conversation than upright postures or backward leans (Burgoon, Buller, Hale, & DeTruck, 1984; Trout & Rosenfeld, 1980). In one particular study in which participants were asked to increase involvement, the one behavior which increased more than any other was the incidence of forward leans (Coker & Burgoon, 1987). However, these studies each indicate that people involved in any type of personal interaction typically feel more warmth and friendship for people who exhibit this posture during discourse.

Body orientation is one additional method of communicating nonverbally through movement of the body. The angle at which an individual is directed towards another in a conversation often sends messages. A side-to-side or back-to-back positioning while interacting tends to evoke interpersonally cold, uninvolved and unavailable emotions; in fact,

when an individual feels uncomfortable in an encounter, he or she will often compensate by shifting his or her body orientation to one that is less direct (Patterson, 1973, 1977).

However, a more direct body orientation increases involvement and positive emotions (Coker and Burgoon, 1987).

## **Gestures**

Gestures are loosely defined as movements of the hands and arms that are visible when people talk. They are “spontaneous creations of individual speakers, unique and personal . . . they are free and reveal the idiosyncratic imagery of thought . . . yet, at the same time . . . they are tightly intertwined with spoken language in time, meaning, and function” (McNeill, 1992, p. 1). According to McNeill, there are five major categories of gesture types: iconics, metaphorics, beats, cohesives and deitics. An explanation of each of these types follows:

- **Iconics** are pictorial in nature, in that they bear a close resemblance to the semantic content of speech with which they are paired. For example, a man outlining the shape of a mountain peak as he utters the words “tall mountaintop” while telling a story.
- **Metaphorics** are similar to iconics, in that they are pictorial. However, they represent an abstract idea, instead of a concrete object. For example, while stating “it was a Broadway Play,” the speaker raises his hands as if offering the listener an “object” of some sort. It is as though the speaker is presenting “the idea of a genre . . . as a bounded container supported by the hands” (p. 14).

- **Beats** look like an individual is beating musical time with the hand. This is simply when a speaker moves his/her hand along with the “rhythmical pulsation of speech” (p. 15).
- **Cohesives** serve to tie together similar themes, particularly when they are manifested at different points in time throughout the discourse. These gestures are repeated movements that occur at different times, signifying the thematic similarity.
- **Dietics** are the pointing gestures with which everyone is familiar. However, this pointing not only serves the obvious function of indicating concrete objects and events, but it also takes place when there is “nothing objectively present to point at” (p. 18). For example, as an individual asks someone “where did you come from before,” he/she may point to an arbitrary space.

The relationship between gestures, in particular iconics, and speech during conceptual development has been the focus of several studies. Most of this research assumes that speakers are familiar with the topic which they are discussing, in which case, speech and gesture are consistent. Consequently, such studies have claimed that gestures and speech provide redundancy (Crowder, 1996; Crowder & Newman, 1993). However, in the case in which gesture and speech are inconsistent, the discrepancies have revealed some extremely interesting information about conceptual growth. Susan Goldin-Meadow has been involved in several studies which examine such discrepancies between gesture and speech that are noted during students’ transitional states in understanding; and, she has found that gestures

can often depict new understanding before linguistic competencies have developed to allow a student to verbally express the understanding (Goldin-Meadow, Alibali, & Church, 1993; Goldin-Meadow, Wein, & Chang, 1992). Roth and Lawless (2002) further validated these findings in a study which revealed similar results, in which they claim that “gestural expressions appear to precede the evolution of new verbal modes of expression” (p. 289). In this manner, the use of gestures not only benefits the listener (as a tool for communication), but also the speaker (as a tool for thinking) (Goldin-Meadow, 1999).

There is less research information available on gestures which serve a social purpose, for instance, a “beckoning” hand movement which accompanies a request for someone’s thoughts about a particular subject or a palm-forward hand “in the face” of a speaker to signal him to stop talking. However, social gesturing warrants a close examination, as “in social interaction the gestures are among the active participants – they play a part in the interaction and help to shape it” (McNeill, 2000, p. 11).

Gestures of the social nature are extremely important in developing relationships, as they often reveal an individual’s true feelings, even when the words that individual speaks do not. Practically all hand movements have some sort of meaning (either explicit or implicit), as what is made manifest by the arms, hands, and fingers is usually representative of the thoughts going on in his mind. The following is a list of relatively common hand movements and the generally accepted meaning of each gesture (Lewis, 1998):

- **limp hands** – boredom or fatigue
- **flat hands** (palm up) – “why?”/ “I don’t know”

- **relaxed hands** – confidence, acceptance, well-being
- **restless hands** – nervousness
- **wringing hands** – discomfort, tension
- **“steeppling”** (joining fingertips and forming what might be described as a “church steeple”) – confidence, superiority (studies have shown that the more important the steeper considers himself, the higher he will hold the hands while steeppling)
- **pinching** (the fleshy part of the hand) – need for reassurance
- **palms up** – honesty, loyalty, submission
- **palms down** – authority
- **rubbing palms together** – positive expectation
- **mouth covering with open hands** – doubt
- **mouth covering** (folding hands and forming a pyramid with elbows on the table)  
- disagreement

Although the corresponding meanings for these gestures are generally accepted by most researchers in the field of nonverbal communication, Lewis also offered some cautions related to gesture interpretation (Lewis, 1998). He explained that it is imperative for gesture researchers to avoid jumping to conclusions immediately upon registering a gesture. He explained that accurate interpretation involves consideration of the context, the cluster of gestures around each individual expression, the cultural background of the person using the gesture, any peculiarities and the physical state of the individual. He also reminds researchers of the following:

- Gestures have no precise interpretation.
- Body movements are “micro-momentary,” so one has to be alert in order not to miss an important expression.
- Gestures come in clusters, therefore it is important to recognize relationships between these and draw meaning from the cluster.
- Researchers must pay attention to any inconsistencies between separate gestures, as well as between speech and gestures.
- Researchers need to check gesture clusters for discrepancies which could indicate an individual is faking an emotion

## **Tool Use and Distribution**

In addition to movements of the hand and body, an individual’s manipulation of his/her surroundings often evokes responses in others present. This is especially true in educational small group settings, in which the surroundings of focus are the tools needed for group activities.

The use of tools in hands-on activities has long been supported as an effective pedagogical method, no matter what the age of the learner. For instance, Chang (2003) described a Taiwanese kindergarten class in an “Exploratory Learning School” in which children experience frequent periods of free playtime throughout the day. During these segments, they are allowed to choose where and what to play, as well as what to play *with*. They are provided a rich supply of tools— toys (blocks, sand, buckets, balls, etc) with which

to play and are allowed to explore and construct their own knowledge, with the help of their peers. In this setting, Chang linked constructive play to social interactions because children often compared their constructed products. For instance, boys liked to compare their guns that they constructed with the play blocks.

The National Science Education Standards (National Research Council, 1996) describe a learning environment as effective only when the appropriate science tools are available for students to use during conceptual development. The access to tools within small groups has been linked to both the number and kinds of verbal interactions an individual expresses within such settings (Carter et al., 1999; Jones et al., 2000). Carter and her colleagues (1999) found that, despite the fact that instructors often stress the need for all students working in groups to have a turn at using equipment, the amount of time which individual students actually have access to such materials varies greatly. In addition, they found the amount of time a student spends manipulating equipment to be positively correlated (correlation = .78,  $p < .05$ ) with the number of verbal interactions a student expresses. Jones and her colleagues (2000) also found that competition over the use of tools often leads to more individual-centered language use (“I,” “me,” “my,” “mine”) than dyad-centered language use (“we,” “let’s,” “us,” “ours”). These studies are indicative of the strong relationship between verbal and nonverbal interactions within small group settings.

Also of interest in the research on tool use is the persistent existence of inequalities in access to tools. For instance, Carter (1999) found that boys are much more likely to dominate the use of tools in mixed gender groups, especially in the initial stages of an investigation; and, Bianchini (1997) found that higher status students (as defined by



perceived academic ability and popularity) almost always have greater access to tools in small groups.

According to the National Science Education Standards (National Research Council, 1996), the use of hands-on activities alone does not promote intellectual development. Rather, tools must be used appropriately in the knowledge construction process, or relevant learning will not take place; however, tool usage is inherently culturally and contextually determined (Jones & Carter 1998). In other words, a student's ability to use tools appropriately within the classroom setting is largely determined by his/her past experiences, both within and outside of the classroom. According to Lockman (2000), human children begin to employ the tools of their culture in daily activities by their second year, if not before, but "mature tool use requires the ability to engage in a type of representational means-end analysis, involving the mental substitution of one means for another" (p. 138).

Based on prior experiences and abilities to transfer tool use between contexts, "tool experts," who determine how and when tools are used, often emerge within student groups. Carter, Westbrook & Thompkins (1999) provide a particularly interesting example of this phenomenon which was observed in the context of a group of ninth-grade students working through a circuit unit. The group was composed of two males and females of similar abilities and motivation. The males largely dominated the use of equipment within the group, because they were able to relate activities to everyday experiences, such as hooking up a car battery or working a circuit breaker at home. However, on one particular day of interest, the assignment was to solve an application question related to the arrangement of batteries in a golf cart. The males within the group openly declared their lack of knowledge about golf

carts, while one of the females stated that her brother owned a golf cart. That particular female then proceeded to take the tools from the resisting males, and the females directed the activity for that particular day. Within groups, such as this one, in which a student (or a group or students) has more experience than another with the use of a tool, learning varies according to how well the students work together within the group.

### ***Theoretical Perspectives on Small Group Research***

Before undertaking a research study of any sort, it is imperative that the researcher considers a theoretical framework. There are several theoretical perspectives from which to choose as a framework when beginning a study examining small groups. While most past research on small groups has been subject specific, a group of researchers recently described a set of interdisciplinary perspectives on small groups which may serve as a framework for research of this kind in any field (Poole & Hollingshead, 2005). These perspectives include the following (Poole & Hollingshead, 2005; Poole, Hollingshead, McGrath, Moreland, & Rohrbaugh, 2004):

- ***Psychodynamic:*** examines groups in terms of the deep psychological dynamics which underlie surface behavior.
- ***Functional:*** examines groups in terms of the processes that function to influence group effectiveness.
- ***Temporal:*** examines groups in terms of how they develop and change over time.
- ***Conflict-power-status:*** examines groups in terms of the dynamics associated with social relationships and the inequalities among group members.

- ***Symbolic interpretive:*** focuses on the social construction of groups.
- ***Social identity:*** examines groups based on the relationship between the social groups to which individual group members belong, which has proved useful for understanding within-group dynamics.
- ***Social evolutionary:*** examines groups in terms of evolutionary theory, in which theorists extend this biological theory into the realms of group behavior, believing that “people have inherent tendencies toward group behavior that have evolved because they increase the likelihood of survival and reproduction (p. 10).
- ***Social network:*** examines groups as interlinked structures embedded within larger social networks.
- ***Feminist:*** examines groups with a focus on the enactment of power and privilege through interactions that favor one gender over another.

### **Conflict, Power, Status Perspective**

A study of this nature, in which sequences and types of interactions paired with who was responsible for the interactions and their influence on overall group dynamics are examined, requires us to employ the conflict-power-status perspective. This perspective is grounded in the theory that managing conflict is fundamental to the existence of society. However, there has been considerable debate in social science research over the effects of disagreement within groups. Is conflict beneficial or not? Poole and Hollingshead (2005) described three distinct forms of conflict and the group dynamics typically associated with each.

- 1- ***Interpersonal conflict*** includes personality clashes, animosity, and annoyance between individuals. This type of conflict tends to be detrimental to group performance, as group members may easily become distracted from the task, fail to work cooperatively, and, ultimately, lead to the production of subpar work.
- 2- ***Cognitive conflict*** is a group's ability to maintain an awareness of differences in viewpoints and opinions related to the group's task, which can be beneficial to many types of group performance, as this type of conflict encourages group members to consider a number of alternate solutions as possibilities before making any decisions.
- 3- ***Process conflict*** concerns disagreement over how a task will be accomplished (i.e. who will do what or how the group will proceed). Despite the fact that relatively little research has been conducted on this type of conflict, it has been proposed that disagreement over the procedural matters of a task can decrease a group's focus on the content of the task, leading to an overall decrease in levels of member satisfaction and group performance.

Wegerif, Mercer and Dawes' (1999) taxonomy of types of talk fits nicely into this conflict framework. They identified "exploratory talk" within small groups (characterized by *cognitive conflict*, or challenges and counter-challenges in which reasoning is evident and the group seeks to reach agreement) as the kind of interaction most likely to produce group gains in conceptual understanding. In addition, they found "disputational talk" (characterized by

conflict over group processes and decision-making) counter-productive. While Wegerif et al. did not distinguish between interpersonal and process conflict in “disputational talk,” it is clear that the type of conflict plaguing this type of talk is nothing like the conflict present in “exploratory talk.”

The proponents of the conflict, power, status theory consistently emphasize the ever-present competition that exists between members of societies or groups within societies – competition for material goods needed for survival, as well as the power and status that provide individuals with some sort of advantage over others. Such competition inevitably results in continuous conflict, causing power and status hierarchies to emerge. Poole and Hollingshead (2005) suggested that status significance is acquired through material resources; and, because power can be used to acquire resources, power and status are often viewed as related concepts. One key distinction, however, made by Poole and Hollingshead, is that status increases one’s likelihood to acquire resources from other group members who willingly share such resources, while, one’s use of power, on the other hand, often produces resistance and conflict.

Regardless of how they are established, power and status hierarchies serve to manage conflict, allowing individuals to cooperate by providing groups with an “organization” function which defines acceptable use of power. While acceptable power use often helps a group to function smoothly, it can also generate an acceptance of inequality among group members.

Most educators are aware that inequalities (such as those related to access to tools) often surface and even sometimes proliferate within small groups, despite their best efforts to

avoid such pitfalls. Julie Bianchini was simply the first to explicitly state that the implementation of groupwork “must be further refined to adequately address the dual goals of excellence and equity” (Bianchini, 1997, p. 1039). Other researchers have since added evidence to this problematic notion.

Poole and Hollingshead (2005) offered two possible explanations for the establishment and proliferation of unequal treatment of individual group members within small groups. First of all, they identified a phenomenon which they refer to as “status generalization.” This term refers to the early establishment of status differences within groups. Poole and Hollingshead stated that “once status characteristics are activated within a group, there is an effect on subsequent points in time” (2005, p. 167). Once an individual is granted deference early on in group interactions, such deference acts to reinforce the person to whom deference was granted and begins the establishment of such behavior as “the norm.” Therefore, the initial status differences demonstrated within a particular group easily serve as a trajectory for future behavior, particularly in groups in which group composition remains fixed over time. Hogan’s (1999) study on student roles within small groups supports this theory of status generalization, as she found that, despite the fact that students sometimes shift slightly from one role to another, the roles that students assume in the early stages of group development tend to remain relatively stable.

Second, Poole and Hollingshead (2005) suggested that coalition formation may play a major role in the establishment and/or perpetuation of small group inequalities. They described this phenomenon as the potential to exclude group members from group decisions. While there are a number of reasons that coalitions form between two or more group

members, such coalitions are difficult to break. In fact, resistance from parties outside the coalition tends to strengthen the bond between members of the coalition. Based on Richmond and Striley's (1996) prior research on the effects of leadership style on group dynamics, one can easily infer that some styles of leadership are more conducive to coalition formation than others. For instance, the presence of an alienating leader (one who disregards the ideas of any others in the group) might easily give rise to the formation of a coalition between all other group members, whereas a persuasive leader (one who tries to convert other group members that challenge their ideas) may try to establish coalitions with group-mates. Furthermore, a group led by an inclusive leader (who encourages all group members' participation) would seem less likely to employ coalitions to exclude one or more members of the group.

Regardless of the cause of small group inequalities, the fact remains that such differences are problematic for teachers trying to construct a setting in which all students can learn. In one particular study on the effects of role assumption (such as those previously described by Hogan, 1999) on participation and productivity within small groups, a group of researchers at Brigham Young University found that introducing small groups as an instructional method requires considering a brand new set of pedagogical issues. After allowing the subjects in their study to comment on how they felt within their small groups, the researchers developed a new appreciation for student concerns about equity and power. Students reported feelings such as the following (Wilcox, Williams, & Reutzel, 1997, p. 350):

- “I felt as if no one listened. Also I felt as if I wasn’t needed. I felt as if I wasn’t there.”
- “Half the group wasn’t listening to me.”
- “I thought it was . . . kind of frustrating because no one would listen to your idea.”

Comments such as these caused this group of researchers to draw the following conclusion: “Educators . . . must extend to all students the opportunity to create environments that allow for voice and, more important, the opportunity of an equitable emergence of voice” (Wilcox et al., 1997, p. 350). This dissertation is aimed at using the conflict, power, status theory to uncover some possible culprits which may contribute to the establishment of inequalities within small groups, with the hope that such revelation might eventually lead to maintaining a more level playing field for all group members within such settings.

### ***Support for Further Research on Small Groups***

Studies which pinpoint issues related to differential power and equity between individuals within small groups (such as the Wilcox study just discussed), provide ample justification for more studies in this field. For, is it not important to search for the underlying causes of such problems? According to Noreen Webb (1982), “most studies [on interactions within groups have examined only] a few characteristics of the individual, group, or setting. Without data on students’ experiences in groups, these studies present incomplete pictures of the influences of group work” (p. 422).

This dissertation research is focused on the relationships between students within small groups, with a focus on differential behavior towards individual students (whether



manifested as verbal responses or nonverbal cues). Behavior refers to everything we do which is observable, including the entire range of verbal and nonverbal interactions of which we are capable. Most conclusions individuals draw about other individuals, which influence their reactions to one another, are largely and primarily based on observations of behavior. Furthermore, behavior is central to the formation and maintenance of human relationships. Therefore, it is ultimately the behavior (both verbal and nonverbal) of individuals within small groups which creates and maintains the group's relational structure, which in turn, determines power and status hierarchies, as well as how any conflict within the group will be resolved.

The purpose of this research is to build on the studies discussed in this review of literature. Based on the continued expression of the necessity to include small group interactions within science classrooms around the country (American Association for the Advancement of Science, 1993; National Research Council, 1996), paired with the fact that this instructional practice is far from reaching perfection in its implementation, more research is needed to validate such mandates. This dissertation is designed to provide new insight on the differential experiences of individuals within small groups related to both verbal and nonverbal behavior, which may ultimately be explained through the use of the conflict, power, status perspective of research on such groups.

## **Chapter 3: Methodology**

The goal of this dissertation is to answer two primary overarching research questions:

- 1- Do the sequential interactions between and among the members of small groups differ, either within or between groups?
- 2- How does nonverbal communication influence the verbal interactions that take place within small groups?

In order to answer these two questions, data have been collected and coding systems and procedures for analysis of these data have been formulated. This chapter includes a description of the middle school elective course from which data were collected, the course participants, and the data collection process for the study, as well as the coding systems devised and the corresponding analysis procedures used.

### ***The Elective Course and its Participants***

This dissertation study is a small part of a large scale study on spatial cognition. The setting of this study was a rural middle school located in the south-eastern United States in which a group of 18 eighth-grade students were selected to participate in a six-week elective course on maps and mapping. The students were selected so that each student in the sample had an overall academic average of 85 or higher; there was an equal number of males and females (9 each); and, the racial makeup of the class was similar to the composition within the school (10 Caucasian, 6 African-American and 2 Hispanic). The students were taught

through inquiry-based methods and were given the opportunity to self-select their own cooperative groups, consisting of 3 students per group, with whom they worked every day during the entire six-week span. The resulting breakdown of the groups was as follows:

- **Group 1** – 2 Caucasian females; 1 Hispanic male
- **Group 2** – 2 Caucasian males; 1 African-American male
- **Group 3** – 2 Caucasian females; 1 African-American male
- **Group 4** – 1 Caucasian male; 1 African-American female; 1 Hispanic female
- **Group 5** – 2 Caucasian males; 1 African-American male
- **Group 6** – 2 African-American females; 1 Caucasian female

### ***Data Collection and Selection***

Each small group of three students was strategically placed throughout the perimeter of the classroom and videotaped using 6 separate video cameras (one per group) on a daily basis. The students' verbal interactions were captured using wireless microphones that were placed in the center of each group along with a microcassette recorder, which also recorded the verbal interactions for backup purposes. In order to manage the data collection process, a team of 3 researchers (in addition to 2 instructors) attended class meetings on a daily basis; and, an additional researcher was responsible for organizing and maintaining the data collected and returned every day, including the video and cassette tapes, as well as the field notes and any written assignments that were collected for scoring and analysis.

Selected videotapes from all 6 small groups were transcribed and reviewed during the weeks following the data collection process; and, as a result, the primary researchers in the large scale study began to recognize some key patterns of interactions taking place within each group. There were some days during which the class activities provided richer discourse for the videos than others, and likewise, there were some groups which provided a greater abundance of material than others to review as well. There was one group of the six, in particular, which seemed to spend more time off task than on during filming; yet, after reviewing several transcripts for this group, the researchers could not determine any specific triggers of the off-task behavior. The videos and transcripts for this group were specifically examined for clues that the students found the material too difficult, perhaps beyond their individual zones of proximal development, or too simple, creating boredom with the tasks. However, there were no clear indications of either of these issues. It seems that the students within this group simply made the decision to discuss personal issues more frequently than any activity assigned to them, for reasons which could not be determined. Consequently, the video tapes of this group's interactions revealed little, if any, information about learning within small groups; and, their transcripts were excluded from the procedure and analysis of this study. However, four days' videos and corresponding transcriptions for the remaining five groups were selected for analysis, based on the amount of discourse and the general plentitude of nonverbal behavior exhibited within their contents.

### ***Pilot Study Results and Development of Dissertation Research Questions***

Previous research related to student responses to one another has been conducted by

Noreen Webb, who has reported some interesting findings on small group interactions and achievement over time (1984a). She noted that when a participant within a small group receives no response to a question or error, the effect is more detrimental to his/her achievement than any type of response (positive or negative) and is negatively related to achievement. This prompted her to conduct a series of studies on the detrimental effects on an individual's achievement related to his/her failure to receive help when requested (Webb, 1985, 1991).

In addition to Webb, Wilkinson also found that low-ability students in mixed-ability groups are less likely to receive “on-task” responses to requests, causing the maintenance, and possibly the proliferation, of the achievement gap between the two ability groups (Wilkinson & Calculator, 1982; Wilkinson & Spinelli, 1983). She also found that a request for information is more likely to receive an appropriate response than a request for action, and that any type of request is more likely to receive an appropriate response if it is direct, on-task, and designated to a specific individual (1983). However, after reviewing tapes of interactions for this study, I hypothesized that the likelihood of receiving an appropriate response may be more dependent upon the individual speaking than the characteristics of the request itself.

In relation to this hypothesis, a pilot study was conducted which employed sequential analysis to examine student responses to one another within one of our five groups of interest (Flynn, et al, 2006). Within the pilot study all student responses (not only those which followed requests for help) were categorized as belonging to one of the following three groups:

- 1- *appropriate* – any response which is related to the preceding remark
- 2- *not-linked* – any response which is unrelated to the preceding remark
- 3- *cut-off* – any response which began before the preceding speaker was finished with his/her remark

The results of this study revealed that the kinds of responses an individual within a small group is likely to receive can vary tremendously from student to student. However, this study only examined the interactions which took place within one small group of three students; therefore, the conclusions drawn were very limited. Despite the limitations of the study, when paired with previous research on student responses to one another, its findings raise some interesting research questions related to the first overarching question of this dissertation: *Do the sequential interactions between and among the members of small groups differ, either within or between groups?* These research questions are as follows:

- 1- What is the relationship between the way in which a student requests help and the type of help he/she receives?
- 2- What is the relationship between the way in which a student requests help and the likelihood that he or she will receive help or not?
- 3- Are these relationships consistent between groups?
- 4- Is there a relationship between the likelihood that a student will receive help when requested within a small group and the individual who is requesting help?

## *Verbal Interaction Analysis*

Descriptive statistics (such as the number and types of speaking turns uttered by each individual student and the number and types of interactions uttered within each group) were collected, recorded and analyzed at this point to identify any interesting trends in the data. Through the use of these statistics, the dominant speakers within each group, as well as the dominating types of overall interactions and responses to questions within each group were determined. This preliminary analysis was used later to guide the qualitative analysis of nonverbal communication within each group.

Using the research questions as a focus, a coding system was formulated which would allow these questions to be answered through this dissertation study, using sequential analysis techniques. Table 1 displays the codes assigned to the various verbal interactions which took place within each small group of interest, while Table 2 provides examples of interactions which would be assigned to each of these codes.

Table 1. Coding scheme for sequential analysis research questions

Code	description of associated interaction
CRQ	content related question
PQ	procedural question
CLQ	clarification question
DOU	expression of doubt
AQ	approval seeking question
RA	request for action
A	simple 1-2 word answer to a question
E	explanation to a question
AE	answer with an explanation
NO	no help provided after a question (ignore/change subject)
DO	student doing work for another
NA	non-specific answer
N	any other type of interaction (not related to questioning)

Table 2. Examples of interactions for each code

Code	Example
CRQ	How do plate tectonics form?
PQ	What does the next question say?
CLQ	What did you say?
DOU	I don't understand.
AQ	Is that right?
RA	Why don't you draw?
A	That's correct.
E	The bulge in the earth came from the pressure underneath – AE like steam and magma rising.
NO	(Previous question: How did you say plate tectonics form?) – response coded NO: We didn't answer the last question.
DO	Let me just do it (followed by taking the materials and completing the task for someone who simply requested help)
NA	I don't know.
N	<i>Any statement that is not a request or a response to a request</i>

Each utterance by an individual within a small group was coded as one of these interaction types; and, each utterance was only coded as one type of interaction. Therefore, on the rare occasion that a question was followed by an unrelated question asked by another student in the group, the interaction was coded as an “NO.” However, if a question was followed by another question on the same topic, the second question was coded according to the coding scheme specifications. In addition, any utterances interjected by individuals outside the group (such as instructors) or in response to individuals outside the group were left uncoded; and, any sequence of “N’s” were recorded as a single “N,” since the likelihood that an “N” follows another “N” is irrelevant in this study.

Inter-rater reliability was established by providing an independent researcher with a



description of the coding system (as shown previously) and a transcript, then comparing her coded transcript with the primary researcher's coded transcript and calculating the percent of similarity. The simple proportion of similarity between the two coded transcripts was calculated at .8809 (approximately 88%), while Cohen's kappa (a reliability measure which accounts for the possibility of random similarity) was calculated at .8482 (Bakeman & Gottman, 1997).

### **Lag Sequential Analysis: Peer Assistance Codes**

Sequential analysis is an innovative tool which allows a researcher studying a given sequence of events to determine the likelihood that there is a relationship between any particular dyad of events. This tool has been used in the past, primarily and almost exclusively, in the behavioral sciences. However, this study demonstrates the enormous potential of sequential analysis in studying small group interactions within school settings.

Using sequential analysis, it is possible to study the strength of the connection at any *lag*, or transition between events. In this study, the lag is the transition from one speaker to another; with, *lag0* (or the antecedent code) being the code for the first interaction, and *lag1* (or the consequent code) being the code for the interaction that immediately follows the one in the *lag0* position. Take, for example, the sequence of interactions below:

Elaine: Do the lines on the contour map ever cross?

Amy: I think they do, because see that corner over there. It looks like  
that to me.

Marcus: I don't get it.

In this sequence of interactions, in the first position, Elaine is speaking at *lag0*, and Amy is speaking at *lag1*; and, *lag0* would be coded as a **CRQ** (content-related question), while *lag1* would be coded as an **AE** (an answer with an explanation). In the next position, Amy is speaking at *lag0*, and Marcus is speaking at *lag1*; and, *lag0* would still be coded as an **AE**, while *lag1* would be coded as a **DOU** (expression of doubt).

In this study, the codes of interactions which took place within each group over all four days of interest were entered into the SAS program (for a sample code, see Appendix A). The output was then analyzed for significance and trends (for sample output, see Appendix B). In essence, *expected frequencies* that each code follows each other code, based on the number of times each code appears within the group of transcripts analyzed, were compared to the *observed frequencies*; and, the resulting standardized residuals were examined. Any residual (*z*) above 1.96 or below -1.96 indicates an event which is occurring more often or less often (respectively) than would be expected if the events were occurring randomly (Bakeman & Gottman, 1997). The greater the positive residual is, and likewise the smaller the negative residual is, the more likely it is that some sort of relationship exists between the corresponding dyad of events. Once the data were entered into the SAS program and the resulting residuals (corresponding with the type of request and the type of response which follows) were analyzed, the first research question related to the sequence of interactions within small groups (*What is the relationship between the way in which a student requests help and the type of help he/she receives?*) was addressed. However, since we were

interested in answering additional questions, some manipulation of the coding scheme was required at this point.

### **Lag Sequential Analysis: Type of Request and Help Provided**

In order to answer the next research question related to the sequence of interactions within small groups (*What is the relationship between the way in which a student requests help and the likelihood that he or she will receive help or not?*), it was determined that a collapsed set of codes would provide more powerful results than that associated with the initial coding scheme. So, after the initial data output was examined for interesting trends and relationships, the response codes were collapsed as follows: simple answer (**A**), explanation (**E**) and answer with explanation (**AE**) were lumped as one single code (**H** – indicating that help was provided in response to the request); while, ignoring a request (**NO**) and any non-specific answer (**NA**) were lumped as (**NOH** – indicating that no help was provided in response to the request). In addition, completing a task for a peer (**DO**) was lumped in with the **NOH**'s, because according to Webb and Farivar (1994) a simple demonstration is not sufficient for student learning. This collapsing was done and a second round of SAS output was generated so that the relationship between each type of request (**CRQ**, **PQ**, **CLQ**, **DOU**, **AQ**, and **RA**) at the *lag0* position and each type of response (**H** or **NOH**) which follows at the *lag1* position could be determined by examining the residuals associated with each dyad of events. This indicated if indeed there are types of requests an individual can present to his/her group which will make the individual more or less likely to receive help.

### **Lag Sequential Analysis: Request Type and Response Type**

The data used to answer each of these first two research questions were entered into the SAS program and analyzed both collectively (all groups combined) and individually (per group), thus allowing the third research question associated with the sequence of interactions within small groups (*Is the relationship between a student's request for help and the type of response he/she receives consistent between groups?*) to be answered through a cross-group comparison of the residuals associated with each dyad of events. The residuals for each dyad of events within each small group were examined for significance, and the results were then compared between groups.

### **Lag Sequential Analysis: Student Requesting Help and Help Provided**

In addition to collapsing the response codes in the original coding scheme and reentering the data for additional analysis, the request codes were also lumped as one single code (**NH** – need help) and the *lag0* was changed to the individual speaking (disregarding the type of interaction). The SAS program was then commanded to generate a new set of output for each individual group, with each residual indicating the relationship between *lag0* (individual speaking/requesting help) and the type of response he/she receives at *lag1* (**H** or **NOH**). This allowed for the determination of whether or not there are individuals within each group who are more or less likely to receive help when requested than others. Consequently, this analysis allowed us to answer the final question associated with the sequences of interactions (*Is there a relationship between the likelihood that a student will receive help when requested within a small group and the identification of the student requesting help?*).

## ***Examining Nonverbal Interactions***

A simple glance at a few of the transcripts associated with each of the five groups within this study quickly indicated some major differences between the amount and distribution of the verbal interactions which took place between groups. Some groups engaged in lengthy discussions on a daily basis, while others discussed very little. Within some groups, each group member participated almost equally, while in other groups, one or two group members dominated the conversation. While the sequential analysis of the verbal interactions that took place within each group provided some verbal clues related to these differences, it would be negligent to ignore the possible influence of the nonverbal interactions that took place within these groups as well. After all, nonverbal communication often shapes a conversation as much as (or more than) what is actually said (Hartley, 1993).

## **Establishing a Framework**

The same five groups of students and corresponding set of four transcripts and videos as those used in the sequential analysis were used to investigate the second overarching research question: *How does nonverbal communication influence the verbal interactions that take place within small groups?* A careful review of the available literature on small group interactions and nonverbal behavior within small groups indicated that there has been very little overlap between the two examined in the past, especially within the context of their relationship to one another in small group communication. In other words, there seems to be a need for a study on the influence of nonverbal communication on the verbal interactions that take place within small groups. However, before a study of this nature could be undertaken, it was essential to provide a working framework for coding nonverbal

interactions. For the purposes of this study, the following types of behavior, which have been defined by past research, were examined as significant types of nonverbal communication and served as the “start list” for coding (Miles & Huberman, 1994):

- ***social gestures*** – any hand and/or arm movements which seem to be unrelated to the subject being discussed, but rather used for some social purpose.
- ***body language cues*** – any shift in body position which cannot be logically explained by a required activity within a group assignment, an unrelated event, or any other nonverbal interaction previously described.
- ***seizing or passing of materials*** – any change in possession of the materials needed for group activities.

### **Theoretical Lens**

According to Creswell (2003), “qualitative researchers increasingly use a theoretical lens or perspective to guide their study and raise the questions . . . they would like to address” (p. 131). The conflict, power, status perspective of small groups, as defined by Poole, et al. (2004), was used to guide this particular investigation of the nonverbal behavior within the five small groups of interest. The use of this perspective allows for a thorough examination of the groups in terms of the dynamics associated with social relationships and the inequalities among group members. The conflict, power, status perspective is grounded in the theory that managing conflict is fundamental to the existence of society. The proponents of this theory consistently emphasize the competition that exists between groups

for material goods needed for survival, as well as the power and status that provide individuals with some sort of advantage over others. Such competition inevitably results in conflict, causing power and status hierarchies to emerge. These hierarchies serve to manage conflict and provide groups with an “organization” function which defines the acceptable use of power. However, despite the fact that acceptable power use often helps a group to function more smoothly, it can also generate an acceptance of inequality among group members.

### **Secondary Research Questions**

During my contemplation of the influence of nonverbal interactions within small groups using the theoretical lens of the conflict, power, status perspective, some underpinning research questions began to emerge:

- 1- How are social gestures used to encourage or deter verbal participation within small groups?
- 2- How is body language used to encourage or deter verbal participation with small groups?
- 3- How does the possession of tools influence power and/or status within small groups?

### **Nonverbal Interaction Coding and Analysis**

According to Miles and Huberman (1994), different levels of coding should take place during qualitative analyses of data. They recommend beginning with *descriptive* codes (which require little interpretation of events) and move towards more *interpretive* codes later

(which tend to explain events) (Miles & Huberman, 1994). To answer my underpinning research questions, the following system for coding was employed. For each group, an initial inventory of nonverbal interactions was taken from each of the four videos of interest, in order to get an understanding of the plentitude and general types of nonverbal communication which took place. This inventory allowed for some subgroups of descriptive codes to emerge under each category of codes in the “start list.” For example, under “body language,” a clear distinction emerged between positive signals (those which encourage participation of other group members) and negative ones (those which deter participation of other group members). Following the establishment of these descriptive subgroups (further described in chapter 4) and two confirming rounds of analysis, the results for each group were analyzed for significance through the conflict, power, status theoretical lens.

The initial analysis (descriptive statistics) of the verbal interactions, which established the dominant speaker(s) within each small group, as well as the SAS results, were used at this point to help determine each groups’ social structure, in order to guide the further analysis of nonverbal interactions. Once each group’s dominant speaker(s) was established, videos and coded transcripts were further reviewed for non-verbal strategies used for establishing and maintaining status hierarchies within each group. Bogdan and Biklen (1992) suggested using such a scheme to further interpret and organize data, assuming it fits well with the theoretical framework for the study, and it fits perfectly with this study’s conflict, power, status perspective. Using this theoretical lens while examining the videos and transcript, clues embedded within the nonverbal behavior were identified which may help to explain why *some* individuals within small groups feel empowered to talk so much, while *others* seem to



simply shut down. Clues associated with social gestures (*How do hand and arm movements seem to encourage or deter verbal participation?*), body language (*How do body movements or positions seem to encourage or deter verbal participation?*), and tool use/distribution (*How does the possession of tools influence power and/or status?*) were identified. Particular attention was given to nonverbal behavior exhibited during instances in which group members disagreed, as understanding how groups manage conflict is paramount according to the conflict, power, status framework.

The types of nonverbal communication exhibited varied greatly between groups, depending upon the types of social structures that established. Therefore, dominating patterns of nonverbal interactions were compared to the patterns of verbal interactions (established by the initial and sequential analyses) within each group, and a cross-group comparison was conducted to establish any noticeable trends between the two types of communication (verbal and nonverbal).

Once a set of codes emerged, inter-rater reliability was established by providing an independent researcher with five video tapes (one fourth of the total reviewed for analysis), along with an explanation of the coding scheme, and allowing her to code for nonverbal interactions alongside the primary researcher. Her inventory of nonverbal behavior was then compared with the primary researcher's list and examined for differences, which were discussed between the two until consensus was reached.

## Chapter 4: Analysis and Results

The analyses of data collected in this study required examination at a variety of different levels, each one involving an increasingly closer look at the behavior of individual students and the context of the dynamics within each triad. The overarching goal of the study began as an attempt to determine what types of relationships exist between peer help given and received within small groups and the individual and/or collective differences within each group. Appropriately analyzing the data in a study of this magnitude required the identification of a theoretical framework. Poole and Hollingshead's (2005) conflict, power, status (CPS) perspective of small group research was used as a theoretical lens in the latter stages of the study, in order to make sense of the verbal and nonverbal behavior documented within each group.

### ***Level I Analysis: SAS analysis of verbal responses to requests for help***

This first level of analysis involved reviewing videos and transcripts of several days of discourse within each triad of students, identifying four days of interest, coding student requests for help and peer responses, and analyzing the data using sequential analysis techniques. The basic coding scheme devised for the analysis is described in Table 1 (p. 61), and Table 2 (p. 62) provides an interaction identified as an example of each type of code. This coding system was both "mutually exclusive," meaning that only one code was appropriate for each individual interaction, as well as "exhaustive," meaning that every interaction was assigned a code (Bakeman & Gottman, 1997).

This level of analysis allowed the researchers to answer four previously identified research questions related to the verbal responses to student requests for peer help.

- 1- What is the relationship between the kind of help a student requests and the type of help he/she receives?
- 2- What is the relationship between the kind of help a student requests and the likelihood that he or she will receive help or not?
- 3- Are these relationships consistent between groups?
- 4- Is there a relationship between the likelihood that a student will receive help when requested within a small group and the individual who is requesting help?

**Question 1: What is the relationship between the kind of help a student requests and the type of help he/she receives?**

In order to answer this research question, each transcript of interest for each small group was coded using the previously described coding scheme, and these codes were entered into a computer for sequential analysis. Generating output from the system requires the identification of lag0 (the “start” code) and lag1 (the “antecedent” code), so that the data can be examined for the existence of a relationship between any pair of lag0/lag1 events. In this case, lag0 was defined as the type of request for help any individual student used during small group discourse, and lag 1 was defined as the type of response he/she received immediately following such a request. Table 3 displays the resulting residuals of interest for all four days’ worth of transcripts from all five groups combined. Any residual greater than 1.96 indicates that lag1 followed lag0 more often than one would expect if events had

occurred randomly; and, any residual less than -1.96 indicates that lag1 followed lag0 less often than one would expect if events had occurred randomly. In addition, the higher a positive residual is or the lower a negative residual is, the more likely it is that some sort of relationship exists between lag0 and lag1. Note all significant residuals are marked by an asterisk.

Table 3. Standardized residuals for lag0 = request; lag1 = specific type of response

<i>Lag0</i>	<i>Lag1</i>				
	A	AE	NA	NO	DO
AQ	13.05*	1.57	0.63	-0.98	-0.07
CLQ	70.71*	13.17*	1.72	29.23*	-0.68
CRQ	56.33*	2.66*	10.14*	25.48*	0.40
DOU	15.93*	0.48	-0.45	1.56	-0.09
PQ	41.17*	-0.06	3.23*	20.44*	2.63*
RA	4.50*	-0.39	-0.33	1.89	-0.07

\*p<.0001

Table 3 indicates some interesting trends in the patterns of peer help given and/or received throughout the class as a whole. For instance, these residuals indicate that students did offer one another help when requested more often than not (overall), as the residuals generated for the “A” responses (simple answers) following each type of request for help were the greatest positive residuals in each case. This indicates some minimal level of functionality among the groups, as social convention would predict that any question be followed by some sort of answer. However, the only types of requests which received an answer with an explanation (AE) more often than one would expect if events were random were clarification questions and content-related questions. This seems to be potentially problematic, considering the fact that many procedural questions were specific requests for

help with completing a task (which often requires more than a simple one- or two-word answer). Also problematic, in relation to procedural questions, is the fact that these residuals indicate that when a student expressed a procedural concern, he/she was likely to have a student simply perform the task for him or her (DO), rather than to actually provide help in response.

Table 3 also indicates that the types of requests which were likely to receive a non-specific answer (NA - e.g. "I don't know") were the content-related questions and procedural questions; and, these two types of requests (along with clarification questions) were also likely to be ignored as well (NO). Therefore, collectively these data indicate that although students were more likely to receive *some* sort of answer to a request for help than one would expect if the interactions were occurring totally randomly, this simple fact does not necessarily indicate that students needing help always received the level of help he/she needed in order to improve his/her understanding of a particular concept or procedure.

### **Question 2: What is the relationship between the kind of help a student requests and the likelihood that he or she will receive help or not?**

In order to answer this research question, an additional sequential analysis was conducted after lumping all of the simple answers (A's) and the answers with explanations (AE's) as a single code (H = help) and all of the non-specific answers (NA's), instances of ignoring a request or changing the subject immediately following a request (NO's), and instances in which a task was simply performed for a student who asked for help (DO's) as a single code (NOH = no help). Lag0 was still defined as the type of request for help, and lag1 was defined as the type of response (either H, NOH, or some other request for help). Table 4

displays the resulting H/NOH residuals for this analysis of events. Once again, any significant residual is marked by an asterisk.

Table 4. Standardized residuals for lag0 = request; lag1 = help/no help

<i>Lag0</i>	<i>Lag1</i>	
	<u>H (help)</u>	<u>NOH (no help)</u>
AQ	14.63*	-0.43
CLQ	83.88*	30.26*
CRQ	58.98*	36.02*
DOU	16.40*	1.02
PQ	41.11*	26.30*
RA	4.11*	3.79*

\*p<.0001

Particularly disturbing is the discovery that despite the fact that help was provided for each type of request for help more often than one would expect (if events were random), the occurrence of “no help” responses following requests for help was significant for each of the following types of requests: clarification questions (CLQ), content-related questions (CRQ), procedural questions (PQ), and requests for action (RA). This indicated to the researchers that even though peer responses to requests for help within small groups may appear to be overwhelmingly positive (helpful) on the surface, the instances in which no help is provided should not be overlooked (as their occurrence may still be significant as well, as in the cases noted in Table 4). This led to the next two research questions in order to determine if these relationships were consistent between groups (question 3) and whether or not any particular students were more or less likely to receive help than others within each small group (question 4).

### Question 3: Are the relationships discovered during the exploration of research questions 1 & 2 consistent between groups?

In order to examine the relationships between requests for help and help given/received within each individual group, the data from all four days' transcripts combined were analyzed for each of the five small groups separately. Residuals were first generated for the unlumped codes (lag0 defined as the type of request for help and lag1 defined as the type of response immediately following a request for help). When the data were analyzed for each group separately, some interesting trends emerged which indicated that individual group dynamics may sometimes vary significantly from the overall patterns of behavior seen in the class as a whole. The following two tables (Table 5 and Table 6) display the breakdown of resulting output within each group for the significant relationships related to answers with explanations (AE) and requests being ignored (NO), previously identified during the analysis of data for all five groups combined.

Table 5. Standardized AE residuals for each group

	lag0 = CLQ/ lag1 = AE	lag0 = CRQ/lag1 = AE
<b>All five groups</b>	<b>13.17*</b>	<b>2.66*</b>
One	3.95*	4.97*
Two	0.70	0.78
Three	0.69	1.38
Four	0.41	1.15
Five	0.54	0.77

\*p<.0001

These residuals demonstrate the fact that one group can significantly skew the data for the entire class, as group one proved to be the only group whose residuals for answers with explanations following clarification or content-related questions were significant (as

were those for the class as a whole). These differences proved to be the first in a long list of distinctions between group one and the remaining four groups in the class. Table 6 further supports this assertion.

Table 6. Standardized NO residuals for each group

	lag0 = CLQ/lag 1 = NO	lag 0 = CRQ/lag1 = NO	lag0 = PQ/lag1 = NO
<b>All five groups</b>	<b>29.23*</b>	<b>25.48*</b>	<b>20.44*</b>
One	0.69	0.85	-0.11
Two	5.66*	4.82*	3.74*
Three	3.60*	6.21*	1.72
Four	2.07*	6.22*	6.14*
Five	13.14*	4.49*	1.20

\*p<.0001

Once again, the interactions among members of group one proved to be very different than those within the other groups (with a couple of exceptions). This group is the only group for which the likelihood that a clarification or a content-related question would be ignored proved insignificant. The likelihood that a procedural question would be ignored within this group was also insignificant (as it was in group five and group three), despite the fact that each of these relationships proved significant when the class data were examined as a whole. This indicates that members of group one were not likely to ignore any type of requests for peer help; whereas, members of the other groups were more likely to do so. The fact that members of the groups three and five did not ignore procedural requests (but did have a tendency to ignore clarification or content-related questions) suggests that these groups may have been more concerned about process than content in many group activities.



After response codes were lumped (A and AE = H or help; NA, NO, and DO = NOH or no help) and these codes were entered and analyses were performed separately for each individual group, group one again stood out as different than the remaining groups in the class. Despite the fact that the analysis of the class data indicated that clarification questions and content-related questions were more likely to receive no help than if events occurred randomly (see Table 7), the results for group one indicated that this was not the case among its group members. In this group the residual for lag0 = CLQ/lag1 = NOH was 0.56 (not significant), and the residual for lag0 = CRQ/lag1 = NOH was 1.78 (not significant); whereas the corresponding residuals in each of the other four groups matched the class residuals (significant).

Table 7. Standardized NOH residuals for CLQ and CRQ (whole class and each group)

	lag0 = CLQ/lag1 = NOH	lag0 = CRQ/lag1 = NOH
<b>All five groups</b>	<b>30.26*</b>	<b>36.02*</b>
One	0.56	1.78
Two	7.14*	7.15*
Three	4.67*	9.33*
Four	1.98*	7.26*
Five	13.77*	3.79*

\*p<.0001

#### **Question 4: Is there a relationship between the likelihood that a student will receive help when requested within a small group and the individual who is requesting help?**

Prior research suggests that the way in which an individual requests help often determines whether or not that individual will receive help or not (Wilkinson & Calculator, 1982; Wilkinson & Spinelli, 1983). However, the results of this study reveal some

contradictory findings, as demonstrated by the results revealed thus far. Flynn, et al. (2006) found that the responses individual students receive within small groups often vary vastly from one student to another. Consequently, in order to explore the possibility that the likelihood of obtaining help in response to an individual request may be dependent upon the individual requesting help, lag0 was redefined as the person requesting help and sequential analyses were performed for each individual group once again (lag1 was still defined as either H - "help" or NOH - "no help"). Table 8 displays the resulting residuals. Note that any residual deemed as an indicator that an individual was "not helped" within his/her small group is marked using one asterisk (i.e. any negative residual below -1.96 associated with helpful responses or H's or any positive residual above 1.96 associated with responses considered "not helpful" or NOH's). Additionally, any residual deemed as an indicator that an individual was "helped" within his/her small group is marked using one asterisk (i.e. any positive residual above 1.96 associated with helpful responses or H's or any negative residual below -1.96 associated with responses considered "not helpful" or NOH's).

It is important to remember that the H and NOH codes are not simply direct opposites of one another. Rather, any H indicates that a simple answer (A) or an answer with an explanation (AE) immediately followed an individual's request for help; whereas, any NOH indicates that a request for help was followed immediately by a non-specific answer, such as "I don't know" (NA), another student simply doing the work for the individual requesting help (DO), or another student changing the subject entirely (NO). There was also a possibility that a request for help could be followed by another request. However, since the

relationship between this pair of events was not of particular interest in this study, the residuals for such pairs are not displayed below.

Table 8. Standardized help residuals for each student within each small group

<b>Lag0: Person (group)</b>	<b>Lag1</b>	
	<b>H (help)</b>	<b>NOH (no help)</b>
Jessica (one)	28.13*	-0.79
Edward (one)	8.06*	1.46
Emily (one)	-4.56*	0.79
James (two)	4.07*	12.50*
Tommy (two)	6.53*	-3.90*
Andre (two)	7.43*	0.00
Angel (three)	8.62*	-0.58
Wanda (three)	14.54*	0.59
Marcus (three)	-4.43*	5.85*
Michael (four)	7.28*	7.55*
Shayla (four)	1.38	4.98*
Darcy (four)	12.02*	-3.56*
Felipe (five)	-0.71	4.93*
Sam (five)	4.99*	1.82
Perry (five)	2.68*	2.06*

\*  $p < .0001$

Table 8 indicates that 11 of the 15 students received “helpful” responses (H) to individual requests more often than would be expected if events were random; and, three students received “helpful” responses (H) fewer times than would be expected if events were random. In addition, six students (none of whom belonged to group one) received responses deemed “not helpful” (NOH) more likely than would be expected if events were random; and, two students received responses deemed “not helpful” (NOH) less often than would be expected if events were random. Of particular interest in this study are students who stand

out as individuals highly likely or highly unlikely to receive help when requested. Such students include Marcus, whose residual for H was -4.43 and for NOH was 5.85, and Shayla and Felipe who each had insignificant H residuals and positive residuals for NOH. Also of interest are Tommy and Darcy who each had positive residuals associated with the likelihood they would receive a response coded as “helpful” (H) and negative residuals associated with the likelihood they would receive a response coded as “not helpful” (NOH).

### **Summary**

Overall, these SAS results corroborate the assertion that the type of response a student receives when he/she requests help depends less upon the way he/she asks and more upon “who the student is” and the dynamics of the individual group. Level II analysis, which involved the examination of the nonverbal behavior within each individual group, provides additional data related to these group dynamics, especially when analyzed through the conflict, power, status perspective (as is done at level III).

### ***Level II Analysis: Inventory and examination of the nonverbal behavior within each small group***

This second level of analysis involved several rounds of reviewing the videos which correspond with each day used in Level I Analysis. Using prior research on nonverbal behavior and a preliminary review of the videos, three categories of nonverbal behavior emerged as significant to our analysis at this level. These categories and the definition of each used in the context of this study are provided below:

- ***Social gestures*** – any hand and/or arm movements which seem to be unrelated to the subject being discussed, but rather used for some social purpose
- ***Body language*** – any shift in body position which cannot be logically explained by a required activity within a group assignment, an unrelated event, or any other nonverbal interaction previously described
- ***Possession of tools*** – any change in possession of the materials needed for group activities

Three distinct rounds of analysis were conducted on each tape of interest in order to answer the previously established research questions related to the nonverbal behavior within each group. These questions were as follows:

- 1- How are social gestures used to encourage or deter verbal participation within small groups?
- 2- How is body language used to encourage or deter verbal participation with small groups?
- 3- How does the possession of tools influence power and/or status within small groups?

Round one of the analysis involved conducting a simple inventory of each type of nonverbal behavior identified within each small group. Round two of the analysis involved reviewing the videos for a second time in order to classify specific behavior observed during

round one as “positive” (encouraging discourse among fellow group members) or “negative” (discouraging discourse). This classification was done based on literature reviewed related to the meaning and/or effects of various types of nonverbal behavior (Lewis, 1998). Finally, round three was conducted as a confirmation round, in order to check for accuracy and completion of the data previously recorded. In addition, during this final round, a fellow independent researcher reviewed several video segments alongside the primary researcher, in order to establish inter-rater reliability. Each segment was reviewed and then discussed between the two researchers so that any discrepancies between the two, concerning which category of nonverbal behavior any particular interaction should belong to or whether any specific action noted should be classified as “positive” or “negative” could be discussed until consensus was reached.

### **“Positive” Social Gestures**

Some examples of social gestures determined to encourage interaction among fellow group members included the following types of actions:

- Pointing at and/or using materials to explain one’s point of view
- Using hands in any way to express an interest in someone else’s opinion (e.g. an open palm facing upward as if to say “what do you think?”)
- Tapping another student to get his/her attention or to get him/her back on task after losing focus
- Tapping another student’s desk in order to get someone back on task

The number of times positive social gestures were noted within each individual group, as well as the percentages of positive social gestures used by each individual within each group, is listed in Table 9 and is discussed further in level III analysis.

Table 9. Frequency and breakdown of positive social gestures noted in each group

Group	Frequency of positive social gestures	Percentages by each individual
One	84	Jessica (22.6), Edward (39.3), Emily (38.1)
Two	40	James (20), Tommy (57.5), Andre (22.5)
Three	41	Angel (63.4), Wanda (17.1), Marcus (19.5)
Four	65	Michael (29.2), Shayla (30.8), Darcy (40)
Five	3	Felipe (66.7), Sam (0), Perry (33.3)

### **“Negative” Social Gestures**

Some examples of nonverbal behavior determined to discourage participation among fellow group members included the following:

- Open hand covering mouth
- Arms crossed (paired with any level of disengagement)
- Open palm facing another or placed in the field of view between two individuals
- “steepling” of hands

The number of times negative social gestures were noted within each individual group, as well as the percentages of negative social gestures used by each individual within each group, is listed below in Table 10 and is discussed further in level III analysis.

Table 10. Frequency and breakdown of negative social gestures noted in each group

Group	Frequency of negative social gestures	Percentages by each individual
One	3	Jessica (66.7), Edward (33.3), Emily (0)
Two	21	James (14.3), Tommy (66.7), Andre (19)
Three	36	Angel (50), Wanda (47.2), Marcus (2.8)
Four	9	Michael (33.3), Shayla (5.6), Darcy (11.1)
Five	38	Felipe (18.4), Sam (42.1), Perry (39.5)

### **“Negative” Body Language**

Body language which was determined to be discouraging to participation by fellow group members included the following types of actions:

- Turning one’s back to the group (or an individual group member)
- Avoiding eye contact by turning away
- Laying head on one’s desk
- Placing one’s head in his/her hands
- Nodding “no” while someone else is trying to share his/her ideas

The number of times negative body language was noted within each group, as well as the percentages of negative shifts in body language demonstrated by each individual within each group, is displayed in Table 11 (below). Positive body language was not recorded, as most groups began each activity positioned in such a way that would encourage participation among all individuals within a small group (everyone facing one another, students looking at each other, etc.). Therefore, it seemed more natural to record any negative shifts away from



this sort of positioning than to try to find a way to note/count instances of positive body language. However, such dynamics are discussed further in level III analysis of the dynamics within each individual group.

Table 11. Frequency of negative body language and breakdown within each group

Group	Frequency of negative shifts in body language	Percentages by each individual
One	4	Jessica (0), Edward (100), Emily (0)
Two	17	James (11.7), Tommy (41.2), Andre (47.1)
Three	23	Angel (17.4), Wanda (73.9), Marcus (8.7)
Four	1	Michael (10), Shayla (80), Darcy (10)
Five	19	Felipe (10.5), Sam (42.1), Perry (47.4)

### Possession of Materials

In terms of material possession, the researchers found it interesting to compare the number of instances within each individual group in which individual students willingly shared materials with any other group member to the number of instances in which materials were taken away from an individual student by another group member. Overall counts, as well as the breakdown by individuals within each group, are displayed below (in Tables 12 & 13) and discussed further in the analysis at level III.

Table 12. Frequency of times materials were shared/seized noted in each group

Group	Frequency of times shared	Frequency of times seized
One	31	10
Two	8	17
Three	16	47
Four	10	30
Five	13	37

Table 13. Frequency and percentage of sharing/seizing of materials by each individual

Person (group)	Frequency of times shared (%)	Frequency of times seized (%)
Jessica (one)	13 (42%)	3 (30%)
Edward (one)	9 (29%)	1 (10%)
Emily (one)	9 (29%)	6 (60%)
James (two)	2 (25%)	6 (35.5%)
Tommy (two)	3 (37.5%)	7 (41.2%)
Andre (two)	3 (37.5%)	4 (23.5%)
Angel (three)	7 (43.75%)	21 (44.7%)
Wanda (three)	7 (43.75%)	25 (53.2%)
Marcus (three)	2 (12.5%)	1 (2.1%)
Michael (four)	1 (10%)	15 (50%)
Shayla (four)	3 (30%)	3 (10%)
Darcy (four)	6 (60%)	12 (40%)
Felipe (five)	1 (7.7%)	0 (0%)
Sam (five)	9 (69.2%)	30 (81.1%)
Perry (five)	3 (23.1%)	7 (18.9%)

***Level III Analysis: Analysis of the overall behavior (verbal and nonverbal) within each small group using the conflict, power, status theoretical lens***

The focus at this culminating level of analysis was the overall dynamics within each group. At this stage, a final review of the verbal and nonverbal behavior was conducted and examined through the previously identified conflict, power, status (CPS) theoretical perspective. This perspective is grounded in the theory that managing conflict is fundamental to the existence of society. The proponents of this theory consistently emphasize the importance of competition for material goods needed for survival within groups, as well as the power and status that provide individuals with some sort of advantage over others. According to this theory, competition inevitably results in conflict, causing

power and status hierarchies to emerge which serve to manage conflict and provide groups with an “organization” function that defines the acceptable use of power. Unfortunately, despite the fact that such structure within small groups often helps them to function more smoothly, it can also generate an acceptance of inequality among group members. Such resulting dynamics are examined within each small group analyzed within this study below.

### **Group One**

This group was the highest functioning group in the class. The SAS results indicated that, as a group, they provided answers with explanations to one another more often than any of the other groups, they were more likely to respond to requests with any kind of help than the other groups, and they were the only group for which responses deemed “not helpful” did not have a significant residual associated with clarification or content-related questions. In addition, they were the only group for which no individual student was more likely to receive “non-helpful” responses than if events were completely random. These results provided a great deal of information about the positive dynamics among this group’s members, which were further supported by the data examined during the analysis of nonverbal behavior within each group as well. Within this group, very little negative body language was noted in comparison with the other groups; there were more than three times as many instances of sharing of materials than seizing of materials; and, there were 84 positive social gestures used in comparison to only 3 negative ones. In addition, the nonverbal behavior exhibited among the three students within this group was proportionately distributed. In other words, no one individual dominated any category of behavior, which further supports the notion that decision-making and discussion time was shared among the triad.

There seemed to be a pre-existing friendship among these three group members from the very start of the six-week period. However, this is based solely on conjecture, as the researchers did not collect any data to assess such prior relationships. Regardless, the level of intimacy shared among these three, paired with the data collected and analyzed (both through the SAS program and the reviewing of the videos for nonverbal behavior), corroborates the research findings of Shah & Jehn (1993). These two found that groups composed of friends enjoy a performance advantage in small groups and that they outperform “stranger” groups due to higher levels of commitment, cooperation, critical evaluation, task monitoring, and positive communication.

According to the CPS perspective, competition results in conflict, in turn, resulting in the establishment of power and status hierarchies. Within this group there was very little conflict, especially that of the interpersonal nature, as materials and decisions were most often shared fairly evenly among all three members. These dynamics made it rather difficult to identify the “organization” structure within the group; however, a careful look at the individual residuals for helpful and “non-helpful” responses to each student within the group raises some interesting points about the group’s functionality. Upon first glance at these residuals (see Table 8), it might appear that Emily was treated unfairly by her “group-mates” (as her residual for “helpful” responses was negative, meaning that the pairing of any interaction by Emily followed by a helpful response occurred less frequently within the four days’ worth of transcripts than one would expect if events were totally random). However, a closer look at the interactions among these three students indicates that this pairing of events occurred so infrequently, not because Emily never received help when she requested it, but

because she asked so few questions in comparison to the number of times the other two asked and she answered. This phenomenon, paired with the fact that Emily's ideas were most often accepted as the group's, led the researchers to identify Emily as the group leader. She almost perfectly fits Richmond and Striley's description of an "inclusive leader" - one who invites and encourages participation among other group members (1996). Such leadership is exhibited in the following segment lifted from a transcript of this group's interactions in which Emily is making sure that Jessica is looking at the right thing for their assignment which requires the use of 3-D glasses.

Jessica: What am I seeing?

Emily: There is supposed to be a little hole in the middle.

Jessica: What?

Emily: Not an actual hole, but a downward slope.

Jessica: Oh!

Emily: See?

Jessica: Yeah, I saw that before.

Emily: Well then, you were looking right at it, and didn't think you saw it.

Jessica: Alright! I can see it! It's like up in the air and then goes down.

Emily: Yeah, good!

Jessica: Cool!

This series of interactions clearly demonstrates the fact that these group members worked well together and were willing to take time out to help one another when one member was having trouble understanding a concept. Such dynamics were the major factor leading to this group's identification as the highest functioning group in the class.

## **Group Two**

This group's residuals for type of request/type of help provided pairings matched those for the class as a whole, and all three group members received helpful responses more often than one would expect if events were random. The number of positive social gestures almost doubled the number of negative social gestures within this group, however, the number of times materials were seized within the group is more than twice the number of times materials were shared. In comparison to the other groups within the class, this group fell somewhere in the middle of many categories of nonverbal interactions, standing out as neither as high functioning, nor as dysfunctional. This group actually spent a great deal of time off-task, primarily due to the interactions of one individual, James, who Hogan would most likely label a "promoter of distraction," as he constantly made light of group tasks through silly or off-task behavior (1999). James demanded the attention of his group-mates, interjecting a number of irrelevant comments during every class period analyzed. A careful look at the residuals for the responses to each student's requests for help indicates that despite the similarities in likelihood that each of the students would receive a helpful response to a request for help, there were some significant differences noted in the resulting residuals corresponding to non-helpful responses. Non-helpful responses included NO (ignoring the individual requesting help), DO (doing the work for the student requesting

help), or NA (a non-specific response to a request). Tommy, who tended to be the student responsible for getting James back on task, was the least likely to receive this sort of response to a request (having a negative residual). Andre, who proved to be more of a “helper” (Hogan, 1999) than anything else, did not have a significant residual for this pairing of events. However, James’ residual for non-helpful responses was positive (12.50), primarily due to the number of times his questions were dismissed by the group as irrelevant.

Tommy seemed to acquire the highest status among the members of this group, as his ideas were typically accepted and recorded as the group’s. Furthermore, a large portion of the positive social gestures used within this group were instances in which Tommy used a tap on the shoulder or on James’ desk to get his attention and get him back on task with the group. This conjecture is supported by the data displayed in Table 9, which shows that Tommy was responsible for 57.5% of the 40 positive gestures noted within this group. James did, however, apparently possess a certain level of power within the group, as he was able to distract the group on many occasions, leading them into long periods of off-task talk and behavior before completing an assigned task.

### **Group Three**

This group was led by Angel, who acted as a persuasive leader (Hogan, 1999). According to Hogan, in groups in which there is a persuasive leader, engagement is most often substantial for the leader, but rarely for anyone else. In fact, most of the engagement by other group members in these groups arises from procedural issues rather than contextual matters. These group dynamics held true for group three, as Angel did the majority of the talking, followed by Wanda (who was most often concerned with simple completion of the

assigned task), and finally Marcus (who spoke considerably less than the other two and was ignored a significant percentage of the time). The group was extremely concerned with process, as opposed to concepts, as illustrated by the fact that a procedural question raised within this group was less likely to be ignored than in some of the other groups and in the class as a whole (see Table 6). According to Poole and Hollingshead (2005) process conflict (disagreements over how a task will be accomplished, who will do what, or how the group will proceed), which was the type of conflict most frequently observed within this group, can decrease a group's level of focus on the task and lead to lower levels of overall performance. Consequently, this group has been identified as one of the two lowest functioning groups of the class (along with group five).

Perhaps the most interesting, yet devastating, dynamic within this group is the formation of a coalition between Angel and Wanda (partially demonstrated by the fact that these two girls combined were responsible for nearly 98% of the times that materials were seized within the group – see Table 13, and a review of the tapes indicate that such “seizing” most often involved Marcus losing materials). While their exclusion of Marcus did not seem to be intentional, it was absolutely evident. Both Angel and Wanda were more likely to receive a helpful response to a request for assistance than one would expect if events were random, while Marcus was less likely to receive a helpful response. In addition, Marcus' residual for non-helpful responses was positive (indicating that he received these types of responses more often than would be expected), while the corresponding residuals for both Angel and Wanda were insignificant (see Table 8). These statistics indicate that the two girls tended to one another's needs; however, they often ignored or overlooked Marcus'.



The nonverbal behavior within this group revealed a great deal of information about the group dynamics as well. There were nearly as many negative social gestures as there were positive ones, most often in the form of a hand over the mouth, which indicates doubt or disagreement (Lewis, 1998). There was more negative body language in this group than in any other group in the class; and, often this behavior manifested itself as a back or backs turned toward Marcus during a group discussion. Furthermore, materials were taken away from an individual student (most often Marcus) more than three times as often as materials were shared among group members within this group. According to the CPS perspective, such competition over resources inevitably leads to the establishment of a power hierarchy, as evidenced by Angel's overwhelming control of the group, followed by Wanda's ability to have her voice heard and Marcus' total lack of authority.

#### **Group Four**

The group dynamics within this group proved to be very similar to those within group two. This group also spent a great deal of time off task, primarily due to the contributions of one group member, Michael (the "promoter of distraction"); and, the individual who seemed to emerge as the leader of the group, Darcy, likewise spent a large portion of her time refocusing the group. The most noteworthy difference between these two groups, however, is that in group four, the third group member (Shayla) did not receive help as frequently as the third member of group two (Andre). Shayla's residual for helpful responses was insignificant, while her residual for non-helpful responses was positive (indicating that she received responses which were not helpful more often than would be expected if events were random).

The researchers actually had more trouble pinpointing group dynamics for group four than any other group in the class. On some days, it seemed as though the group members worked really well together, while on other days, the group seemed unable to get anything accomplished. Perhaps this can be partially explained by the mixed signals being sent through the nonverbal behavior observed within this group. The students within this group used positive social gestures far more often than negative ones (outnumbering them 65 to 9), and there were only ten instances of a negative shifts in body language noted throughout the entire four days' videos within this group. However, materials were often taken away from individuals without permission during classroom activities (occurring 30 times throughout the four days' time); and, materials were rarely shared among the group members (only witnessed 10 times during the span of observation). These stark differences in nonverbal behavior patterns, paired with the lack of consistent productivity within group four, seem to indicate the strong influence of material possession within small groups. Shayla was the individual who most often had materials taken away from her, demonstrating her lack of power or status within the group; and, this status placement corresponds well with the SAS results, which indicate clearly that Shayla's questions and/or concerns were not highly valued among the group either. In addition, Shayla was responsible for 80% of the negative body language within the group, which usually occurred as a result of her frustration. On the other hand, Darcy rarely had materials taken from her, her ideas were most often accepted as the group's ideas, and the SAS results indicate that her questions and/or concerns were usually addressed appropriately (making her the high status member of the group).

## Group Five

This group has been identified as the lowest functioning group in the class due to the combination of data from the sequential analysis of helping behavior and the nonverbal interactions among the group members. The leader within this group, Sam, is best described as “alienating” (Richmond & Striley, 1996). Alienating leaders simply declare their views and disregard the ideas of any others, removing themselves from any discussion within the group; and, this is exactly what Sam did most frequently, causing a great deal of frustration for the other members of his group, especially Perry. Perry’s frustration can be detected as sarcasm in the excerpt below in which the two disagree about what is represented by a series of circles on a topographic map.

Perry: That’s another volcano?

Sam: Yeah.

Perry: I doubt it. That’s a volcano, that’s a volcano, that’s a volcano?

Sam: No, well it could be Hawaii you know?

Felipe: No, that’s where the lava . . . and that’s a volcano.

Perry: They’re all volcanoes?

Sam: That’s what this is.

Perry: OK. (said sarcastically)

Sam: Actually those other ones aren’t volcanoes.

Perry: Yeah, whatever.

Felipe: This is a volcano, because. . .

Sam: Yeah, you can tell that one in the middle is a volcano.

Perry: Alright, put whatever you want, dude. (said angrily)

By this point in the six-week period, Sam had established himself as the group's decision maker. He often completed group assignments with little or no input from the other two group members, and when the other two did try to contribute in writing, Sam frequently erased and changed their answers. There was very little interaction after the first few days the group worked together, and when there was interaction, it was usually composed primarily of interpersonal conflict in which group members accuse one another of being wrong and tell one another they are not listening to the others' point(s) of view. According to the CPS perspective, such conflict is defined by personality clashes, animosity and annoyance and it is detrimental to group performance and member satisfaction (Poole & Hollingshead, 2005).

The nonverbal behavior indicates the group's lack of functionality as well. There were only three positive social gestures used throughout four days' worth of observation, whereas there were 38 negative social gestures noted. In addition, there were 19 negative shifts in body language, and materials were seized (most often by Sam – 81.1% of the time) almost three times as often as they were shared. Both the verbal and nonverbal behavior of this group demonstrates institutional mechanisms established which assign the decision-making rights of the group to Sam. While such power was granted to other individuals within other groups in the class (such as Darcy and Tommy), none of the other class members took advantage of his/her power quite like Sam did, which led to a great deal of hostility and a lack of willingness to work cooperatively among group members.

## Chapter 5: Discussion

### *Summary of results*

The push for small group instruction within science education continues to spread worldwide. It is no secret that major plans for reform within science classrooms often focus on the switch from traditional teacher-led instruction to self-discovery (often mediated by peers within small group settings). The concept of social interaction within small groups as a venue to increased student learning has become widely accepted by the science education community. In fact, it is a key component of both the *Benchmarks for Science Literacy* (American Association for the Advancement of Science, 1993) and the *National Science Education Standards* (National Research Council, 1996). However, it is important for science teachers to understand that it is not simply the act of placing students into groups and allowing them to “explore” which constitutes better instruction. Rather, such instructional methods require meticulous planning and continuous monitoring (and intervention when necessary) in order to increase student understanding of science concepts. Without such planning and monitoring, small groups can become “mini traditional classrooms,” in which individual students act as teachers who “know it all” and must provide the “right” information to the other group members (or not, depending on the group dynamics); and, many students *still* miss out on the opportunity to learn through inquiry and exploration.

This study examined the relationships between the verbal and nonverbal behavior of students within small groups and the peer help given and received. All results were interpreted from the conflict, power, status perspective, in order to make sense of the extreme

variability in the behavior noted between individual groups. While the sequential analysis of the verbal behavior within each group indicated that every group studied demonstrated a basic level of social functionality (as the most common response to every type of question in every group was, indeed, a simple answer), the frequency of answers provided to peers which included explanations, the distribution of help given and/or received within each group, and the wide range of variability in nonverbal behavior, each contributed to a diverse array of group dynamics within the class. The apparent status and power hierarchies established within each small group in the class, as determined during the close examination of these group differences, created varying degrees of functionality among the groups as well.

Group one was identified as the highest functioning group in the class. The group members experienced very little interpersonal conflict throughout the course of the six-week period, and they shared ideas with one another more freely than the members within any other group. It was more difficult to identify a leader in this group than any of the others within the class, most likely because “talk time” and power were more evenly shared between the three members of this group than those in any of the other four groups examined. However, after careful review of the transcripts and videos, Emily emerged as the leader, (in the end) and she was most often the group member who refocused the group whenever they happened to stray from the topic of interest. Despite the difficulty with which Emily was identified as the group’s leader, her leadership style proved to be more effective in encouraging participation than that of any other group leader in the class. She was the only group leader identified as an “inclusive leader,” according to Richmond and Striley’s

taxonomy of group leadership styles (1996); whereas, each of the other group leaders in the class exhibited more characteristics of the persuasive and/or alienating leader.

The lowest functioning group in the class, group five, was identified as such because of the overall lack of content-related interaction among its group members and the leadership style assumed by the clearly identified head of this group, Sam. Sam demonstrated all the characteristics of an alienating leader (Richmond & Striley, 1996). He discouraged participation among the other two group members in several ways. He often read questions silently and answered them for the group without so much as speaking to either of his group mates; when the other two group members *did* have the opportunity to contribute ideas on paper, Sam frequently erased and revised their work (without offering any explanation); and, during verbal disagreements about Sam's ideas, the conflict often turned personal in nature, always resulting in the recording of Sam's ideas (never anyone else's). The power Sam utilized within this group seemed to be self-delegated, which could have easily contributed to the existing personality conflicts between Sam and the other group members, according to Poole and Hollingshead (2005).

Groups two, three, and four fell somewhere in between group one and group five, in terms of functionality, according to the CPS perspective - some groups sharing power and status more equally than others, each establishing its own operational structure. According to the residuals resulting from the responses offered to individual students within each group (reported in Table 8), many students within the class often received appropriate responses to their questions. However, a few resulting residuals provide cause for great concern, as they indicate that some students within the class were often ignored or had their work done for

them in response to their asking questions. The vast differences among these individual residuals (paired with the group-by-group questioning results provided in Tables 3-7) indicate findings which are somewhat contradictory to those of Wilkinson, who found that questions are more likely to receive a response if they are for information rather than action (Wilkinson & Calculator, 1982; Wilkinson & Spinelli, 1983). Our results indicate that the identification of the individual asking a question is more indicative of whether or not a helpful response will be provided than the type of question that the student asks.

### ***Unanswered Questions***

While this study provides a great deal of insight into group dynamics as related to peer help given and received within a small group setting, there are still some lingering questions left unanswered. For instance, what are the teacher effects on group dynamics? Throughout the course of this study, there were two official instructors within the class at all times and usually two to three additional data recorders (monitoring video cameras throughout the class) within the room. It is extremely likely that this unique ratio of adults to children within the class, paired with the fact that the students were aware of the fact that they were being recorded every day, affected their behavior in a positive way. Despite the fact that there was such an overwhelming presence of adults and “digital eyes” within the class, there were still some groups in which students did not work well together. This leads to the question: how much influence do “teachers” have on group dynamics?

In addition, there were some students who were clearly excluded from the decision making processes within their individual groups (i.e. Marcus in group three, Felipe in group five, and Shayla in group four). What was it about these individual students put them at such



a disadvantage? Why did their group members seem to ignore them in so many instances? Was it something that they could control (such as their own verbal or nonverbal behavior), or was it something else (such as race, gender, or simple personality conflicts)?

Finally, despite the fact that this study's findings are in direct conflict with Wilkinson's findings that an individual student is more likely to receive help from a peer if his/her request is for information than for action, some of Wilkinson's additional findings were not addressed by this study (1982, 1983). For instance, she also found that a student is more likely to receive help if he or she directs a question to a specific person and/or if he/she asks the question a second time (once it has not been answered following the initial request). It would be interesting to note, especially in the case of Marcus, Felipe, and Shayla, if such practices seemed to make any difference for them (or not).

### ***Limitations***

While this study compares the dynamics of several small groups to one another, there are obvious limitations to the conclusions which can be drawn. First of all, each of these groups was created from one small class of students with "homogeneous" ability levels (at least in terms of overall GPA). Therefore, we know little about how ability-levels may have affected the group dynamics. In addition, we know very little about the existing relationships between individual pairs and groups of students within the class, which very likely influenced the group dynamics. Although we allowed the students to self-select their groups, there were some students who were placed into groups by means of default (they did not choose anyone to work with, or no one chose them, so they were left to work with a pair of

individuals who did not have a third member). And, finally, teacher effect (which could possibly be of great influence) was not explicitly examined in this study.

### ***Recommendations***

As previously noted, science teachers are being urged to incorporate small group instruction into their daily instructional planning. However, without proper training, such instructional practices could result in disaster for some students. In order to avoid such problems, the following recommendations (which are being made based on the findings within this study) should be considered before implementation.

First and foremost, as with any instructional practice, teachers should plan carefully. No one should consider a small group lesson as one which requires less preparation. In reality, it likely requires more thought and consideration of individual students' needs than any other instructional means. It would likely be useful to have students within small groups develop some norms for participation and to practice asking specific questions (as such questions are more likely to receive helpful responses than other types of questions). Also, in order to force groups to share decision making processes, it may be helpful to assign students individual roles. In addition, do not let the same student always record any individual group's answers. Rather, require a "passing of the pen" (to the right or the left) periodically. This seemed to be fairly effective within the instruction provided during this study. In addition, when students work in groups, we found that a shared space for each group member (such as a table or a blocked-off area of the floor) proved to allow for more equal participation than individual desks which were "grouped together." While such grouping made for more clear-cut data collection (in terms of passing and/or seizing tools), this

arrangement did not seem to encourage the sharing of tools and or information among individual group members within each group.

In addition to meticulous planning, constant monitoring is a must in order to encourage positive group dynamics as well. The teacher has a responsibility to circulate throughout the class, listening carefully (without intruding or “giving” students information) to the types of interactions (both verbal and nonverbal) taking place between students within each group. He/she should monitor gestures and body language (as much as verbal participation), as nonverbal communication sometimes says more than words spoken and can possibly influence the verbal participation of individual group members (according to the findings in this study). The instructor should pay close attention to cases in which one student seems to be constantly dominating the conversation or those in which a student never participates. Under such circumstances, the teacher should intervene, asking the dominant speaker if he/she knows what his/her group mates think about the subject being discussed and/or asking the passive group member what he/she thinks. Such behavior modeling can often shift existing group dynamics, at least temporarily; and, while teacher intervention may not cause ever-lasting change, without such intermittent “controls,” individual groups can actually be counterproductive (decreasing student learning in some instances).

### ***Future Research***

This study, being one of the first of its kind (to examine the relationship between the verbal *and* nonverbal interactions which take place within small groups) has created nearly as many questions as it has answered. As a result, there are many avenues for future research in this arena. Some possibilities for additional study might include an examination of group

dynamics preceded by some formal assessment of the existing relationships between the individuals within each group; an examination of group dynamics using groups that have been created based on gender or ethnicity or ability; a closer examination of the relationship between responses offered to questions within small groups and the way in which they are asked (whether they are directed at a specific individual, second attempts, etc.); or, a careful examination of the verbal and nonverbal participation of individuals who are often ignored and/or excluded from group participation within small groups (to determine if there is anything such individuals do to “trigger” this treatment). Each of these ideas for future research would add to the knowledge base built upon by this study and would provide teachers with a better idea about best practices for implementing small group instruction within science classrooms.

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## **APPENDICES**

## *Appendix A: Sample SAS Code*

```
/* REC and FAM interaction code scheme - group interaction sequential analysis */
/* SERG - Cedar Creek - Spring 02 */
/* Data from Lynnae Flynn - followup to original Butler study*/
/* Sequential analysis using log linear statistics */

data w_in;
infile 'E:\SequenceGroup-Flynn\031102-seq_res.txt' DLM=' ';
input person $ inttype $;

/* produce input lines from sequence stream that have lag 0 and lag 1 in a single record*/
data seq_rec;
    set w_in;
    attrib laglst length=$2; /*sets char variable*/
    attrib lag1 length=$2;

    intnum=_N_;

    lag1=inttype;
    lag0=laglst;
    lagpr=lag0 || lag1;
    laglst=inttype;
    retain laglst;

run;

*proc print data = seq_rec;
*    var    intnot lag0 lag1 lagpr;
*run;

/* produce frequency counts of the lag0-lag1 pairings */
proc freq data=seq_rec;
    where intnum > 1;

    tables lag0 lag1 lag0*lag1 /out=seq_pr outexpect sparse;
run;

/* change the pairings that have a zero freq count to a very small number */
data seq_pr2;
    set seq_pr;
```

```

        if COUNT=0 then COUNT=1e-20;
run;

proc print data = seq_pr2;
run;

/* set structural zeros for repeat pairings */
data seq_pr3;
    set seq_pr2;

        if lag0=lag1 then COUNT=0;
run;

proc print data = seq_pr3;
run;

/* log-linear analysis of the lag0 lag 1 sequential pairs */
proc catmod data=seq_pr3;
    weight COUNT;
    model lag0*lag1=_response_
    / freq pred=freq noparm noresponse oneway;
    loglin lag0 lag1;
run;

```



## Appendix B: Sample SAS Output

lag0	Frequency	Percent	Frequency	Percent
AQ	4	1.25	4	1.25
CLQ	55	17.19	59	18.44
CRQ	30	9.38	89	27.81
DOU	4	1.25	93	29.06
H	109	34.06	202	63.13
N	92	28.75	294	91.88
NOH	3	0.94	297	92.81
PQ	22	6.88	319	99.69
RA	1	0.31	320	100.00

  

lag1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
AQ	3	0.94	3	0.94
CLQ	55	17.19	58	18.13
CRQ	30	9.38	88	27.50
DOU	4	1.25	92	28.75
H	110	34.38	202	63.13
N	92	28.75	294	91.88
NOH	3	0.94	297	92.81
PQ	22	6.88	319	99.69
RA	1	0.31	320	100.00

## The FREQ Procedure

Table of lag0 by lag1

lag0	lag1	Frequency,	Percent	Row Pct	Col Pct	AQ	CLQ	CRQ	DOU	H	N	NOH	PQ	RA	
Total															
AQ		4				0	0	0	0	4	0	0	0	0	
1.25						0.00	0.00	0.00	0.00	1.25	0.00	0.00	0.00	0.00	
CLQ		55				0	0	0	0	53	0	1	1	0	
17.19						0.00	0.00	0.00	0.00	16.56	0.00	0.31	0.31	0.00	
CRQ		30				0	3	0	1	24	0	2	0	0	
9.38						0.00	0.94	0.00	0.31	7.50	0.00	0.63	0.00	0.00	
DOU		4				0	0	0	0	4	0	0	0	0	
1.25						0.00	0.00	0.00	0.00	1.25	0.00	0.00	0.00	0.00	
H		109				0	8	5	1	2	89	0	4	0	
34.06						0.00	2.50	1.56	0.31	0.63	27.81	0.00	1.25	0.00	
Total		320				3	55	30	4	110	92	3	22	1	
100.00						0.94	17.19	9.38	1.25	34.38	28.75	0.94	6.88	0.31	
(Continued)															

## The FREQ Procedure

Table of lag0 by lag1

lag0	lag1										
Frequency,											
Percent											
Row Pct											
Col Pct	,AQ	,CLQ	,CRQ	,DOU	,H	,N	,NOH	,PQ	,RA		
Total											
N	3	44	25	2	0	0	0	17	1		
92											
28.75	0.94	13.75	7.81	0.63	0.00	0.00	0.00	5.31	0.31		
	3.26	47.83	27.17	2.17	0.00	0.00	0.00	18.48	1.09		
	100.00	80.00	83.33	50.00	0.00	0.00	0.00	77.27	100.00		
NOH	0	0	0	0	0	3	0	0	0		
3											
0.94	0.00	0.00	0.00	0.00	0.00	0.94	0.00	0.00	0.00		
	0.00	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00		
	0.00	0.00	0.00	0.00	0.00	3.26	0.00	0.00	0.00		
PQ	0	0	0	0	22	0	0	0	0		
22											
6.88	0.00	0.00	0.00	0.00	6.88	0.00	0.00	0.00	0.00		
	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00		
	0.00	0.00	0.00	0.00	20.00	0.00	0.00	0.00	0.00		
RA	0	0	0	0	1	0	0	0	0		
1											
0.31	0.00	0.00	0.00	0.00	0.31	0.00	0.00	0.00	0.00		
	0.00	0.00	0.00	0.00	100.00	0.00	0.00	0.00	0.00		
	0.00	0.00	0.00	0.00	0.91	0.00	0.00	0.00	0.00		
Total	3	55	30	4	110	92	3	22	1		
320											
100.00	0.94	17.19	9.38	1.25	34.38	28.75	0.94	6.88	0.31		

obs	lag0	lag1	COUNT	EXPECTED	PERCENT
1	AQ	AQ	0	0.0375	0.0000
2	AQ	CLQ	0	0.6875	0.0000
3	AQ	CRQ	0	0.3750	0.0000
4	AQ	DOU	0	0.0500	0.0000
5	AQ	H	4	1.3750	1.2500
6	AQ	N	0	1.1500	0.0000
7	AQ	NOH	0	0.0375	0.0000
8	AQ	PQ	0	0.2750	0.0000
9	AQ	RA	0	0.0125	0.0000
10	CLQ	AQ	0	0.5156	0.0000
11	CLQ	CLQ	0	9.4531	0.0000
12	CLQ	CRQ	0	5.1563	0.0000
13	CLQ	DOU	0	0.6875	0.0000
14	CLQ	H	53	18.9063	16.5625
15	CLQ	N	0	15.8125	0.0000
16	CLQ	NOH	1	0.5156	0.3125
17	CLQ	PQ	1	3.7813	0.3125
18	CLQ	RA	0	0.1719	0.0000
19	CRQ	AQ	0	0.2813	0.0000
20	CRQ	CLQ	3	5.1563	0.9375
21	CRQ	CRQ	0	2.8125	0.0000
22	CRQ	DOU	1	0.3750	0.3125
23	CRQ	H	24	10.3125	7.5000
24	CRQ	N	0	8.6250	0.0000
25	CRQ	NOH	2	0.2813	0.6250
26	CRQ	PQ	0	2.0625	0.0000
27	CRQ	RA	0	0.0938	0.0000
28	DOU	AQ	0	0.0375	0.0000
29	DOU	CLQ	0	0.6875	0.0000
30	DOU	CRQ	0	0.3750	0.0000
31	DOU	DOU	0	0.0500	0.0000
32	DOU	H	4	1.3750	1.2500
33	DOU	N	0	1.1500	0.0000
34	DOU	NOH	0	0.0375	0.0000
35	DOU	PQ	0	0.2750	0.0000
36	DOU	RA	0	0.0125	0.0000
37	H	AQ	0	1.0219	0.0000
38	H	CLQ	8	18.7344	2.5000
39	H	CRQ	5	10.2188	1.5625
40	H	DOU	1	1.3625	0.3125
41	H	H	2	37.4688	0.6250
42	H	N	89	31.3375	27.8125
43	H	NOH	0	1.0219	0.0000
44	H	PQ	4	7.4938	1.2500
45	H	RA	0	0.3406	0.0000
46	N	AQ	3	0.8625	0.9375
47	N	CLQ	44	15.8125	13.7500
48	N	CRQ	25	8.6250	7.8125
49	N	DOU	2	1.1500	0.6250
50	N	H	0	31.6250	0.0000
51	N	N	0	26.4500	0.0000
52	N	NOH	0	0.8625	0.0000

Obs	lag0	lag1	COUNT	EXPECTED	PERCENT
53	N	PQ	17	6.32500	5.3125
54	N	RA	1	0.28750	0.3125
55	NOH	AQ	0	0.02813	0.0000
56	NOH	CLQ	0	0.51563	0.0000
57	NOH	CRQ	0	0.28125	0.0000
58	NOH	DOU	0	0.03750	0.0000
59	NOH	H	0	1.03125	0.0000
60	NOH	N	3	0.86250	0.9375
61	NOH	NOH	0	0.02813	0.0000
62	NOH	PQ	0	0.20625	0.0000
63	NOH	RA	0	0.00938	0.0000
64	PQ	AQ	0	0.20625	0.0000
65	PQ	CLQ	0	3.78125	0.0000
66	PQ	CRQ	0	2.06250	0.0000
67	PQ	DOU	0	0.27500	0.0000
68	PQ	H	22	7.56250	6.8750
69	PQ	N	0	6.32500	0.0000
70	PQ	NOH	0	0.20625	0.0000
71	PQ	PQ	0	1.51250	0.0000
72	PQ	RA	0	0.06875	0.0000
73	RA	AQ	0	0.00938	0.0000
74	RA	CLQ	0	0.17188	0.0000
75	RA	CRQ	0	0.09375	0.0000
76	RA	DOU	0	0.01250	0.0000
77	RA	H	1	0.34375	0.3125
78	RA	N	0	0.28750	0.0000
79	RA	NOH	0	0.00938	0.0000
80	RA	PQ	0	0.06875	0.0000
81	RA	RA	0	0.00313	0.0000

obs	lag0	lag1	COUNT	EXPECTED	PERCENT
1	AQ	AQ	0	0.0375	0.0000
2	AQ	CLQ	0	0.6875	0.0000
3	AQ	CRQ	0	0.3750	0.0000
4	AQ	DOU	0	0.0500	0.0000
5	AQ	H	4	1.3750	1.2500
6	AQ	N	0	1.1500	0.0000
7	AQ	NOH	0	0.0375	0.0000
8	AQ	PQ	0	0.2750	0.0000
9	AQ	RA	0	0.0125	0.0000
10	CLQ	AQ	0	0.5156	0.0000
11	CLQ	CLQ	0	9.4531	0.0000
12	CLQ	CRQ	0	5.1563	0.0000
13	CLQ	DOU	0	0.6875	0.0000
14	CLQ	H	53	18.9063	16.5625
15	CLQ	N	0	15.8125	0.0000
16	CLQ	NOH	1	0.5156	0.3125
17	CLQ	PQ	1	3.7813	0.3125
18	CLQ	RA	0	0.1719	0.0000
19	CRQ	AQ	0	0.2813	0.0000
20	CRQ	CLQ	3	5.1563	0.9375
21	CRQ	CRQ	0	2.8125	0.0000
22	CRQ	DOU	1	0.3750	0.3125
23	CRQ	H	24	10.3125	7.5000
24	CRQ	N	0	8.6250	0.0000
25	CRQ	NOH	2	0.2813	0.6250
26	CRQ	PQ	0	2.0625	0.0000
27	CRQ	RA	0	0.0938	0.0000
28	DOU	AQ	0	0.0375	0.0000
29	DOU	CLQ	0	0.6875	0.0000
30	DOU	CRQ	0	0.3750	0.0000
31	DOU	DOU	0	0.0500	0.0000
32	DOU	H	4	1.3750	1.2500
33	DOU	N	0	1.1500	0.0000
34	DOU	NOH	0	0.0375	0.0000
35	DOU	PQ	0	0.2750	0.0000
36	DOU	RA	0	0.0125	0.0000
37	H	AQ	0	1.0219	0.0000
38	H	CLQ	8	18.7344	2.5000
39	H	CRQ	5	10.2188	1.5625
40	H	DOU	1	1.3625	0.3125
41	H	H	0	37.4688	0.6250
42	H	N	89	31.3375	27.8125
43	H	NOH	0	1.0219	0.0000
44	H	PQ	4	7.4938	1.2500
45	H	RA	0	0.3406	0.0000
46	N	AQ	3	0.8625	0.9375
47	N	CLQ	44	15.8125	13.7500
48	N	CRQ	25	8.6250	7.8125
49	N	DOU	2	1.1500	0.6250
50	N	H	0	31.6250	0.0000
51	N	N	0	26.4500	0.0000
52	N	NOH	0	0.8625	0.0000

obs	lag0	lag1	COUNT	EXPECTED	PERCENT
53	N	PQ	17	6.32500	5.3125
54	N	RA	1	0.28750	0.3125
55	NOH	AQ	0	0.02813	0.0000
56	NOH	CLQ	0	0.51563	0.0000
57	NOH	CRQ	0	0.28125	0.0000
58	NOH	DOU	0	0.03750	0.0000
59	NOH	H	0	1.03125	0.0000
60	NOH	N	3	0.86250	0.9375
61	NOH	NOH	0	0.02813	0.0000
62	NOH	PQ	0	0.20625	0.0000
63	NOH	RA	0	0.00938	0.0000
64	PQ	AQ	0	0.20625	0.0000
65	PQ	CLQ	0	3.78125	0.0000
66	PQ	CRQ	0	2.06250	0.0000
67	PQ	DOU	0	0.27500	0.0000
68	PQ	H	22	7.56250	6.8750
69	PQ	N	0	6.32500	0.0000
70	PQ	NOH	0	0.20625	0.0000
71	PQ	PQ	0	1.51250	0.0000
72	PQ	RA	0	0.06875	0.0000
73	RA	AQ	0	0.00938	0.0000
74	RA	CLQ	0	0.17188	0.0000
75	RA	CRQ	0	0.09375	0.0000
76	RA	DOU	0	0.01250	0.0000
77	RA	H	1	0.34375	0.3125
78	RA	N	0	0.28750	0.0000
79	RA	NOH	0	0.00938	0.0000
80	RA	PQ	0	0.06875	0.0000
81	RA	RA	0	0.00313	0.0000

## The CATMOD Procedure

## Data Summary

Response	lag0*lag1	Response Levels	72
Weight Variable	COUNT	Populations	1
Data Set	SEQ_PR3	Total Frequency	318
Frequency Missing	0	Observations	72

## One-Way Frequencies

Variable	Value	Frequency
ffffffffffffffffffffffffffffffff		
lag0	AQ	4
	CLQ	55
	CRQ	30
	DOU	4
	H	107
	N	92
	NOH	3
	PQ	22
	RA	1
lag1	AQ	3
	CLQ	55
	CRQ	30
	DOU	4
	H	108
	N	92
	NOH	3
	PQ	22
	RA	1

## Population Profiles

Sample	Sample Size
ffffffffffffffffffffffff	
1	318



## The CATMOD Procedure

## Response Profiles

Response	lag0	lag1
1	AQ	CLQ
2	AQ	CRQ
3	AQ	DOU
4	AQ	H
5	AQ	N
6	AQ	NOH
7	AQ	PQ
8	AQ	RA
9	CLQ	AQ
10	CLQ	CRQ
11	CLQ	DOU
12	CLQ	H
13	CLQ	N
14	CLQ	NOH
15	CLQ	PQ
16	CLQ	RA
17	CRQ	AQ
18	CRQ	CLQ
19	CRQ	DOU
20	CRQ	H
21	CRQ	N
22	CRQ	NOH
23	CRQ	PQ
24	CRQ	RA
25	DOU	AQ
26	DOU	CLQ
27	DOU	CRQ
28	DOU	H
29	DOU	N
30	DOU	NOH
31	DOU	PQ
32	DOU	RA
33	H	AQ
34	H	CLQ
35	H	CRQ
36	H	DOU
37	H	N
38	H	NOH
39	H	PQ
40	H	RA
41	N	AQ
42	N	CLQ
43	N	CRQ
44	N	DOU
45	N	H
46	N	NOH
47	N	PQ
48	N	RA

## The CATMOD Procedure

## Response Profiles

Response	lag0	lag1
49	NOH	AQ
50	NOH	CLQ
51	NOH	CRQ
52	NOH	DOU
53	NOH	H
54	NOH	N
55	NOH	PQ
56	NOH	RA
57	PQ	AQ
58	PQ	CLQ
59	PQ	CRQ
60	PQ	DOU
61	PQ	H
62	PQ	N
63	PQ	NOH
64	PQ	RA
65	RA	AQ
66	RA	CLQ
67	RA	CRQ
68	RA	DOU
69	RA	H
70	RA	N
71	RA	NOH
72	RA	PQ

## Response Frequencies

Sample	1	2	3	4	Response Number	5	6	7	8	9
10	1E-20	1E-20	1E-20	4	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20

## Response Frequencies

Sample	11	12	13	14	Response Number	15	16	17	18	19
20	1E-20	53	1E-20	1	1	1E-20	1E-20	3	1	
24										

## Response Frequencies

Sample	21	22	23	24	Response Number	25	26	27	28	29
30	1E-20	2	1E-20	1E-20	1E-20	1E-20	1E-20	1E-20	4	1E-20

2007 17

The SAS System

10:39 Friday, July 20,

The CATMOD Procedure

Response Frequencies

```

Sample      31      32      33      34      Response Number
35      36      37      38      39
40
ffffffffff
fff
1      1E-20      1E-20      1E-20      8      5      1      89      1E-20      4
1E-20
```

Response Frequencies

```

Sample      41      42      43      44      Response Number
45      46      47      48      49
50
ffffffffff
fff
1      3      44      25      2      1E-20      1E-20      17      1      1E-20
1E-20
```

Response Frequencies

```

Sample      51      52      53      54      Response Number
55      56      57      58      59
60
ffffffffff
fff
1      1E-20      1E-20      1E-20      3      1E-20      1E-20      1E-20      1E-20      1E-20
1E-20
```

Response Frequencies

```

Sample      61      62      63      64      Response Number
65      66      67      68      69
70
ffffffffff
fff
1      22      1E-20      1E-20      1E-20      1E-20      1E-20      1E-20      1E-20      1
1E-20
```

Response Frequencies

```

Sample      Response Number
71      72
ffffffffff
1      1E-20      1E-20
```

Maximum Likelihood Analysis

Maximum likelihood computations converged.

Maximum Likelihood Analysis of Variance

Source	DF	Chi-Square	Pr > ChiSq
lag0	8	261.76	<.0001
lag1	8	259.06	<.0001
Likelihood Ratio	55	389.81	<.0001

## The CATMOD Procedure

## Maximum Likelihood Predicted Values for Response Functions

-----Observed-----			-----Predicted-----		
Function Number	Function	Standard Error	Function	Standard Error	Residual
1	2.62E-15	1.414E10	2.409921	1.145415	-2.40992
2	2.62E-15	1.414E10	1.722994	1.151876	-1.72299
3	2.62E-15	1.414E10	-0.35843	1.242296	0.358431
4	47.438	1E10	3.455563	1.142863	43.98243
5	2.62E-15	1.414E10	3.1147	1.142788	-3.1147
6	2.62E-15	1.414E10	-0.64842	1.275394	0.64842
7	2.62E-15	1.414E10	1.390873	1.116998	-1.39087
8	2.62E-15	1.414E10	-1.7516	1.512155	1.751595
9	2.62E-15	1.414E10	2.124509	1.181234	-2.12451
10	2.62E-15	1.414E10	4.493637	1.046646	-4.49364
11	2.62E-15	1.414E10	2.412212	1.145417	-2.41221
12	50.02199	1E10	6.226205	1.036286	43.79579
13	2.62E-15	1.414E10	5.885343	1.036514	-5.88534
14	46.0517	1E10	2.122223	1.181232	43.92948
15	46.0517	1E10	4.161516	1.008139	41.89019
16	2.62E-15	1.414E10	1.019048	1.433629	-1.01905
17	2.62E-15	1.414E10	1.437581	1.187501	-1.43758
18	47.15031	1E10	4.493637	1.046646	42.65668
19	46.0517	1E10	1.725284	1.151878	44.32642
20	49.22976	1E10	5.539278	1.043691	43.69048
21	2.62E-15	1.414E10	5.198416	1.043732	-5.19842
22	46.74485	1E10	1.435296	1.187499	45.30955
23	2.62E-15	1.414E10	3.474588	1.015481	-3.47459
24	2.62E-15	1.414E10	0.332121	1.438797	-0.33212
25	2.62E-15	1.414E10	-0.64384	1.275398	0.643844
26	2.62E-15	1.414E10	2.412212	1.145417	-2.41221
27	2.62E-15	1.414E10	1.725284	1.151878	-1.72528
28	47.438	1E10	3.457853	1.14286	43.98014
29	2.62E-15	1.414E10	3.116991	1.142789	-3.11699
30	2.62E-15	1.414E10	-0.64613	1.275396	0.646129
31	2.62E-15	1.414E10	1.393164	1.117001	-1.39316
32	2.62E-15	1.414E10	-1.7493	1.512156	1.749304
33	2.62E-15	1.414E10	3.16467	1.178802	-3.16467
34	48.13114	1E10	6.220726	1.036336	41.91042
35	47.66114	1E10	5.533798	1.043742	42.12734
36	46.0517	1E10	3.452374	1.142908	42.59933
37	50.54034	1E10	6.925505	1.032278	43.61483
38	2.62E-15	1.414E10	3.162385	1.178804	-3.16238
39	47.438	1E10	5.201678	1.005183	42.23632
40	2.62E-15	1.414E10	2.05921	1.431637	-2.05921
41	47.15031	1E10	2.829288	1.178686	44.32103
42	49.83589	1E10	5.885343	1.036514	43.95055
43	49.27058	1E10	5.198416	1.043732	44.07216
44	46.74485	1E10	3.116991	1.142789	43.62786
45	2.62E-15	1.414E10	6.930985	1.032233	-6.93098
46	2.62E-15	1.414E10	2.827002	1.178685	-2.827

## The CATMOD Procedure

## Maximum Likelihood Predicted Values for Response Functions

Function Number	-----Observed-----		-----Predicted-----		Residual
	Function	Standard Error	Function	Standard Error	
47	48.88492	1E10	4.866295	1.005127	44.01862
48	46.0517	1E10	1.723827	1.431533	44.32787
49	2.62E-15	1.414E10	-0.93383	1.307658	0.933832
50	2.62E-15	1.414E10	2.122223	1.181232	-2.12222
51	2.62E-15	1.414E10	1.435296	1.187499	-1.4353
52	2.62E-15	1.414E10	-0.64613	1.275396	0.646129
53	2.62E-15	1.414E10	3.167865	1.178758	-3.16786
54	47.15031	1E10	2.827002	1.178685	44.32331
55	2.62E-15	1.414E10	1.103175	1.153698	-1.10317
56	2.62E-15	1.414E10	-2.03929	1.539463	2.039293
57	2.62E-15	1.414E10	1.10546	1.190455	-1.10546
58	2.62E-15	1.414E10	4.161516	1.050001	-4.16152
59	2.62E-15	1.414E10	3.474588	1.057052	-3.47459
60	2.62E-15	1.414E10	1.393164	1.154924	-1.39316
61	49.14274	1E10	5.207157	1.047111	43.93559
62	2.62E-15	1.414E10	4.866295	1.04711	-4.8663
63	2.62E-15	1.414E10	1.103175	1.190453	-1.10317
64	2.62E-15	1.414E10	-4.31E-7	1.441236	4.311E-7
65	2.62E-15	1.414E10	-2.03701	0.615588	2.037007
66	2.62E-15	1.414E10	1.019048	0.253556	-1.01905
67	2.62E-15	1.414E10	0.332121	0.281307	-0.33212
68	2.62E-15	1.414E10	-1.7493	0.543704	1.749304
69	46.0517	1E10	2.06469	0.241808	43.98701
70	2.62E-15	1.414E10	1.723828	0.241423	-1.72383
71	2.62E-15	1.414E10	-2.03929	0.615583	2.039293

## The CATMOD Procedure

## Maximum Likelihood Predicted Values for Frequencies

		-----Observed-----		-----Predicted-----		Residual
lag0	lag1	Frequency	Standard Error	Frequency	Standard Error	
AA						
AQ	CLQ	1E-20	1E-10	0.583261	0.299734	-0.58326
AQ	CRQ	1E-20	1E-10	0.29345	0.155054	-0.29345
AQ	DOU	1E-20	1E-10	0.036609	0.025778	-0.03661
AQ	H	4	1.987382	1.659507	0.835846	2.340493
AQ	N	1E-20	1E-10	1.18017	0.598266	-1.18017
AQ	NOH	1E-20	1E-10	0.027393	0.020847	-0.02739
AQ	PQ	1E-20	1E-10	0.210521	0.113623	-0.21052
AQ	RA	1E-20	1E-10	0.009089	0.010137	-0.00909
CLQ	AQ	1E-20	1E-10	0.43844	0.258427	-0.43844
CLQ	CRQ	1E-20	1E-10	4.686072	1.02033	-4.68607
CLQ	DOU	1E-20	1E-10	0.584598	0.300422	-0.5846
CLQ	H	53	6.645801	26.5005	3.841071	26.4995
CLQ	N	1E-20	1E-10	18.84601	2.976694	-18.846
CLQ	NOH	1	0.998426	0.437439	0.257837	0.562561
CLQ	PQ	1	0.998426	3.361791	0.820253	-2.36179
CLQ	RA	1E-20	1E-10	0.145149	0.146014	-0.14515
CRQ	AQ	1E-20	1E-10	0.220588	0.132816	-0.22059
CRQ	CLQ	3	1.723861	4.686072	1.02033	-1.68607
CRQ	DOU	1	0.998426	0.294123	0.15541	0.705877
CRQ	H	24	4.710486	13.33292	2.55314	10.66708
CRQ	N	1E-20	1E-10	9.481799	1.901579	-9.4818
CRQ	NOH	2	1.409759	0.220084	0.132512	1.779916
CRQ	PQ	1E-20	1E-10	1.691383	0.462114	-1.69138
CRQ	RA	1E-20	1E-10	0.073027	0.074009	-0.07303
DOU	AQ	1E-20	1E-10	0.027519	0.020943	-0.02752
DOU	CLQ	1E-20	1E-10	0.584598	0.300422	-0.5846
DOU	CRQ	1E-20	1E-10	0.294123	0.15541	-0.29412
DOU	H	4	1.987382	1.663313	0.837745	2.336687
DOU	N	1E-20	1E-10	1.182876	0.599634	-1.18288
DOU	NOH	1E-20	1E-10	0.027456	0.020895	-0.02746
DOU	PQ	1E-20	1E-10	0.211004	0.113884	-0.211
DOU	RA	1E-20	1E-10	0.00911	0.01016	-0.00911
H	AQ	1E-20	1E-10	1.240641	0.72031	-1.24064
H	CLQ	8	2.792623	26.35568	3.827119	-18.3557
H	CRQ	5	2.218419	13.26006	2.541975	-8.26006
H	DOU	1	0.998426	1.654223	0.833302	-0.65422
H	N	89	8.005698	53.32809	5.741847	35.67191
H	NOH	1E-20	1E-10	1.237809	0.718677	-1.23781
H	PQ	4	1.987382	9.512775	2.105514	-5.51277
H	RA	1E-20	1E-10	0.410725	0.411064	-0.41072
N	AQ	3	1.723861	0.887139	0.517523	2.112861
N	CLQ	44	6.157268	18.84601	2.976694	25.15399
N	CRQ	25	4.799437	9.481799	1.901579	15.5182
N	DOU	2	1.409759	1.182876	0.599634	0.817124
N	H	1E-20	1E-10	53.62112	5.757337	-53.6211
N	NOH	1E-20	1E-10	0.885114	0.516344	-0.88511

