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Productive Whole-Class Discussions: A Qualitative Analysis of Peer Leader Behaviors in General Chemistry

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by

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Dedication

This dissertation is dedicated to
my inspiring parents, Johnny and Linda,
for their continued love and belief in me

and to my loving husband, Sonny, the light of my life,
for his constant support and never ending encouragement,
without his encouragement I would never had been able to complete this dream

and to my devoted children, Sheila, Michael, Joshua, and Tiffany
for their compassion and continued patience throughout this process

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Peer leaders

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List of Abbreviations

ADR	Average Discussion Rating
CTQ	Critical Thinking Questions
F/R	Feedback/Responses
IP	Interpersonal Skills
PP	Procedural Practices
QT	Questioning Techniques
RTOP	Reformed Teaching Observation Protocol
SII	Strengths, Improvements, & Insights
SQ	Supervisory Qualities
Ss	Student
SS	Students
WGR	Weekly Group Report

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ABSTRACT

The intention of this research was to describe behaviors and characteristics of General Chemistry I peer leaders using a pedagogical reform method referred to as Peer-led Guided Inquiry (PLGI), and to discuss the ways in which these peer leaders created productive whole-class discussions. This reform technique engaged students to work on guided inquiry activities while working cooperatively in small groups, led by undergraduate peer leaders. These sessions were video recorded and transcribed. The data was evaluated using grounded theory methods of analysis. This study examined the dialog between students and peer leaders, paying specific attention to question types and observed patterns of interactions. The research took shape by examining the kinds of questions asked by peer leaders and the purposes these questions served. In addition to looking at questions, different kinds of behaviors displayed by peer leaders during their small group sessions were also observed. A close examination of peer leader questions and behaviors aided in developing an answer to the overall research question regarding what factors are associated with productive whole-class discussions.

Five major categories of peer leader behaviors evolved from the data and provided a means to compare and contrast productive whole-class discussions. While no category single-handedly determined if a discussion was good or bad, there was a tendency for peer leaders who exhibited positive traits in at least three of the following categories to have consistently better whole-class discussions: Procedural Practices, Supervisory Qualities, Questioning Techniques, Feedback/Responses, and Interpersonal Skills. Furthermore, each of the major categories is tied directly to Interpersonal, Communication, and Leadership skills and their interactions with each other. This study also addressed applications that each of these categories has on instructional practices and their need in peer leader training. In addition, a scale was developed for rating the relative effectiveness of whole-class discussions in terms of student participation. This study provides a tool for measuring productive whole-class discussions, as well as practical applications for peer leader (or teacher) training.

Chapter 1: Introduction

"Tell me and I shall forget,
Show me and I may remember,
Involve me and I will understand."
.... *Old Proverb*

In spite of research demonstrating that reform methods work, many educators are still practicing traditional modes of teaching. The limited success of reform is accredited to a lack of knowledge on the instructor's part about the role he/she plays when using these new methods (Staples, 2007). This study uncovers the intricate skills critical to bring about productive whole-class discussions in a reform setting, while actively involving students and increasing responsibility for their own learning. The results from this study shed new light on five over-lapping classroom practices and the role of individuals leading these discussions: Procedural Practices, Supervisory Qualities, Questioning Techniques, Feedback/ Responses and Interpersonal (or social) Skills.

Social constructivism states that knowledge is constructed in a social setting. According to this constructivist theory, students learn best when they are actively involved in the learning process as opposed to sitting passively, listening to a lecturer. We know from research that knowledge is built through interactions with others through social discourse, not directly transmitted from one individual to another (Hmelo-Silver, 2008). This study proposes an additional technique be added to small group learning environments to increase cooperation, student participation, and understanding. Periodic whole-class discussions are one way for students to continue the process of constructing meaning in an active manner. In whole-class discussions, students share ideas actively, and often reveal misconceptions. Whole-class discussions can be an effective means of bringing about conceptual understanding.

Rationale

Vygotsky (1929) first verbalized the idea that student talk precedes all learning and that students learn through verbal communication with each other. Others have said that learning is created in a social context and knowledge is constructed by interacting with others (Driver, 1994; Limon, 2001). The premise of this study is that if student talk is a measure of learning (Vygotsky, 1978) then student participation during whole-class discussions can be used as a gauge directly related to what students are learning. Whole-class discussions promote classroom engagement in that they compel students to take on a more active role in the learning process (Yazedjian, 2007). Whole-class discussions provide a social setting for students to learn and develop chemical understandings (O'Donnell, 1999).

The idea of using dialog to promote learning through class discussions is not new to science education or to learning in general. Dialog and education date back to some of the earliest ideas about learning, where stories are passed down from generation to generation in the form of folklore. The idea of Socratic learning, holding discussions through a series of questions, dates back to earlier days and is still quoted by many today as valuable lessons that have been handed down through time (Paul, 1989). Many instructors use the Socratic method to discuss complex topics, while exposing contradictions in the ways students think and feel (Hamilton, 2006). Information is transmitted in science classes through lecture, recitation, guided discussions, student generated inquiry discussions, and peer collaboration (van Zee, et al, 2001).

Whole-class discussions are being presented as a method to bring about conceptual understanding and an increase in student learning of chemistry. Integrating the ideas that talk is central to learning (Vygotsky, 1978) and should be central to teaching (Mercer, 1996) has many implications for chemical education. In chemistry classes' students are expected to take abstract ideas and varying levels of matter (macroscopic, particulate, and symbolic) and form relationships, creating conceptual understandings (Gabel, 2005). In most cases, students do not see practical application for this learning and try to get by on memorization and algorithms. In order to communicate ideas and understandings, an individual needs to employ mental processes to express his/her ideas and experiences through words (Mortimer, 1998). Whole-class discussions are being suggested as a method to provide students working in small groups additional opportunities to communicate and hear ideas.

Many different kinds of active learning environments have been developed in the last 30 years. The role of the instructor is to match the method to the desired outcome or to the desired level of cognitive processing (Mandl, 1992). Different kinds of activities need to be selected by instructors based on whether students need to learn factual information or develop mastery levels of comprehensions and understanding (Baumfield, 2002; Graesser, 1994; Hofstein, 2004; Rop, 2002; Roscoe, 2007). Constructivists have suggested that students are more active in the learning process and work better when working together in small groups to actively construct new knowledge (Bodner, 2003). When students are working together in small groups, individuals swap a multitude of ideas and perspectives. Whole-class discussions provide opportunities for student to hear other students explain how they attack and work problems. The aftermath of seeing other students model problem solving skills leads to greater understanding, enabling students to internalize and recall information. From a social constructivist standpoint, students mediate each other's learning through the practice of holding whole-class discussions (O'Donnell, 1999).

There is a good deal of information to be learned about whole-class discussions from reading the literature (Bligh, 1986; Dallimore, 2004; Kirkton, 1971; Marshall, 1985; Neff and Weimer, 2003). Each of these researchers have made long lists of things one should do while leading students in discussions. However, even with these long lists of behaviors and the integration of social constructivism into science education, instructors are still not using whole-class discussions in their classrooms (Lin, 2008). Two reasons that instructors are not using discussions in their classes are (1) educators' lack of pedagogical knowledge, and (2) the pressure to "cover" the standards. If instructors are adequately trained and provided with a supportive environment, they will be more inclined to teach using social constructivist practices such as whole-class discussions. Initial conclusions that can drawn from the literature appear to be:

(1) discussions are a great way to actively involve students in learning;

(2) there are several lists of rules for how to conduct useful discussions;

(3) teachers are not using whole-class discussions;

(4) teachers do not know how to lead successful discussions.

Whole-class discussions that involve many students are highly related to an increase in student learning (Bligh, 2000); but what should educators do to create productive whole-class discussions? If patterns that lead to effective whole-class discussions can be identified, then they can be taught to others and used to promote conceptual learning in chemistry classes. Webb (2006), compared teacher talk with student talk, stating that because classrooms are made up of so many overlapping factors, examining instructor practices may be the best place to start (Webb, 2006).

Several problems occur during the use of small groups. Instructors need to teach students to work together in groups. Videotaped observations of classes have shown that students working in cooperative learning environments spent more time on task than students working in traditional classes (Liang, 2005). However, effective group work does not just happen as a result of putting students in groups and instructing them to work together. According to King (2002), students working in groups without some kind of intervention tend to be focused only on completing their worksheets or the problems assigned and less likely to clarify ideas leading to conceptual understanding.

In Lin's (2008) study of how the classroom environment changed when students were encouraged to develop and ask questions, the major complaint from students was that they did not know what the answers were. Students working in small groups were under the impression that their teachers helped them less than they helped students in a more traditional setting; however, the students in the small groups took on a more active role in learning (Lin, 2008). Teachers are commonly expected to know and give the answers. Not providing students with answers develops into a problem for many instructors (Furtak, 2005). Permitting students to struggle with information and misconceptions before intervening is very difficult for many instructors. Instructors must permit students time to struggle with new ideas instead of jumping in and offering answers (Furtak, 2005). The same kind of problem is especially true for students leading students, also known as peer leaders. Unless someone acts as mediator with overt leadership qualities, students will continue to move through assignments racing against the clock, with the slower students getting further and further behind. Yet when instructors monopolize whole-class or small group discussions, it stands to reason that students are going to be less involved (Kirkton, 1971).

So, where is the balance between letting students actively learn and permitting educators to "share" their knowledge? When should educators compromise? The balancing act of when to explain and when to let students figure things out, leads to thoughts about what can be done to promote thoughtful interactions between different groups of students. One solution lies in holding whole-class discussions, led by students, between groups of students, to stimulate questioning skills and engage students in high-level cognitive processing. The method being examined in this study serves to benefit students by utilizing the benefits of social constructivism, increasing confidence levels, and addressing the best ways to discover the answers sought during whole class discussions.

Through a series of videotaped classroom observations conducted over the course of three years, examples of student and peer leader dialogue and behaviors were identified, categorized according to their similarities, and finally, analyzed and interpreted. The intent was to provide guidelines for leading whole-class inquiry discussions that could be used by peer leaders, teaching assistants, and teachers who are interested in utilizing more interactive practices. Additionally, the results could prove useful for those educators who are using cooperative learning groups and want to enhance student participation and learning. These techniques are valuable assets that need to be addressed in peer leader training programs, and these techniques may be necessary for those responsible for training any of the abovementioned categories of instructional personnel.

The purpose of this grounded theory research is to describe the factors that are associated with productive whole-class discussions. A grounded theory study can be used when a researcher wants to discover something about which there is no hypothesis to be tested (Strauss, 1998). Through the process of coding, categorizing, and discovering emergent themes, the unknown combination of variables that lead to productive whole-class discussions will become salient. In essence, the results of this research will propose hypotheses based upon the findings. This leaves the door open for future researchers to either support or disprove the hypotheses, most often through quantitative analysis (Glaser, 1967). A quantitative study may have supplied a general overview of the relative distribution for each of the five main categories found in this study; however, it would not have found the five categories (Marshall, 1985). This work contributes to the growing research on the use of discussions in the classroom. While the literature contains several lists of classroom practices, there is limited research on the critical components actually needed to create productive whole-class discussions. This study sought to fill the gap in the research on peer-led whole-class discussions and the behaviors needed to create productive whole-class discussions.

Overview of the Study

This study takes place in a large research university in the southeastern United States, where large General Chemistry I classes, made up of approximately two hundred students are subdivided into small sections of twenty students, who are further subdivided into small cooperative learning groups of four. An undergraduate student who has successfully completed the course (referred to as a peer leader) supervises each section of twenty. Within their small groups, students work together on chemistry guided inquiry activities. As students struggle to make sense of new and difficult chemical concepts, much of their 'meaning-making' occurs through classroom discourse. Peer leaders guide students through these activities, and encourage students to work together to solve problems as a team. This method of reform, referred to as Peer-led Guided Inquiry, has been shown to increase test scores when compared to traditional lecture classes (Lewis, 2005).

This study examines the videotaped behaviors and interactions of General Chemistry I peer leaders as they work with college students participating in Peer-led Guided Inquiry. The intent of this study was to isolate, describe, and compare different types of behaviors occurring during peer-led whole-class discussions. In order to conduct the study whole-class discussions were identified, rated, and examined for levels of discussions.

This process began by watching the videos and coding for questions asked by peer leaders and students. In all, there were eighty-four discussions held by thirteen different peer leaders during thirty-four different class sections. The data collected to answer the research questions consist of videos, which were coded for student behaviors, peer leader behaviors, and questions. Frequency counts were recorded for each class session, followed by the use of time-ordered matrices to help determine interactions occurring between the various codes.

Research Question

What factors are associated with productive whole-class discussions?

In order to arrive at an answer to the primary question, several transitional questions were explored.

1. What is a *productive* whole-class discussion?
2. What behaviors are *students* exhibiting during whole-class discussions?
3. What behaviors are *peer leaders* exhibiting during whole-class discussions?
4. What kinds of *questions* are peer leaders asking?
5. Do the various peer leader *behaviors i*nteract with each other to create productive whole-class discussions?

Limitations of the Study

The first and main limitation to be discussed here is known as the Hawthorne effect. The Hawthorne Effect refers to behavioral changes that were due to having a camera in a classroom (De Amici, 2000). While means can be taken to reduce the effect of being videotaped, the effect cannot be completely eliminated although the effect is expected to diminish over time (Bligh, 1986). To reduce the effect, video cameras were placed in the back of the room and the cameraperson remained as quiet and unobtrusive as possible. This is a common limitation in observational research of any kind (Bligh, 1986). Peer leaders were warned the first time their classes were taped, but no notice was given for subsequent tapings in order to “capture” peer leaders in a natural setting. The videos used for this study only consisted of peer leaders that were taped more than once and so it is expected that the Hawthorne effects should be marginal.

The second limitation is the small number of participants that does not permit generalizability. By quantitative standards, there were a small number of participants in this study: thirty-four videos were analyzed in total, there were only thirteen different peer leaders being observed for whole-class discussions. However, qualitative studies are not used to find generalizability (Hadjioannou, 2007). Qualitative research encompasses the experiences of the sample in order to gain awareness of what might be occurring in other classes. This is not really a limitation in terms of a grounded theory study, but needs to be mentioned for the sake of those who are not aware of the purposes of this type of study. The limitation refers to the idea that without further research, these results cannot be automatically transferred to a more global setting (Charmaz, 2006).

Chapter 2: Literature Review

"*The recognition, by teachers, of the role of language and of discursive interactions in the process of elaboration of scientific concepts has been one of the most important conditions in making possible changes in teaching practice.*"
.... Mortimer, 2000

Summary of Review Process

The literature review conducted for this study began as a search for the impact of questions in peer-led sessions. This grounded theory study started as a descriptive study of the types of questions that peer leaders ask during whole-class discussions. When a grounded theory approach is used, there is a dispute between scholars as to when the literature review should be done. Several researchers have recommended that the literature review be left until the end in order "to avoid importing preconceived ideas and imposing them on your work" (Charmaz, 2006; Glaser and Strauss, 1967). Researchers are encouraged to wait to read about the findings of others so that their data can be viewed without any bias from earlier studies.

While the researcher did set out to do a qualitative research study, she did not set out to do a grounded research study and thus began with a thorough search through the literature looking at questions. After extensive video taking, transcribing, and coding, it became apparent that the answer to what behaviors are associated with productive whole-class discussions did not lie entirely on the types of questions being asked. The researcher began to recode the videos in search for similarities and differences between the different peer leaders, classes, and discussions. It was not possible to do an extensive literature review at that time because she was not aware of the categories that would be revealed as a result of the coding processes and as such did the remaining portion of the literature review after results emerged from an independent examination of the data.

Overview of Literature Review

The literature review is divided into three parts. First is the theoretical background, which sets the stage for this study by defining social constructivism and cooperative learning. These definitions are followed by an explanation of a new reform strategy known as peer-led guided inquiry and the associated need for peer leader training. The first section concludes with a review of literature discussing the necessary components of productive classrooms.

Second is the area of focus in this study, whole-class discussions. Each idea presented builds an argument for why whole-class discussions will enhance cooperative learning settings. The argument begins with the importance of having students dialogue in the classroom, followed by a discussion of the benefits for having whole-class discussions in terms of instructor and student perspectives. The second section ends with a short discussion about the need to train individuals to lead whole-class discussions and student perceptions of these discussions.

Third is a discussion of prior research regarding each of the five aspects of teaching that emerged as salient in this study: Procedural Practices, Supervisory Qualities, Questioning Techniques, Feedback/Responses, and Interpersonal Skills. Procedural Practices deal with classroom practices and rules describing how a class operates in terms of day-to-day functions. Supervisory Qualities describe leadership skills involved in running a class. Questioning Techniques link types of questions asked to the perceived intent of the question. Feedback/Responses connects instructor replies to student levels of involvement. Interpersonal Skills relate personality attributes with social interactions, often affecting classroom dynamics.

Theoretical Background

The purpose of this research is to move beyond the question of whether or not cooperative learning is useful; rather, the desire is to discover ways to enhance a reform method that increases student productivity while working in cooperative learning groups. This enhancement involves the use of whole-class peer-led discussions to boost student learning. Understanding the theory of social constructivism provides a starting point for enhancing cooperative learning groups. Vygotsky's theory says that language is a human element and that learning in a social setting helps students to internalize new material (Vygotsky, 1978). There has been a vast amount of research stating that students have much to gain by orally communicating with each other. When students are provided with opportunities to voice their understandings, they hear alternate ideas expressed, often challenging their own ideas (Hmelo-Silver, 2008; Mortimer, 2000; Sherrod, 2008).

Considering how much time students spend in oral communication in a cooperative learning setting, and the implications for teaching and learning that whole-class discussions offer, classroom conversations and interactions have been an area of concern for many researchers (Chin, 2006; Hennings, 2008). Some studies have looked at instructors, claiming that instructors are the reasons for successful gains in student learning (Schroeder, 2007). Other studies have looked at specific types of questions being utilized by instructors, suggesting that the kind of questions asked, influence student ability to think (Chin, 2004; Elder, 1998; Winne, 1979). Still others look specifically at the structure of cooperative learning environments, claiming that it is the classroom environment that determines how much learning occurs (Guthrie, 2001). There is a vast amount of research on questions, or small groups, or whole-class discussions, but most of this research is focused on primary and secondary education and even then, any discussion of the combined topics is neglected, especially with regard to higher levels of learning. The present study looks at the combined effects of the following: instructor behaviors, questions, and classroom environments. The researcher is looking at an enhancement technique to foster student learning and increase productivity while using cooperative learning groups.

Social Constructivism

The theory of constructivism is widely accepted by math and science instructors (Byrnes, 2001). Constructivism is a theory of learning that presents a foundation for understanding how students learn new material based on their earlier understandings (Ferguson, 2007; Limon, 2001). Constructivists believe that learning is not transmitted from one person to another but instead is an active process in which learners construct understandings based on prior knowledge (Bodner, 1986; 2001; 2003; Driver, 1994; Johnson, 1983). In other words, students learn by adding newly gained information onto their earlier understandings. The theory of constructivism has four practical classroom applications:

(1) instructors should be viewed as a facilitators instead of as transmitters of knowledge;

(2) instructors should look for opportunities to reveal misconceptions, since learning is based on prior knowledge;

(3) students should be actively involved in learning; and

(4) instructors should pace activities because learning is a process and requires time (Kaufman, 2003).

Even though not all constructivists have the same beliefs about how learning occurs, they all agree that learning is based on prior knowledge and occurs through active processes. In this light, a constructivist instructor's job is to help connect the new knowledge to a student's prior knowledge. This process of connecting new and prior knowledge is often referred to as conceptual change. It is believed that conceptual change occurs because of three factors:

(1) the initiation of cognitive conflict through discrepant events, also known as disequilibrium in Piagetian terms (Byrnes, 2001);

(2) the use of skills requiring students to compare and contrast information (Hester, 1994); and

(3) the sharing of ideas through discussions (Limon, 2001).

In this research, the focus will be on the processes that lead to productive whole-class discussions and conceptual change. These whole-class discussions are based on social constructivism, the theoretical framework that emphasizes interactions among learners (Graduate Student Instructor Teaching and Resource Center, 2002)**.** Social constructivism is a theory that meaning is co-constructed through discourse (Ferguson, 2007). Studies from a variety of social sciences have examined group processes and found many positive results that emphasize the social construction of knowledge, especially in settings where elaboration and clarification of ideas are stressed as important (Michael, 2003). According to Vygotsky (1978) problem solving skills are developed through social interactions. Vygotsky (1978) states that knowledge begins as an *inter*personal process and later becomes *intra*personal. However, in order to achieve the interpersonal understanding, social interaction is crucial. Other social constructivists share similar thoughts concerning the importance of these social interactions. For example, Solomon (1987) when discussing primary and secondary education, claims that it is through the process of interacting with others that individuals gain greater understandings of their own thoughts.

Similarly, at the college level, the process of socially constructing knowledge fosters metacognitive skills in students. In a pedagogical model by Michael and Modell (2003) about helping students learn to learn, the idea of metacognition is discussed. Metacognition refers to an individual thinking about one's thinking and should be the ultimate goal of all education according to Michael and Modell. This idea is followed with a claim that the "richness" of one's education increases as material learned is connected with material learned previously, a metacognitive skill. The more links are made to earlier ideas, the "richer" the knowledge learned. This "richness" of knowledge is developed through practices that permit students to clarify and elaborate concepts. When possible, Michael and Modell encourage educators to provide opportunities for students to teach, because teaching is the best way to learn something (Michael and Modell, 2003). Using a social constructivist framework, Michael and Modell designed a pedagogical model to help instructors help students learn science. Michael and Modell's model, examining conceptual change and cognitive development, resulted in the creation of ten assertions:

(1) Newly acquired information is based on previously learned knowledge.

(2) Newly acquired information cannot be stronger than the foundation it is built on.

(3) Being asked to memorize something and solving a problem involve different skills.

(4) In order to retrieve stored information students need to develop schema to file new information so it can be recalled later.

(5) Practice alone does not bring about conceptual understanding; students require feedback at opportune times in order to know if they are doing something correctly or not.

(6) It is necessary that students build links from new information to previously learned material in order to retain and retrieve newly learned ideas.

(7) The more links a student creates between new and old ideas, the more adept the student will be at solving problems never encountered before.

(8) Not all knowledge can be directly transferred to a new situation, but the better a student understands something the more likely transfer to another situation will occur.

(9) Students working together are likely to learn more than students working alone are.

(10) Students that talk and explain their ideas seem to learn more than students who are not given this opportunity do.

While all of these assertions hold true for the reform measure being implemented in this study, the primary focus of the research presented in this dissertation is on three assertions (numbers 5, 9, and 10,) dealing with feedback, group work, and student talk. The idea that students require feedback at opportune times to move forward in learning (assertion 5), that students learn more when working together than they do alone (assertion 9), and that the students who are talking are learning more (assertion 10) support the use of whole-class discussions, the enhancement technique being proposed in this study. Holding frequent and short whole-class discussions increases the number of students involved in the problem solving process, increases opportunities for students to explain themselves, while simultaneously increasing the opportunity for students to receive feedback from other students. All ten of the assertions are listed here in order to demonstrate the interconnectedness of each constructivist idea. These assertions support a theoretical argument for teaching chemistry in a social setting, involving students in cooperative learning groups.

Cooperative Learning

.A cooperative learning group as defined by Cohen (1994) consists of a group of students who are collectively working on a task. While Cohen does not specify an exact number of students, she does say that a group should be small enough to encourage participation from everyone. In cooperative learning groups, students share how they arrive at answers and combine individual strengths to solve problems. Students do not require constant supervision – by an instructor or peer (student) leader because they are learning to work collectively together (Staples, 2007).

According to Slavin (1996), cooperative learning has been described as “one of the greatest success stories in the history of educational research.” Certainly there is a vast amount of evidence that students working together in cooperative learning groups bring about many positive benefits (Bowen, 2000; Deering, 1993; Gillies, 2004; Hogan, 1999a; Johnson, 1983; Johnson & Johnson, 1999; Lee, 2006; Mandl, 1992; Nystrand, 2003; Slavin, 1996). Studies have shown that the integration of cooperative learning in educational settings leads to the development of more autonomous thinkers with greater levels of understanding and a tendency to remember information longer (Balfakih, 2003). Results from other studies indicate that cooperative learning groups are useful in raising students’ self-esteem, and in providing for a wider sense of citizenship (Barbosa, 2004). Students also learn to listen to each other, to negotiate ideas and to make sense of new information, skills desired by employers (Jacques, 2007). Students working together for a common goal learn many processing and work-related skills, while simultaneously receiving support from each other (Sutherland, 2002). Student achievement gains have been generated from the use of cooperative learning groups (Donovan, 2005; Lewis, 2005).

There is evidence to support why cooperative learning groups work. Slavin (1996) presents four theoretical perspectives on why cooperative learning groups are so successful. First is the idea of motivation that comes from the active pursuit of knowledge. Second is the perspective of social cohesion that comes from students caring and helping each other. Third is the cognitive developmental perspective that comes from interpersonal influences, which increase student achievement (an idea stemming from Vygotsky). And fourth is the cognitive elaboration perspective, which states that in order for individuals to recall information they must relate the new knowledge to a piece of information already in their memory (Slavin, 1996). Each of the theoretical perspectives is built on the idea that students must be active participants in their own learning and that cooperative learning groups are successful because of student levels of involvement.

Being active in the learning process is often a two-fold process, implying that students can be givers and receivers of knowledge. Students learn by giving help and receiving help, by discussing ideas and concepts, and by internalizing new problem solving skills. Webb (1995) provided several interacting reasons for this. First through the process of explaining an answer or idea, students have to restructure the vague thoughts in their minds and find words to verbally express their ideas or understandings. This process in itself is very helpful and does not occur just by reading or solving problems. Second, receiving information under circumstances where it is directly applicable (like working on a project or worksheet together) helps students develop efficient problem solving skills. Webb (1995) found that immediately applying or practicing the new skill after receiving help, was the number one predictor for being able to recall the new information later.

With students taking on a new role as active participant in the learning process, changes in the role of educators using cooperative learning arise. Webb (2003) discusses four major requirements for promoting learning in small groups. First, instructors need to provide clear expectations that students should be more concerned with developing processes and understanding, than with finding answers. Second, instructors need to structure activities so understanding is critical to complete a task. Third, instructors need to model the process of asking questions until everyone is confident of an answer. Fourth, instructors need to monitor students working in groups, noticing the kinds of answers recorded in each group.

In addition to the altered roles required of educators, instructors must alter the way they measure success in cooperative learning groups. Cohen (1994) states that productivity usually refers to academic achievement, the kind that can be measured by having students take a test. When referring to small group interactions, however, productivity can be discussed in terms of "equal-status interaction within small groups" or as "positive inter-group relations." When students are asked to answer conceptual questions that do not have an apparent right answer, productivity depends on the interaction of group or class members. When working on conceptual problems, gains in student achievement are based on the frequencies of student interactions (Cohen, 1994). Given problems with 'right answers', a reliable predictor of student success is which students consistently provided detailed and elaborate answers within a group (Webb, 1983/1991). The student who does the explaining benefits. This finding is in agreement with Wu (2007) who states that in order for cooperative learning groups to be successful, there needs to be interactive engagements between students, in addition to having plenty of dialogue and discussions occurring during an activity.

Active Learning Environments

The philosophy of cooperative learning has triggered the use of new pedagogical practices in many science classes. Several alternative forms of active learning are springing up across the country: problem based learning (PBL), peer led team learning (PLTL), process-oriented guided-inquiry learning (POGIL), and peer led guided inquiry (PLGI) (Eberlein, 2008). Each of these methods of reform was designed to replace or augment lecture and involves students teaching students in cooperative learning group settings. To help bridge traditional teaching methods to more active teaching methods (PLGI in particular), two new terms need to be clarified: *peer leader* and *inquiry* activities.

Peer leaders. Some cooperative learning environments rely on peer leaders, rather than instructors, to guide students working in small groups. Peer leaders are undergraduate students who have previously passed the course. This practice of using peer-led small groups has been associated with many success stories about the effects of students leading students (Cracolice, 2001; Gosser, 1998; Hanson, 200; Moog, 2002; Staumanis, 2004; Varma-Nelson, 2004). The use of peer leaders is in support of Vygotsky's idea about how students learn new knowledge and acquire skills within a zone of proximal development. This zone refers to a region between what a student could do with some assistance and what he could do without any help. Peer leaders are closer to the students' level of understanding and provide just enough guidance to help students understand, than that of the professors with mastery level understanding (Byrnes, 2001).

Inquiry. The other term that needs to be clarified is inquiry. The National Science Education Standards assert that inquiry is understood to be an active learning process that closely reflects scientific methods. In other words, inquiry as an active learning process implies that students play an active instead of passive, role in inquiry learning (Anderson, 2002). Here the term "inquiry" refers to a change in the order of phases occurring in an instructional strategy, coined by Abraham as the Learning Cycle approach (Abraham, 2005). According to Abraham (1982) traditional learning moves students from the concept to the data: inform → verify → practice; while the Learning Cycle approach involves the data and builds to develop concepts: exploration → invention → application.

Traditional instructor centered learning begins with the '*inform*' stage, where students are expected to read a text, come to lecture and hear the instructor go over the material read prior to lecture; the concept being learned about is identified in this stage. The next phase is the '*verification*' phase typically achieved in a laboratory section, where students verify the concept learned in lecture. This is followed by the '*practice*' phase where students' work on problems concerning the concept learned in lecture and lab (Abraham, 2005). Abraham's Learning Cycle, however, moves from the data to the concept and more closely model scientific methods of reasoning through assessing data in order to gain insights into science (Global Heartbeat, 2007). These active inquiry activities begin with the '*exploration*' phase, where students explore patterns revealed in the data and are followed by the '*concept invention*' stage, where students invent an explanation for the patterns observed in the data. This process continues with the '*application*' stage where students apply the concepts uncovered in the previous stage to verify their ideas (Abraham, 2005). Inquiry therefore refers to a more scientific view of problem solving, similar to what a scientist would do in a natural setting. Scientists observe phenomena and then search for answers to explain the observations (Roehrig, 2004). As a result of trying to mimic more natural processes students in classes doing inquiry activities move through the learning stages differently from traditional classes (data → concepts instead of concepts → data).

PLGI. With an understanding of the terms peer leader and inquiry, a distinction can be made between each of the four active learning methods: PBL, PLTL, POGIL, and PLGI. These active learning methods differ from each other in fundamental ways concerning: the number of students in a group, the leader of the group(s), and the implementation of the learning cycle. First, while only a small difference, there is a difference in the number of students in each group. Second, is the matter of who is facilitating the group? Third, is the application of the learning cycle, and, in the case of PLTL and PBL, the absence of guided inquiry activities (Lewis, 2004).

PBL involves groups of 8-10 students working together on problems with an instructor facilitating the flow of classroom talk. PLTL involves groups of 6-8 students working together on problems, with a peer leader facilitating the process. POGIL involves whole classes divided into groups of 3-4 students working together on guided inquiry activities, and is usually facilitated by an instructor. PLGI is a cross between PLTL and POGIL. Whole classes are divided into groups of 20 students, which are further subdivided into groups of four, where they work on guided inquiry activities that are facilitated by peer leaders.

The PLGI approach has students taking on more of an active role in the learning process. The process of the Learning Cycle begins with the '*exploration*' phase, where students explore data and models and recognize a need for further explanations or theories to explain their findings. This is followed by the concept '*invention*' phase, where students try to explain inductively the results of a problem or activity that was performed. During the '*application*' phase, students apply their understandings and modify their ideas. Students are 'guided' through the Learning Cycles stages via the materials designed to promote thinking (Farrell, 1999).

Evaluations have demonstrated that PLGI reform sections out-performed traditional sections on American Chemical Society standardized end of the year final exams, in spite of fears concerning the damage that missing one lecture a week may cause (Lewis, 2005). PLTL evaluations had similar results, with the students involved in the smaller sections testing higher in the end of the year evaluations (Lyle, 2003; Wright, 1998). Students benefited by increased comprehension (Wilcox, 2004), lowered drop rates in chemistry classes (Coe, 1999), increased motivation (Byers, 2002), increased grade distributions (Lyle, 2003), and increased student participation (Garratt, 2000). In addition to these evaluative measures, students learned how to work together and problem solve at rates much higher than in lecture settings (Farrell, 1999). These improvements were supplemented with an increase in innovative competence, increased productivity, and marketable skills for the workforce (Micari, 2007).

Peer Leader Training

As new pedagogical practices begin to become part of our educational settings, new demands are created; one example would be the demand to train peer leaders (Hmelo-Silver, 2008). The problem is that there is not a lot of literature available concerning the skills that peer leaders need to lead students well. The literature regarding instructor skills can be mined for insights that apply to peer leaders.

It is important for instructors to model questions that promote deep reasoning and metacognition, so that students can share in the responsibility for their own learning. It is also important that instructors become familiar with the kinds of discourse moves that they can make, and the role these verbal exchanges play in stimulating or shutting down student participation (Hmelo-Silver, 2008). Instructors can encourage beneficial group interactions by encouraging students to work collectively by bringing together their different strengths and assets. Instructors will need to challenge students to work and solve problems on their own (Ngeow, 2001).

Similarly, Schroeder (2007) did a meta-analysis of research on science teaching published in the United States during a twenty-four year period, ending with 2004. These studies ranged from kindergarten to twelfth grade. Dependent variables for each study dealt with student achievement, and independent variables represented different pedagogical practices. Sixty-one studies were used in the meta-analysis and sorted into ten different teaching strategies. The most valuable contribution received from the Schroeder study, in terms of this dissertation, is her idea that if effective instructor strategies could be isolated, then perhaps they could be taught to other instructors who were less effective. In order to isolate effective instructor strategies, classroom environments need to be examined.

Classroom Environments

Trying to define a classroom environment is challenging. Hadjioannou (2007) refers to a classroom environment as a community with many different variables interacting act various levels. This complicated make up of classroom settings, and the associations between so many variables have resulted in the formation of long descriptive lists trying to explain classroom environments. Guthrie and Cox (2001) examined environmental factors that would increase student motivation, resulting in seven categories that are necessary in order to promote motivation in a successful reading course. Among them was the need for instructors to provide opportunities for collaborative learning. The results of this study indicate that not all seven categories occur at the same time or the same rate. The important findings from this study revealed that when at least two of the categories were visible in a given lesson, student participation increased (Guthrie and Cox, 2001).

In another study, six similar conditions were found necessary to create a supportive knowledge-building environment (*according to Scardamalia, 2003 as quoted by Hmelo-Silver, 2008). Again the results revealed the importance of student collaboration stating that student ideas need to be negotiated and discussed, building on each person's input. Furthermore, all members need to participate: students need to feel like they have accomplished something because of their work. And lastly, there must be knowledge-building discourse between members in a group.

Both of these examples point to how important collaboration and student discussions are. Students need to collaborate, negotiate, and discuss, while building on each other's ideas. The more students explain concepts to each other, the more likely they are to grasp the material (McNeil, 2007). There is a plethora of evidence encouraging instructors to promote student talk in the classrooms; however, instructor talk still makes up to seventy percent of the dialogue in classrooms (Boyd, 2006; Brualdi, 1998). Even in circumstances where instructors are trying to use active learning with discussions, instructors fall back to systematic formats of instructor-centered dialogues, where the discourse patterns are instructor-student-instructor-student-instructor, beginning with instructor questions and ending with instructor summations. In spite of all the research dealing with the value of student talk, instructors are still doing most of the talking. As evident in a study by Roehrig (2007) the significance of getting students to openly discuss new material is illustrated in tying together the inter-connectedness of classroom environments with whole-class discussions.

In this study by Roehrig (2007) student achievement was compared between several different science classes that were implementing a new curriculum. The results from this study indicated that there were differences in student achievement based on the classroom environment. The reform consisted of using inquiry activities and a more student-centered approach. David, a newly hired first year instructor, became so stressed from the reform measures, that he quit after one year and went on to a more traditional school setting. David, who believed he was integrating reform methods in his class, was only observed checking assignments and occasionally holding a quick discussion. David's primary goal was to have students complete their worksheets. He often expressed frustration and felt that this new curriculum was too theoretical to effectively teach math skills. David's class was summarized as being very task-centered, leaving students to draw their own conclusions. Student scores were lower for his class then for classes with wrap-up discussions that engaged students in communally making sense of the assignment. The results of David's class, as compared to the other classes, demonstrate that meaningful knowledge building is less likely to occur in situations where instructors do not intervene with questions and hold discussions about the material. David moved and left this school at the end of the year and went to work in a more traditional setting (Roehrig, 2007). Merely requiring instructors to hold whole-class discussions does not guarantee that students will automatically participate or that discussions will be successful. The classroom environment resulting from instructor discomfort, lack of skill in leading whole-class discussions, and the inability to direct student dialogue without searching for specific answers reduces the chances for productive whole-class discussions.

In summary, it can be concluded from the literature that cooperative learning groups are beneficial to students because when students are talking about the content, they are learning. Cooperative learning groups are designed to encourage student dialogue between members. What is being explored in this study is an additional means to enhance cooperative learning groups by holding frequent and short whole-class discussions, where students are the ones that are primarily involved in the talking processes. Existing literature clearly supports the idea of having whole-class discussions.

Area of Focus: Whole-class Discussions

Teaching methods that accentuate student involvement through discourse and two-way communication are regularly referred to as "discussions." A discussion typically involves an oral exchange of information, providing students with an opportunity to verbalize conceptual insights, think aloud, and receive instantaneous responses (Ewens, 2003). Whole-class discussions between peer leaders and their students are the primary focus of this study. The topic of whole-class discussions is divided into three major sections: (1) Dialogue in the classroom, which discusses several different patterns of discourse exchanges between instructors and students; (2) Arguments for having whole-class discussions from the standpoint of first, instructors and then, students as well as the benefits of having the discussions; (3) Need for training if educators are expected to led these discussions.

Dialogue in the classroom

A review of the literature revealed three different types of exchanges occurring between instructors and students. While each of these methods is similar in that each is instructor-centered, they provide direction concerning what is presently being practiced by educators. Instructors are asking questions, permitting students to respond, and then instructors are answering the students. It does not seem to matter so much how the discussions begin, but more so how the discussion develops over time (Wells, 2006). One of the goals of educators should be to promote dialogue between instructors and classmates, and classmates and classmates, because students learn when they are talking (*Franklin, 1996 as stated by Wells, 2006).

Dialogue in the classroom has been studied at for many years (Brualdi, 2005; Wells, 2006; Wilen, 1986). We know instructor talk makes up at least seventy percent of classroom discourse and usually follows a triadic pattern of exchange between instructors and students (Baumfield, 2002). A triadic form of discussion (IRE) has three parts: initiation, response, and evaluation (Boyd, 2006; Chin, 2006; van Zee, et al, 2001; Wells, 2006). The instructor initiates the discussion, usually in the form of a question, a student responds, and the instructor offers some kind of evaluative statement about the previous comment. Several problems arise from this kind of verbal exchange. First, these triadic exchanges are very structured and forced; they do not represent how things are discussed in the real world. Second, these triadic exchanges provide no opportunities for students to express their own ideas; students are typically expected to respond with the "right" answers only. Third, the final words of the instructor are evaluative in nature and not intended for promoting student discussions. The main purposes of these triadic exchanges are to get the correct answers so the instructor can move on. It is usually assumed that once a "right" answer has been given that everyone understands the material so an instructor can move on. ...If instructors could provide some form of scaffolding, leading students with only enough assistance to move forward, (Byrnes, 1996) in the last stage of triadic exchanges instead of simply providing evaluation, students would play a more active role in the co-construction of knowledge.

A slightly different form of triadic dialogue is known as IRF: initiation, response, and feedback. The last stage here is feedback, which may or may not be evaluative in nature. The feedback could be a means of encouraging students to generate further ideas that could later be tested. Similar to IRE, IRF does little to encourage student discussions due to the restrictive nature of the kinds of answers provided by students. (Chin, 2006). Triadic dialogue, where the instructor has the last word, does little to encourage student discussions. Once again, this triadic exchange is often used to check for correctness of student answers.

Another very similar form of triadic discussion involves the use of question-answer- evaluation format, QAE, in an inquiry-based classroom. In a typical classroom setting, evaluation would imply if an answer were correct or not. In an inquiry classroom, however, correctness is not sufficient because typically there is no right or wrong answer. In this kind of instructor-student interaction, the instructor does not offer up judgment concerning the correctness of an answer, but instead puts that responsibility back onto other students by asking more questions and breaking the triadic form. This form of interactive dialog is more in line with the social constructivist way of thinking because knowledge is being constructed collectively through the interactions of several students rather than just instructor-student instructor-student. All too often though, due to an instructor's lack of understanding about his/her role in an inquiry classroom, the final stage in QAE involves the instructor's summation of an answer before students can move on (Morge, 2005). The process of evaluating students' answers before they can move on, inhibits students from pursuing the issue and does little if anything to build confidence in students.

If the third and final response in the triadic exchange stimulated further discussion, another question or a comment could be posed that encouraged further elaboration on the part of the student. The triadic exchange would have greater value if educators would use student contributions to direct class discussions (Chin, 2006).

Benefits of Using Whole-Class Discussions

Comparing triadic forms of dialogue with the necessary components of cooperative learning, one can see how the triadic forms do not lead to interactive participation between students. Leading figures in college teaching and learning have stated that classroom discussion and Questioning Techniques are valuable (vanVoorhis, 1999). Everything that occurs in a classroom - from orally checking answers to discussions complex ideas without resolutions - should be linked in some way to learning. Whole-class discussions are being proposed as a way stimulate student learning through questioning, encourage students to take a more active role in learning, and enhance cooperative learning settings.

Whole-class discussions have many advantages to add to cooperative learning settings. Each of the skills valuable to small groups working cooperatively together, becomes magnified when groups participate in whole class discussions. Students must assimilate the ideas in their heads before they can explain the material to the class, and the explanation is useful to the whole class because students are all working on the same material. Whole-class discussions increase student interactions, thereby increasing student talk, an idea previously established by Vygotsky (1978) as being useful to learning. Whole-class discussions also increase social interactions and it has been established by others that knowledge is socially constructed (Bianchini, 1997; Crawford, 2000; Driver, 1994; Kittleson, 2004).

There is a vast amount of growing literature discussing the benefits of using whole-class and small-group discussions to engage students in a variety of different disciplines at varying levels (Ellis, 2008; Lee, 2006; Visschers-Pleijers, 2006; Wang, 2005; Webb, 1991; Windschitl, 1999). This list is not intended to be all-inclusive, but rather demonstrative of the growing literature and conceived importance discussions are playing in educational reform. Discussions have been encouraged in a variety of different kinds of disciplines from sciences to humanities (Boyd and Rubin, 2006; Bradley, 2002; Clarke, 2007; Favero, 2007; Guiller, 2007; Keefer, 2000; Kucan, 2007; Sawler, 2007; Pontecorvo, 1993; Solomon, 2004; Wang, 1999; Wattiaux, 2006).

In addition to the studies in different disciplines, there are studies specifically dealing with discussions in science classes. For example, Ash (2008) looked at fifth and sixth graders working in small groups during biology classes. This study revealed that the more students talked to each other about newly learned ideas, the more they began to talk and reason like scientists, integrating everyday knowledge with scientific lines of thinking. Similarly, Mortimer (1998) found that when students talked during whole-class discussions they were more likely to use scientific lines of talking.

In another study, Roehrig (2007) observed four high school chemistry instructors using a new reformed curriculum on the gas laws. This mixed method study involved instructor observations and interviews, while also measuring student learning. The results from this study demonstrated that the classrooms that implemented higher-levels of reform (more student-centered) had higher learning gains than classrooms using traditional, instructor-centered methods. The student-centered classrooms held student directed discussions, while instructor-centered classrooms held no discussions or used only instructor-centered triadic discussions. Similarly, Wu (2006) investigated students' behavioral, emotional, and cognitive involvement in instructor-centered and student-centered classrooms. The major finding to result from this study was that while there were no significant differences between the final achievement scores for each group, the student-centered groups were much more emotionally engaged. Another interesting finding in the same study was that the low-level students did better in the instructor-centered classrooms. The authors surmised that this was because the low-level students were not able to stay on topic and attentive to the assignment, another reason for holding periodic whole-class discussions.

The literature reviewed revealed benefits of whole-class discussions for both instructors and students. The first part of this section explains why instructors would want to incorporate time for whole-class discussions into their educational methods. The second part of this section includes reasons that students would want their instructors to use whole-class discussions.

Benefits for instructors. Whole-class discussions have several benefits to offer instructors in cooperative learning environments. For starters, whole-class discussions help instructors to better understand student perceptions about what they are supposed to be doing. In one study by Hogan (1999b), it was noticed that students working in cooperative learning groups spent too much time trying to figure out what to do, rather than actively involved in learning, while working in their groups. The time off-task is presented as a good reason for having short periodic whole-class discussions. One positive example involves using a whole-class discussion to have assignments rephrased. In just a matter of a few minutes, the entire class can hear what is supposed to be done directly from the mouths of other students who are rephrasing the assignment. The practice of using whole-class discussions to have students explain an assignment helps to keep students on task because they have heard the assignment multiple times.

In a three-year classroom research study, where class time was used for whole-class discussions concerning reading assignments, students spent more time using higher-level thinking skills, than in a traditional lecture setting. The whole-class discussions in this study provided many benefits. Students had more opportunities for instructor-student interactions, increased relationship building and cooperation between students, and learned valuable time management skills. These whole-class discussions provided more opportunities for spontaneous feedback, set expectations for student responsibilities for learning, and complimented different learning styles. At the end of this study student evaluations revealed that the highly motivated students preferred whole-class discussions, while the students that were less interested in the topic preferred the lecture format (Wattiaux, 2006). These results would suggest that whole-class discussions may involve more work on the part of the students. Perhaps this is the reason that non-interested students prefer the lecture format. In a traditional setting, the instructor is performing and delivering the important concepts that need to be learned while the student sits passively in his/her seat.

Another reason why educators may want to incorporate whole-class discussions into their practice is that discussions can be used to make immediate, on-the-spot formative appraisals of students' progress in several groups at one time. Whole-class discussions provide students with an opportunity to display knowledge by answering and asking questions, as well as by encouraging students to explain and justify their answers (van Zee, 2001). Whole-class discussions can also be used as a formative assessment measure, indicating problems that students may be experiencing, and thereby providing instructors with the opportunity to modify their lesson plans in order to help boost student learning (Chin, 2008). This kind of on-the-spot assessment is very useful in terms of figuring out if the class should proceed ahead with new knowledge or perhaps back track a little and have others explain an idea that is not clear.

While some educators may argue that they can check on how students are doing by listening to small group discussions, research demonstrates that students speak differently in small groups and whole-class discussions. Mortimer (1998) looked at patterns in student discourse during whole-class and small-group discussions. The results of his study revealed that students commonly used everyday language during the small-group discussions and would use scientific language when involved in whole-class discussions. Mortimer's work suggests that student small group discussions and whole-class discussions benefit students differently in regards to the construction and transmitting of knowledge in social setting. Students profit from a balance of investigating new ideas in small group discussions and communicating these new ideas in larger whole-class discussions. This process is referred to as "rhythm of discourse" and is considered an important part of classroom dialogue because students have a tendency to store and recall information better when they can apply the new knowledge to everyday ideas (Mortimer, 1998).

The idea of first having students discuss ideas in small groups and then as a whole class is further illustrated in the work of others. For example, van Zee, et al (2001) looked at the types of questions asked by students in three different kinds of settings: instructor guided discussions, student-generated inquiry discussions, and small groups. A comparison between each of these environments revealed that students asked questions when they were discussing topics that they were familiar with. Having small-group discussions before whole-class discussions would provide students with an opportunity to become familiar with the material and increase student participation and question asking.

Whole-class discussions also present opportunities for instructors to model questioning skills, while permitting students to see if they are on the right track or not, often increasing student levels of confidence. Whole-class discussions provide educators with additional opportunities to help students practice skills such as listening, rephrasing, verbalizing, and questioning. Having whole-class discussions is one more way for instructors to provide opportunities for students to self-check the success of their individual groups, while also helping to maintain the momentum of groups that may have been stuck, thus increasing their task-related interactions.

Benefits for students. Not only are whole-class discussions helpful for instructors, but students also appreciate the opportunity to share ideas. End of the semester evaluations demonstrate something about student viewpoints concerning a class. In a study by Bradley (2002) there were no significant differences in test scores of sections that used discussions and traditional classes, however, student evaluations were much higher and more positive in classes with whole-class discussions compared to the traditional lecture classes. These results are similar to Wu (2006), who also found no significant differences between test scores in classes with and without discussions.

In another study examining the effectiveness of discussions Dallimore (2004), performed a study based solely on student perceptions. Students were asked to rank professors based on how well they increased student participation, and increased or decreased the effectiveness of discussions. This study resulted in six categories of behaviors that increased effectiveness of discussions. Students ranked “required grade” for participation as a reason for both improved quality of discussions and for effectiveness of discussions. Students elaborated on the effectiveness of the discussions by discussing the instructor’s method of calling on students at random to answer questions and discuss issues, so students had to come prepared.

In addition to liking the course and coming prepared, whole-class discussions benefit students by offering other advantages. Students: (1) jointly construct knowledge, (2) synergistically work together and collaborate with their peers, and (3) share growth and understanding between classmates, which is better than what could have been achieved alone. (Wells, 2006). Discussions offer additional advantages for students by helping to develop problem-solving skills, encouraging heightened levels of thinking, promoting participation, and retaining information (Ewens, 2003).

Favero (2007) demonstrated that when instructors ask questions and permit students to answer using a whole-class discussion format, students become better at solving problems, have higher test scores, acquire useful skills to use in other domains, and bonded together as class members. This work supports the ideas presented by Slavin (1990) that discussions have constructive effects on interpersonal associations between groups of students and issues dealing with equity. Discussions, both whole-class and small-group, aid in motivating students to come to class and to do the required work before showing up for class. Additionally, students in active learning environments are more socially engaged, exhibiting increased proficiency when compared with students in more traditional settings (Wattiaux, 2006; Yazedjian, 2007).

The use of whole-class discussions has many benefits to offer students regardless of their age. For example, Empson (1999) observed a first grade class trying to learn about fractions through classroom talk and the sharing of ideas revealing that even when children as young as first graders are permitted to talk and discuss ideas, the amount of learning that occurs is compounded through discussions. In addition to improving class grades, even greater strides are made in learning to openly discuss and argue ideas with others. Involvement in interactive class activities stimulates students' abilities to think critically (Fassinger, 1995)

In another research study involving two non-majors college level science classes, ninety students were divided into seven groups of twelve to thirteen students (Lord, 2007). Each group received the same puzzle but with different sets of instructions; each successive group received incrementally more hands on active participation. The first group was not given the puzzle, just a lecture on how to solve it. The seventh group was taught how to solve the puzzle by the instructor and then the student was instructed to teach another group member, who taught another group member and so on. The groups in between one and seven received more and more hands on interactions, in increasing increments. The conclusion, student success rate increased with activity rate, in other words, the more active a student was in this process, the more success he/she experienced. The astounding part of this study is in the rate of retention weeks later: the more active the students had been, the more they retained (Fig. 2.1).

When the results of Wattiaux's (2006) study, that interested students prefer whole-class discussions, are combined with the results of Lord's (2006) study, that students retain information longer when they teach each other, the benefits of students using whole-class discussions become apparent. The cone in figure 2.1 is presented in defense of using whole-class discussions in cooperative learning environments. The cone shows that students who teach other students recall information at a percentage somewhere between eighty and ninety-eight percent. Whole-class discussions provide students with opportunities to teach each other. Whole-class discussions are presented as an enhancement tool that will help students to understand and remember chemical concepts longer than traditional lectures, because students are teaching and learning during these discussions.

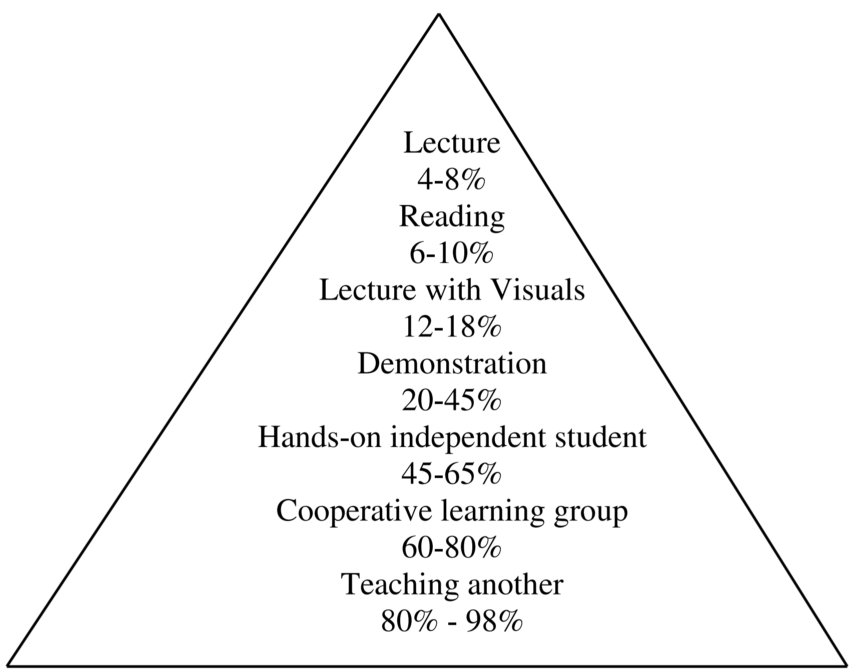

Figure 2.1 Cone of Learning: percentage of retention after six weeks.

Similarly, Meloth (1994) demonstrated a multifaceted relationship between conversations and learning; students that supply elaborate explanations, learn more than students that ask for help and more than students that give out answers do. The results coincide with Lord that explainers (or students that teach others) remember the material for a longer period. While other studies have found that the use of whole-class discussions also increases a student's ability to change his/her mind on a particular belief or stance, while simultaneously increasing a student's ability to express reasons for their personal beliefs, a life skill worthy of holding onto outside of a classroom setting (Grace, 2007).

Others have observed that the levels of student interest were higher with discussions than the more traditional lecture classes (Bradley, 2002; Favero, 2007; Wu, 2006). Discussions increase the likelihood that information learned in class will be remembered and recalled (Lord, 2007). Discussions greatly enhance student understandings (Hadjioannou, 2007). Research revealing that students have greater understanding and higher rates of retention clearly illustrate why students would want instructors to use whole-class discussions.

Need for Training

Training is necessary, then, in order to facilitate productive whole-class discussions. Many researchers agree that learning is "most effective" when students are provided with opportunities to discuss new material (Wells, 2006). Research results indicate that whole-class discussions are beneficial, but as stated by Roehrig (2007) just telling instructors to conduct whole-class discussions does not guarantee much success.

Instructors need training in developing skills to productively lead whole-class discussions and actively involve students in more than simple recall of questions. Instructors need to learn how to promote whole-class discussions and students need to learn how to participate in whole-class discussions. Should instructors be told to read the literature, to use active teaching styles, and to lead more whole-class discussions? There are several books with either a collection of articles for instructors to read or with lists of kinds of discussions and when each style should be used (Bligh, 1986; Jaques, 2007; Neff and Weimer, 2003). Instructors, as learners must be permitted to absorb new information before they can incorporate new skills and apply them (Zohar, 2006). It is not enough just to tell someone that they need to integrate new forms of teaching, instead you must educate and train instructors regarding new pedagogical reforms.

It would be easy to see why an instructor could say that using whole-class discussions does not work. In a study by Anderson (1997) twenty fourth-grade student discussions were analyzed. The instructors in this study were using active forms of learning and using whole-class discussions. The results of this analysis revealed that student arguments given during discussions are oftentimes not clear due to their misuse of pronouns and everyday expressions. Students do not state conclusions and finally they do not provide support for the things they do say. These results were very disappointing to the instructors involved. In another study by Newton (1999), classes were observed which were claiming to use reform methods that included the use of discussions; the results of viewing these secondary science classes showed that the classes were primarily instructor driven. Of the thirty-four classes observed, only two held whole-class discussions and these were instructor driven and lasted no more than ten minutes. Other researchers analyzing group discussions have found that the primary focus of most groups was on Procedural Practices (Albe, 2008; Kittleson & Southerland, 2004). This activity, although necessary, can cause a group to stay stuck for too long of a period and therefore slows down their production if not managed properly. Learning to use discussions successfully is one of the critical aspects of using discussions (Dallimore, 2004).

Instructors need to facilitate discussions, without telling students the answers and without relying solely on the use of recall Questioning Techniques. Chin did a study where instructors used cartoons as a scaffolding measure, providing an alternative way for educators to tap into students' thinking. The results of this study indicated the importance of an educator's role in promoting discussions by remaining neutral and asking probing questions (Chin, 2008). Often students get the right answers for the wrong reasons; asking for clarity, explanations, and justification can indeed help students see the flaws behind their thinking, as well as provide the opportunity for educators to reevaluate the way student understanding is progressing. Cohen (1994), found a negative relationship between instructor talk and small-group interactions, the more often small groups were interrupted with instructor instructions, the less students talked. This means that students should be permitted time to discuss amongst themselves. Instructors should encourage students to work together and should refrain from presiding over the groups, telling them what needs to be done next. It is through student discussions that students learn. Groups of students should be permitted time to struggle with the new information before an intervention occurs, but without training how would educators know that their students need time to discuss. Ideally, interventions should involve other students, a good reason for whole-class discussions, and instructor training.

Instructors can be taught to guide class discussions by using student questions to direct the focus of the discussions instead of only going over questions pre-selected before class began. Students in turn, also need to be taught how to use discussions to enhance their educational experiences. Wang (1999), as a result of first asking students questions while they were working in small groups, found that whole-class discussions vastly improved. Grice (1989) suggests that people contributing to a discussion should make their contribution as informative as required, without saying more than is required; less leaves the listener confused, while more is boring (*Grice 1989, as cited by Anderson, 1997).

Emergent Categories of Behavior

These guidelines suggested by Grice concerning what students should and should not say during a discussion (i.e. How much information is enough? When does enough become too much?) are indicative of the complicated interactions occurring during whole-class discussions. According to the literature, instructors should use whole-class discussions to engage students in learning and while there are several lists of "things" instructors should and should not do, there is very little literature concerning the processes that help instructors to lead productive whole-class discussions. Many different interactions occur during these discussions. As previously mentioned, after videotaping, transcribing, and coding, several categories of peer leader behavior emerged.

The remaining portion of Chapter 2 will be spent reviewing literature discussing the five categorical findings that emerged from this qualitative grounded research study. This part of the literature review was explored after the analysis of all the data (Charmaz, 2006; Glaser and Straus, 1967). The literature was examined for each of the resulting five categories in order to learn what was already known about each of the categories and to determine if the results of the present study supported or refuted prior research findings.

Procedural Practices will be discussed first because they are the easiest to see in a classroom. Procedural Practices refer to the routines that an instructor uses to make a class run smoothly. After that, Supervisory Qualities will be discussed. In order to use Procedural Practices well, an instructor should have good Supervisory Qualities. Instructors do not need to be authoritarian, yet they need to have control in the classroom. Proper instructional supervision influences student willingness to participate which often determines the kinds of questions that will be asked and answered in the classroom. Likewise, the kinds of Feedback/Responses given to students after a question is asked or an answer given will influence the level of student participation. Interpersonal Skills are a logical extension of all four of the previous behaviors. In order to build a rapport with students, one needs to have more than an authoritarian or an authoritative outlook. Subtle nuances of personal interactions are very important in creating a classroom atmosphere. Classroom atmosphere determines student comfort and willingness to participate in whole-class discussions.

Procedural Practices

Procedural Practices of instructors are often referred to as organizational skills and are highly stressed in instructor training manuals. These organizational skills establish the kinds of routines that develop in a classroom and determine how a class operates. Routines can range from how you enter and leave a room, make transitions between various activities, turn in homework assignments, pass up papers, or how the instructor gets a class's attention (Johnson, 2005). Bafumo (2005) states in her article *Operation Organization,* that being committed to organization is a valuable asset that would profit instructors. She goes on to say that organizational skills are what separate effective instructors from ineffective instructors (Bafumo, 2005). While others feel that developing skills which emphasize organization and time management are valuable for both instructors and students (Boller, 2008).

In order to smoothly incorporate Procedural Practices into a classroom setting that will become routines, the instructor needs to be organized, and thoughtful about the kinds of problems that may arise during class. Hennick (2007) states that it is worth the little bit of time that it takes in the beginning of the semester to teach students the procedural routines that an instructor wishes to incorporate into his/her classes. Hennick claims that starting the year off with an emphasis on procedures will save time over the semester. Classes will get a lot more done because students will not have to break old habits and replace them with new ones. Students quickly learn the routines and most often do what is clearly expected of them. The time it takes to establish Procedural Practices is valuable and will "pay" for itself in the end.

Petrie (1998) reiterates the importance of teaching students classroom procedures by claiming that the use of routines helps to diminish disruptive classroom behaviors. Rademacher (1998) reports that effective instructors plan routines that help classrooms run smoothly. In addition to planning, effective instructors clearly tell students what the Procedural Practices are in addition to explaining their importance. Effective instructors who elaborate on the Procedural Practices deal with problems quickly and quietly so as not to reinforce negative behaviors. Consistently following classroom procedures increases students' sense of self-respect. Student-instructor relationships can be destroyed from student lack of understanding about classroom procedures and instructor hasty responses to correct something that was not clear in the beginning (Sharpe, 1998).

The phrase Procedural Practices can also refer to nonverbal behaviors. Petrie (1998) discusses nonverbal Procedural Practices as a way of creating a classroom environment. Nonverbal techniques include the instructor's physical proximity, the instructor's body language (such as smiling, frowning, and crossing of arms), the instructor's voice, and the instructor's arrangement of the room. Nonverbal Procedural Practices can convey friendliness or disdain, helping to build or tear down relationships with students, quite unintentionally. The basic rules of nonverbal cues are best when used as preventative solutions. Instructors need to be aware of their expressions. Often verbal techniques can be invalidated by facial expressions that say the opposite (Petrie, 1998).

It is not just instructors that benefit from being organized and integrating Procedural Practices into their lessons. De Smet (2007) observed peer tutor behaviors and coded for events occurring in three different categories while working with small groups. The three coded categories were organizational and social support, facilitation of learning contents, and facilitating knowledge construction. The results of this coding process indicated that organizational and support skills were demonstrated more than the other two, indicating that various different "kinds" of instructors benefit from Procedural Practices that emphasize organizational skills. While each of the studies cited here support the use of Procedural Practices in a classroom they offer no evidence that the instructors (or peer tutors) are indeed effective merely as a result of being organized.

Supervisory Qualities

Procedural Practices are not enough on their own; instructors must also possess other behavioral traits, which may include Supervisory Qualities: management skills, which embrace authority without being too over-bearing and appearing authoritarian. Procedural Practices deal with classroom practices that an instructor establishes, but students follow, while Supervisory Qualities are traits observed in an instructor involving leadership qualities. In an attempt to see if classroom management is related to student interest in a classroom setting, questionnaires were administered to 1900 students in an assortment of different schools for several years in a row. This study revealed a positive correlation between classroom management strategies and student interest. Effective instructors established clear guidelines and monitored students' adherence to the rules. Students felt that having constant supervision helped the class to flow while also involving the majority of students and increasing student competence (Kunter, 2007).

While active participation is desired in classes today, instructors should not presume that students will appreciate the significance and function of an activity. If students do not see the usefulness in what they are doing, they will see the activity as useless and unprofitable and will be less inclined to participate. Relating this activity to the course material or some other practical application will help students to see the significance of an activity. Strategies for getting students involved include lecture, reading, homework, and instructor modeling. Providing discussions and time limits for various activities will aid in the flow of the class and make the transitions from one activity to another easier and more comprehensible (Yazedjian, 2007).

In order to develop a full picture of the opportunities provided to students in a particular setting, it is necessary to gain an insight into the social setting within a classroom, in addition to understanding how an instructor organizes and supports students in a collaborative setting. In a study by Staples (2007), the instructor being observed used discussions on a regular basis in her teaching. One component of this instructor's effective practice was offering support to students as they contributed to discussions. The instructor's use of Supervisory Skills helped students share freely without fear of being laughed at and to control the flow of the class. The instructor observed in this study encouraged negotiation of meanings among students. Her role was a very active role throughout the year; although students became better at negotiating amongst themselves, they did not become self-governing.

Other studies have found that the amount of time an instructor spent in procedural and supervisory activities in a class were found to be inversely proportional to the levels of self-efficacy. The more self-efficacy an instructor has, the more willing the instructor tends to be in terms of risk-taking and the more apt instructors are in conducting whole-class discussions (Haney, 2002).

Questioning Techniques

Supervisory traits are not enough on their own; instructors must also possess other behaviors, which may include Questioning Techniques. In a traditional classroom, question answering and asking are ordinary practices regularly spotted in classroom observations. Questions are the most prototypical of all instructional activities that occur in a classroom setting (Gavelek, 1985). The single most frequent classroom event involves a question (Brualdi, 2005; Gavelek, 1985; Hammer, 1995; Shodell, 1995; Sutherland, 2002; Teixeira-Dias, 2005; Webb, 1995/ 2003;). There is an abundance of literature across a variety of disciplines that addresses issues regarding the timing, characteristics, and use of instructor questions (Gall, 2007). Many researchers agree, however, that there is limited research concerning student questions at any level, especially in cooperative learning groups (Baumfield, 2002: Brualdi, 2005; Gavelek, 1985; Harper, 2003; Hofstein, 2004/ 2005; Hogan, 1999a). There is even less literature available on the use of peer leader questions in cooperative learning groups.

The discussion on questions is different from the previous sections because of the vast amount of research performed in this area and the impact on student learning. Consequently, the topic of questions is subdivided into five subsequent sections. Previous research on effective Questioning Techniques will be examined first in order to establish guidelines about what is already known. Second several other studies have examined the kinds of questions asked by instructors; these will be compared and contrasted with the present study in Chapter 5. Still others have looked specifically at instructor or student questions. Both of these areas will be assessed. The last part of this section will discuss Questioning Techniques specific to whole-class discussions.

Instructor use of questions. Instructor talk makes up at least seventy percent of classroom discourse and usually follows a pattern of initiation, response, and feedback (Baumfield, 2002). Prevailing research reveals that instructors ask between 300 to 400 questions in a given day (Brualdi, 2005; Wilen, 1986). In fact, studies show that the majority of class talk is initiated by instructor questions (Brualdi, 2005). Instructor use of questions is not new to academia; ninety years ago research stated that eighty percent of an instructor's day was spent in asking questions (Brualdi, 2005; Durham, 1997). Asking questions is considered, as a rule, to be a prominent teaching tool because of the power of the question to impact student thinking and learning (Durham, 1997). There is an abundance of literature across a variety of disciplines that address issues regarding the timing, characteristics, and use of instructor questions (Boyd, 2006; Chin, 2006, 2008; Durham, 1997; Ge, 2004; Kirkton, 1971; VanVoorhis, 1999; Wilen, 1986;). Some who state that training specific to asking questions improves student achievement gains (Redfield, 1981). While many areas of teaching may have changed throughout time, this is not one of those areas. Asking questions continues to be the most conventional technique used by instructors for instigating responses from students (Baumfield, 2002).

Why do instructors use so many questions? Instructors ask questions for a variety of different reasons. According to Taba, as quoted by Wilen and Baumfield, instructors ask questions because it is "the most influential single teaching act" (Baumfield, 2002; Wilen, 1986). It is generally alleged that one must be competent at questioning in order to be a skillful instructor (Brualdi, 2005). There seem to be two major reasons why instructors use questions: to help instructors and to help students.

Questions help *instructors* by:

- Providing a means for instructors to evaluate and assess student conceptions and misconceptions, monitor student behavior, and solicit feedback (Wilen 1986; VanVoorhis 1999).
- Aiding in the development of lesson pacing and revisions (Brualdi, 2005).
- Maintaining the flow of classroom activities (Baumfield, 2002; Wilen, 1986).

Students are helped by instructor questions because they provide opportunities for students:

- to openly articulate their ideas, thereby increasing student participation;
- to listen to different interpretations from their peers (Brualdi, 2005);
- to answer higher-ordered questions, increasing levels of conceptual understanding (King 2002).

The art of asking questions involves more than just picking the right kinds of questions to ask. There are an abundance of different thoughts concerning the use of questions. For example, how long should instructors wait for an answer, how many questions should instructors ask, and at what levels should questions be asked? The average time that instructors waited between asking a question and calling on a student to answer is between one to three seconds. Researchers observed that instructors provided extra time when asking clarification or explanation questions (Heinze, 2006).

In terms of how many questions to ask, researchers learned that student achievement was not related to the number of factual or higher order questions asked by an instructor (Winne, 1979). Science is centered around asking and answering questions. Our classrooms however are centered on answering questions, however, asking good questions is often harder than answering them, and is a valuable skill to teach students. One way to teach this skill is through modeling (Orr, 1999). In a study by Baumfield (2002) they found that often students did not ask questions because they were afraid they would embarrass themselves in front of their peers and because they had poor modeling of question asking by their instructors.

Kinds of questions used by instructors. In a study performed by Tan (2007) in an English class in China, instructors were observed using questions for multiple purposes, such as checking on student understanding, maintaining classroom control, demonstrating authority, gaining respect, and keeping students' attention. Five kinds of questions were observed in these classes: yes/no questions, short answer/retrieval-style questions, open-ended questions, display questions, and referential questions seeking new knowledge. The impact of the kinds of questions asked in these classes was considered negative because instructors over used questions to steer students directly to answers. Students were not permitted to think independently of the instructor or to investigate other options. These traditional ways of teaching are thought to hinder many students and suggestions are made to decentralize ways of teaching. Tan suggests that instructors reduce the number of low level questions being asked, permit students more time to answer questions, and encourage students to be more responsible for their own learning.

A positive example of instructor's use of questions can be found in a study of fourth and fifth grade elementary English language learners observed by Boyd (2006). Boyd looked at an instructor's use of questions based on the kinds of student responses elicited. Three major forms of questions were coded for in this study: display questions, authentic questions, and clarification requests. Questions were coded as display questions when it was presumed that the instructor knew the answer to the question she was asking. When it was implicit that the instructor did not know the answer, the question was coded as authentic. Clarification questions were those questions asking for more details or descriptions. The results of this study demonstrated that it was not the actual kind of question that was asked that stimulated student talk, but more a combined effect from building on student responses. This questioning technique proved to be very effective.

Research on effective questioning techniques. In a review on effective instructor questions and Questioning Techniques, Wilen (1986) stated that questions are an extremely powerful teaching tool because of their outstanding ability to influence student thoughts and knowledge (*Taba, 1966 as cited in Wilen, 1986). Questioning Techniques were correlated with student achievement, resulting in the identification of eleven effective questioning practices. Effective instructors phrase questions clearly and ask questions that are related to the subject matter rather than procedural. Effective instructors match the cognitive demand of a question with the cognitive ability of a student. For example, effective instructors ask lots of low level questions in low level classes and ask high cognitive level questions in higher level classes. Effective instructors allow three to five seconds of wait time before rephrasing a question. They encourage students to try to answer, use an equal number of volunteer and non-volunteer answers, and permit students to shout out answers in unison on occasions. Effective instructors encourage positive responses by asking recall questions to make students comfortable, asking for clarity to help students elaborate, and using specific praise to help students feel confident (Wilen, 1986). When looking deeply into this literature it becomes clearer that an instructor's Questioning Techniques involves more than just *asking* questions.

Additional studies reveal more components of the effective Questioning Techniques. Research by Chin (2004) uncovered six things that educators could do to stimulate deeper thinking through questions. (1) Become familiar with the various levels of thinking elicited by different types of questions. (2) Be aware of the cognitive skills that you are trying to develop in your students and craft questions to help attain these goals. (3) Provide wait time, in other words, pausing after asking a question and before calling on someone. (4) Present a friendly and helpful educational setting. (5) Pay attention to the kinds of questions they ask and their responses. (6) Seek out opportunities to ask questions. As the literature is examined, it becomes obvious that just asking questions is not enough to stimulate student talking and encourage whole-class discussions.

The more a researcher investigates an instructor's Questioning Techniques, the more he/she becomes aware of the evolving intricacies of asking questions. For example, according to a later study by Chin (2008), asking questions is not a simple undertaking. In addition to the six factors revealed in a 2004 study, Chin reflects on four major factors that instructors must consider when using questions as a teaching tool. Instructors need a good grasp of the material, they need to be able to successfully link questions together to construct learning, they must be able to encourage student participation, and they need to be able to get through the designated material in a timely fashion. In order to effectively use questions as a means of teaching students, instructors need to reflect on what it is that they hope students will learn in a particular class session and then plan for the links between what students already know and what it is that they would like students to know.

Reflecting and thinking before planning a class is critical to effectively leading students with questions, but thinking in one's mind and actually doing something are usually quite different from one another. One-way to observe oneself in action could be with a video camera, as did Speer (2008) in a study involving a calculus-teaching assistant (TA). The TA was videotaped during recitation classes that meet three times a week. In these recitation classes, TAs were directed to act as facilitators, asking questions and pushing students for information and explanations, while students worked together in small groups. Soon after each taping, the researchers and the TA would sit down and discuss the videos together. In these discussions, the TA would explain what he was doing and why he made the instructional decisions that he made, specifically referencing the video portion being discussed. The preliminary results of this study suggest that instructor-student conversations can be categorized into five different classifications. These TA-student discussions were based on: procedural administrative things, going over correctly solved answers, detected errors before a discussion, detected errors during a discussion, and working with students that are having difficulty on a question. Through the process of watching the videos and explaining his actions to the researcher, the TA was able to observe the immediate effects of many of his actions and refine his use of questions. In this capacity a teaching assistant performs as an instructor would in a classroom, but is actually still considered to be a student because he is continuing to improve upon his ability to question students and bring about the intended results.

Student gains from asking questions. Because "questions are at the heart of the scientific investigation" (Middlecamp, 2005), instructors should be teaching students to ask questions, in addition to just answering them. Asking questions motivates students to be self-learners while simultaneously influencing cognitive processes and facilitating different kinds of learning (King 2002). Before a student can formulate a question there must be some kind of "knowledge-constructing" occurring within the mind of the individual (King, 1994). In order to put together a question, a student must have thought about what he already knows and try to piece it to what he/she is trying to learn (Shodell, 1995). Just because a student answers a question with the correct answer does not imply that he understands, but in order to ask a high-level thought-provoking question, understanding must be present.

Some educators feel that it is possible for students to get answers right without knowing what they are doing (Van Voorhis, 1999). For example, Harvard graduates were asked about what created the seasons (Schnepps, 1988). The majority of the students asked did not know the answer; most of the students talked about the Earth being closer to the sun and did not mention anything about the Earths tilt on its axis, in spite of taking numerous science classes before graduating. Unless students feel free enough to ask questions, chances are that instructors will not be able to help students with their misconceptions.

In another study looking at student questions, Miyake (1979) noticed that in order for students to ask questions, they had to know something about the material being discussed: students did not ask high-level questions about material they did not understand. In a lecture setting where students are usually hearing information for the first time, students are less likely to ask questions. In a small group setting where students are actually working together on problems, there is a greater chance that students will ask questions before they become too lost for a question to help (Miyake, 1979).

The literature indicates that while students may not see the immediate benefits of asking questions in class that there are many. In a review of intervention studies teaching students to ask questions, Rosenshine (1996) found that students who were taught to ask questions as they read through textbooks had improved comprehension skills. The other benefits mentioned in this section, such as constructing knowledge in order to ask questions, and revealing misconceptions, may not be readily identified by students as benefits to asking questions. Instructors will have to continue to model asking questions and continue to prompt students to ask questions.

Questions in whole-class discussions. In addition to using questions to check for student understanding, keep students' attention, and uncover student misconceptions – questions can be used to direct whole-class discussions. Whole-class discussions have been presented as a way to actively involve students in the learning process. Questions have been presented as way to actively involve students in the learning process. What is being explored in this section of the literature review is the use of questions to actively involve students in whole-class discussions. The major reason for ineffective whole-class discussions is due to the kinds of questions being asked by instructors, according to Kirkton (1971). The questions being asked by instructors to stimulate discussions are factual, recitation kinds of questions that do little or nothing to stimulate student thinking, and therefore little to stimulate discussions. Student questions are also valuable in classroom discussions. Questions demonstrate what students do or do not understand and misconceptions held by students. Student answers to questions, should direct the next phases of teaching (van Zee, 2001).

In an effort to investigate effective questioning skills in elementary students, researchers found that students participated in whole-class discussions when instructors set up their classes to explicitly request questions concerning topics that were familiar to students (Van Zee, 2001). Other researchers found that the higher the level of instructor questions asked, the more interactive the class became (Erdogan, 2008). Instructors should therefore structure their classes so that both the instructors and the students are asking high-level questions.

In another study, student and instructor questions were analyzed during discussions resulting in seven assumptions, four based on student use of questions and three based on instructor use of questions. The results of this study revealed that students asked questions when they were invited to ask questions, knew something about the topic being discussed, felt comfortable in the classroom, and worked in groups. On the other hand, the instructors involved in this study asked questions to develop conceptual learning and to bring about student thinking. The three assertions dealing with the instructors use of questions dealt with times when instructors were trying to develop student understanding, when instructors were asking students to clarify their answers, and instructors implementing "wait time," the amount of time provided by an instructor for a student to answer (van Zee, 2001).

In another study, Christoph and Nystrand (2001) observed a ninth grade English instructor and concluded that instructors who led effective discussions incorporated three strategies into their classes. These tactics involve the development of a classroom culture of respect, phrase questions in a manner that encourages students to talk, and most importantly, permitting time for the development of student interpersonal relationships. The results of Christoph and van Zee did not uncover any ideas that were not already observed when looking through the research on effective Questioning Techniques. This would imply that learning to effectively use questions would benefit instructors from many different standpoints since the way that questions should be used does not differ between settings.

Feedback/Responses

Asking questions demonstrates several things about an individual's understanding; it depicts the arrangement of information concerning an individual's knowledge. However, a question does not exist in isolation; it exists as an interacting dyad with two parts, a question and an answer. To focus on only one part would mean that you are only telling half of the story. Several studies have examined instructor responses to student questions, each resulting in a list of the kinds of responses. The results of some studies indicate that lack of student participation might be due to the ineffective instructor responses (Durham, 1997). It is, therefore, essential that instructors learn to give feedback that aids in developing effective classroom discussions instead of merely giving answers (Keefer, 2000).

With the increase in the use of inquiry based classrooms there is a need for educators to develop strategies for withholding answers. In an inquiry setting where instructors were trying to learn to withhold answers, Furtak (2006) observed the kinds of

Feedback/Responses that instructors gave students. Instructors were observed answering students from either a constructivist or scientific viewpoint, meaning that instructors either encouraged students by gently guiding them or that instructors left students to figure out what they could on their own. Instructors either withheld or directly gave answers, or provided students with hints (Furtak, 2006).

Similar results are reiterated in a study by Chin (2006) stating that instructors respond to students in several ways. If a student gives a correct answer, an instructor can either announce that the answer is right and move on or ask more questions that build on the previous question. If a student's answer is incorrect, an instructor could correct the incorrect answer by explicating telling the "right" answer or they could ask more questions that build on the previous question in order that students can determine that the last answer does not "fit" the new ideas or answers. The last choice, to ask questions, works best in both situations (if an answer is correct or incorrect). If the instructor remains neutral, does not offer evaluative comments, and always follows the same format, then students cannot guess the correctness of an answer merely because the instructor asks more questions.

Hammer (1995) believes that he can gain understandings about what students believe by holding discussions, listening to his students, and remaining neutral. His secrets for leading a successful discussion are (1) do not tell students their answers are wrong, (2) allow plans to be diverted by student questions and references of understanding, (3) participate only as a facilitator, and (4) permit students to explore and reason by being sensitive to their levels of understanding (Hammer, 1995).

Student responses to questions can be used as a means to gauge student understanding. This process is referred to as formative feedback and is aimed at enriching student learning and instructor understanding. Feedback provides benefits for both instructors and students. Formative assessments are defined as socially interactive opportunities for both students and instructors to communicate meanings and understanding. Student responses to questions permit instructors to gain an understanding of what students understand, while simultaneously helping students to see if they themselves understand (Cowie and Bell, 1999). The skills required for educators to effectively use student comments as formative assessments mean that educators must notice what students are doing, recognize the significance of what students are saying, (either positively or negatively) and respond with feedback appropriate to encourage student development. Instructors need to overhear students working and be available for student questions (Cowie and Bell, 1999).

There are other decisions that an instructor needs to make when providing students with Feedback/Responses, such as, how long do I [the instructor] need to wait before intervening, how will I intervene, and which method will I use? Instructors must continuously make on-the-spot decisions concerning when and how they will respond to the needs of their students. While understanding these methods will not make the decisions easier, it is a first step in being able to make decisions to help students (Leib, 2005). Instructors must be continually listening, assessing, responding, and planning, being prepared to jump back and forth between the various categories as needed. Instructor Feedback/Responses are as responsible for encouraging student participation in a classroom as any of the other categories that emerged from this study.

Interpersonal Skills

While Procedural Practices, Supervisory Qualities, Questioning Techniques, and Feedback/Responses are all important in whole-class discussions, Interpersonal Skills are imperative. Interpersonal Skills refer to interactions that occur between instructors and their students as a result of personality traits. Several studies indicate the importance of Interpersonal Skills, attempting to explain the role an instructor's personality plays in developing relationships with students. Hajioannou (2007) found that the variety of communication that occurs in a classroom is related to the classroom environment, and that to understand one kind of communication you must look at communication in detail. Their detailed study of a fifth grade public school class makes several implications concerning the role that interpersonal relationships play in the classroom. This study concludes that instructors should take care to create positive, trusting, and respectful relationships with their students while simultaneously providing opportunities for student collaborations (Hadjioannou, 2007).

In another study indicating the importance of Interpersonal Skills, instructor effectiveness was rated by two different groups of students: those still in school and professionals that had graduated three years earlier. These evaluations were not of a particular instructor but instead of instructors in general. The open-ended surveys resulted in three themes: personality, process, and performance. Of these three, personality was confirmed as the most significant for both sets of students (Jahangiri, 2008). In yet another study, strong Interpersonal Skills came across as being extremely important (Ertmer, 2005). Interpersonal Skills are a strong prerequisite for working with others, and while content knowledge is important, it can be taught.

On the other hand, the literature is not in total agreement in terms of the importance of Interpersonal Skills in the classroom. Fassinger (1995) asked students to complete a Likert-scale survey ranking class traits, student traits, and professor traits. These results indicated that professor traits did not help to explain student interactions and levels of participation (Fassinger, 1995).

In Gordon's quantitative study of vocational education instructors, interactions between personality types and teaching effectiveness were investigated. Personality types were measured via the Myers-Briggs Type Indicator (MBTI), and teaching effectiveness by the Classroom Observation Keyed for Effectiveness Research (COKER). Nine different personality types were observed. The effective instructors displayed more sensing characteristics than intuition characteristics. According to the MBTI, sensing reveals an instructor's use of his/her five senses to determine what is going on in a classroom, while intuition is the way that an instructor instinctively perceives what is going on. Fifty-nine percent of the instructors in this study were labeled as ineffective when comparing the MBTI with the COKER. This would imply that the ineffective instructors have not acquired the fundamental teaching capabilities necessary to bring about effective learning. The implications of this study are that educators should become aware of the importance of personality theory and its impact on student learning and put this knowledge into practice (Gordon, 1999).

The results of Gordon (1999) support Bligh (1986) who states that personality type can be misconstrued to suggest that some people should not become instructors. However, being aware of the different personality traits may affect the kinds of interactive processes that one chooses to use in a class setting. Bligh does not suggest that instructors try to change their personalities, even if they could. Instead Bligh believes that instructors should use a variety of different teaching methods to curtail the effects of personal styles. Instructors who are meek or dominating would benefit from whole-class discussions because the monotony of traditional lectures would be broken.

However, regardless of personality type, instructor training needs to encourage student instructors to build relationships with their students by using methods that increase class building skills and interactions between students (Evelein 2007). Sanders and Horn state that effective instructors are essential to student success, and that a few helpful instructors cannot counterbalance the effect of ineffective instructors (*cf Rushton, 2007). This kind of thinking led Rushton to research the question "are certain instructor personality types more effective at teaching than others?" This work assumed that effective instructors shared common personality traits. The results of this study indicate that effective instructors need to be people oriented and intuitive, looking at the overall big picture. Similar to Bligh's and Gordon's studies, Rushton's study concluded that while instructor's personalities cannot be changed, an awareness of these behaviors can be beneficial for instructor development (Rushton, 2007).

Summary of Literature

The three parts of the literature review set the stage for the present study by first developing a clear idea about what is meant by social constructivism and how students benefit from working together in groups. The second section revealed the benefits of using whole-class discussions to actively involve students in the learning process. The third section examined what other researchers have observed concerning the five categories of behaviors that emerged from this study.

The theoretical foundation for this study is social constructivism, which implies that knowledge is constructed in the minds of students through social interactions with each other. When students are actively involved, they are learning (Vygotsky, 1978). The use of cooperative learning groups permit students to become actively involved in the learning processes by talking and developing problem solving skills together. This study examines whole-class discussions to be used as an enhancement technique in cooperative learning environments and furthering the construction of knowledge on the part of students.

Whole-class discussions have many benefits to offer students: higher interest levels, more active involvement, greater understanding, and longer periods of recall. Instructors also benefit from using whole-class discussions by building relationships with students, assessing student understandings and misconceptions, guiding students to understanding, and providing summative closures. The synergistic effects of having concepts rephrased by several different students help instructors gain an understanding of what students comprehend and help students approach problems from different perspectives.

Even though whole-class discussions have deep-rooted pedagogical value, little research compares actual classroom practices with effective and ineffective discussions. There is also limited research that explains the behaviors necessary to conduct effective discussions. A more inclusive and detailed picture of peer-led whole-class discussions can help to facilitate the development of productive whole-class discussions in other settings.

The five categories that emerged from this study include: Procedural Practices, Supervisory Qualities, Questioning Techniques, Feedback/Responses and Interpersonal Skills. The literature was examined to first see if other researchers had indeed seen the same five types of behaviors occurring in a classroom. Each of the categories were examined in the literature in order to see if other researchers had seen the combined effects of these five categories or to see if one of these five was more important than the other four.

This literature review identified many constituents of effective classrooms and the instructor qualities that aligned with these parts. An extensive search did not, however, find any studies that looked at whole-class discussions being facilitated by peer leaders. While lots of research was found on discussions and many suggestions were made regarding instructor behaviors needed for effective whole-class discussions, there was limited research conducted that actually observed and categorized these behaviors. Nor did any studies concerning instructor's Procedural Practices, Supervisory Skills, Questioning Techniques, Feedback/Responses or Interpersonal Skills show up in combination in other studies.

Instructors have a direct effect on the "nature of group discourse" by adding or detracting from the learning process (Anderson, 2007). An understanding of the role that an instructor plays in the classroom, combined with the idea that students construct knowledge when they are talking, helps to reinforce the importance of educating instructors about pedagogical techniques that emphasize discursive activities (Walker, 2007). This study begins by looking at the behaviors of instructors (or peer leaders in this case) and the effect these behaviors have on student participation levels.

Chapter 3: Methods

"Since cooperative learning is highly dependent for its success on the quality of students' verbal interactions, it is especially important for researchers to peer into the 'black box' and examine those interactions in their natural contexts."
....Deering and Meloth (1993)

Purpose

With all the evidence supporting the use of whole-class discussions, why aren't more instructors using this process in their educational settings? Boaler (*cf Staples, 2007, p. 162) surmises that more educators are not using whole-class discussions because they do not really have an understanding about the "nature of the practices." The term "practices" is two-fold referring to an instructor's (a) knowledge about how student discussions bring about learning and, (b) an understanding about how roles change during whole-class discussions.

The purpose of this study is to uncover the behaviors that are associated with productive whole-class discussions. This chapter describes the evolution involved in this grounded theory study to uncover the dynamic aspects of creating productive whole-class discussions. Many studies look at the questions that instructors ask, while others look at classroom environments which include: physical layout, organization, atmosphere, and student-centeredness. This study looks at questions and classroom environment, in addition to peer leader behaviors, as well as their interconnectedness to each other.

The researcher is seeking to develop theory about the behaviors that are associated with productive whole-class discussions in General Chemistry I Friday small groups. There are no existing theories concerning this issue. When there are no existing theories to explain a particular event, a grounded theory methodology is useful (Grinnell P. 26). The research is not testing hypotheses; instead, the research is generating them. The grounded theory approach, developed by Glaser and Straus (1967), inductively explores patterns within the data to create hypotheses. This method is different from deductively analyzing data, testing a hypothesis, and looking at previous theories to explain an event. Through the process of coding and categorizing emergent themes, the researcher identifies variables that lead to productive whole-class discussions.

This study is an inductively grounded approach to gathering emergent data. The data was examined using the constant comparison method to uncover core categories within the data by coding and classifying the principal patterns in the data. The important research categories gradually became clearer as videos were viewed and data was analyzed (Miles, 1994). The emerging patterns led to distinct categories that later developed into hypotheses (Glaser, 1978; Glaser & Strauss, 1967; Miles & Huberman, 1994). It is from these hypotheses that a theory emerges.

Research Questions

The primary question being examined is: W*hat behaviors are associated with productive whole-class discussions*? To investigate the behaviors associated with productive whole-class discussions, several concepts had to be operationalized.

- What is a **productive** whole-class discussion?
- What kinds of behaviors are **students** exhibiting during whole-class discussions?

- What kinds of behaviors are **peer leaders** exhibiting during whole-class discussions?
- What kinds of **questions** are peer leaders asking?
- Do the various peer leader **behaviors** work together to create productive whole-class discussions?

Examining Whole-Class Discussions: The Applicability of Grounded Theory

This study began with the idea that a qualitative approach would be best suited to differentiate among the levels of "success" observed in each of the peer led classes. Video and audio recordings of peer leaders were collected and organized. However, many organizational problems arose. The researcher was sure that the differences between the whole-class discussions was what made the class sessions a "success," but was not sure what data needed to be collected and analyzed. What questions needed to be asked? What was being considered in this study: peer leaders, students, questions, the PLGI process? As the study unfolded and these kinds of questions arose, the study developed into a qualitative grounded theory study. The researcher was not testing a hypothesis or looking for data support a specific belief, instead the researcher was looking to generate theoretical ideas about what creates productive whole-class discussions (Bowen, 2005; Glaser, 1965; Strauss, 1998). In keeping with the ideas defining grounded theory, this study (1) looked at the relationships between categories, (2) produced a theory, and (3) created results which can be studied further (Charmaz, 2006; Connell, 1997).

The phrase, grounded theory, refers to the development of theory from data methodically acquired from social research. Grounded theory uses an inductive approach, meaning that researchers move from the specific data to a more general theoretical meaning. Hence the theory is "grounded" in data. This process requires orderly and systematic uncovering of categories to form patterns, which can then be used to explain social processes (Glaser & Strauss, 1967). Comparative analysis is at the heart of this approach.

The comparative analysis method is a qualitative tradition built upon the idea of comparing concepts. Many such comparisons are made between these concepts, contrasting the similarities and differences among groups or individuals being studied. These comparisons produce categories and develop associations between the various groups (Scott, 2004). The hypothesis produced from this kind of qualitative research is therefore suggested by the data and categorical evidence. The hypotheses that evolve may seem dissimilar to each other, but as the study progresses and relationships between hypotheses are established a theory emerges (Glaser & Strauss, 1967). The resulting products of a grounded theory approach have testable outcomes, in other words it is the intent of grounded theory that the predictions formed are followed up with further quantitative measures (Taber, 2000).

One example of this process involves the work of Hood who was examining the components of a marriage that stayed together, when the wife worked. Listed below are Hood's hypotheses that support her theory of the role of bargaining processes relating to her particular participants. Through the process of hypothesizing about what took place

Hood “reveals how implicit rules and tacit agreements about rights and obligations shape bargaining” (Charmaz, 2006).

1. “Wives working for ‘self’ as opposed to ‘family’ reasons will be more likely to remain in the labor force after the need for their incomes has diminished.
2. Couples with competing goals will experience more strain than those with complementary goals.
3. Increased work commitment on the part of a wife (accompanied by a decrease in the amount of companionship she able to offer her husband) will cause most problems in husband- and couple-centered marriages and least in child-centered marriages.
4. Wives working for self reasons married to job-oriented men are most likely to move toward recognition as coproviders (and increase their wage ratio).
5. Couples who are most ambivalent about their definition of the wife’s responsibility to provide will be likely to resolve this inconsistency either by having the wife quit work or by accepting her as a coprovider.
6. Job-oriented husbands will have an easier time accepting their wives’ increased work commitment than will career-oriented husbands.
7. Job-oriented husbands and families with younger children will be most likely to increase their share of household responsibility, where career-oriented husbands and fathers of older children will be less likely to.
8. Regardless of her share of the family income, a wife’s bargaining power will be improved by gains in self-esteem and increased social support outside the marriage.”

The benefits provided through Hood's hypotheses and theory is that they describe findings that resulted from the study and the implications in regards to the individuals in her study.

The primary research question being addressed in this study necessitates this methodological approach. The exploratory characteristic of the research question, what *behaviors are associated with productive whole-class discussions*, lends itself to a qualitative naturalistic inquiry (Lincoln and Guba, 1985). The examination of peer-led whole-class discussions takes place within a natural setting where one would expect to find whole-class discussions – in the classroom. This kind of setting is field focused because it takes place in a natural setting (in the field where it naturally occurs) rather than in a laboratory setting. Exploratory approaches were used here to observe, compare, and contrast different intricate pieces of a classroom setting.

The topic being examined has many different parts that could be the cause of productive whole-class discussions. The qualitative methods used in this study are more adaptable to an emergent design. Rather than starting with a preconceived notion about what causes productive whole-class discussions, this study needed to unfold as new categories were revealed. There was not enough known about productive peer-led whole-class discussions before this study began to adequately examine the many variables that arose as the study progressed (Lincoln and Guba, 1985). This research is uncovering relevant variables that as of yet have not been identified. This kind of study cannot be done experimentally because we are attempting to study human beings in a very natural setting with minimal input by the researcher. An inductive research approach is optimal in order to answer the question proposed here; a methodical and exhaustive analysis will yield constructive and beneficial descriptions about the Friday small group settings (Eisner, 1998; Lincoln and Guba, 1985; Marshall, 1999).

Eisner (1998) describes a qualitative study in terms of having six features. This study has all six of the features. These features will be listed to help the reader to clearly understand why the question being examined in this study clearly warrants a qualitative inductive research methodology.

This study occurs in a natural setting (also stated by Lincoln and Guba), in the classroom at the same time that students are participating in class discussions. Students are not being taken out of class or put in some simulated class situation. This study is field focused, occurring in a natural setting.

Second is the instrument collecting the data (also stated by Lincoln and Guba) – Eisner refers to the human as an instrument because things are seen and then interpreted by the researcher. In this study the instrument collecting and interpreting the data is a human instrument, the researcher herself.

The third feature involves the interpretative nature of the data; the researcher was responsible for this part. The researcher systematically observed peer leaders, questioned them about their behaviors, and followed up on explanations from other sources such as journals or end of the year evaluations.

The fourth feature deals with "the presence of voice in the text." The researcher; struggled with this aspect because it is atypical of the kind of work seen in the chemistry department. It was extremely difficult and not altogether possible to describe this work without including a kind of personal signature on the work performed here. It was not possible to remain neutral and refrain from using words like "I" and "we."

The fifth feature of qualitative inductive research is the "attention to particulars," meaning that qualitative descriptions are sometimes transformed into quantitative figures. When descriptive words are reduced to numbers part of their meaning is lost, the transformations are not equivalent to each other. Great care should be taken to make the meaning very precise and clear when this needs to be done. This feature, attention to particulars, is the "criteria for judging the success" of descriptive terms into numerical data (Eisner, 1998). In other words, the researcher's work should appear to be sound, logical, thought out and well explained. Individual readers have to determine if the transformation of words into numbers makes sense and was satisfactorily done or not. (Eisner, 1998)

Setting and Participants

Setting

This study took place in the United States in a large southeastern public research university. The data for this research were collected during the fall semesters of 2004, 2005, and 2006. The individuals being observed are either taking General Chemistry I or peer leading for General Chemistry I. These large chemistry classes are made up of approximately 200 students and are normally taught in large lecture halls, until recently when a reform was implemented. This reform began in the fall of 2003 and created a more student-centered approach to learning. This reform is an integration of two models: PLTL, Peer-Led Team Learning (Gosser, et al, 2001) and POGIL, Process-Oriented Guided-Inquiry Learning (Eberlein, 2008; Farrell, 1999). This combined method is called PLGI, Peer-Led Guided Inquiry.

Curriculum. General Chemistry I is a required entry-level course for all science majors. While taking this course, students learn basic chemical principles and applications, which includes discussions concerning both the properties of substances and reactions, and the periodicity of elements and compounds. In addition to these basic understandings, students will learn about thermochemistry and atomic-molecular structure and bonding.

Course. The General Chemistry I classes previously met on Mondays, Wednesdays, and Fridays for 50-minute lectures. Since the implementation of PLGI, the Friday lecture has been replaced with small group sessions. All of the classes involved in this study meet three times a week: Monday and Wednesdays for 50-minute lectures and again on Fridays to work in small sections of twenty for 50-minute periods. In these small sections of twenty, students are further subdivided into cooperative learning groups with no more than four students per group. During the first three years (2003-2005) of PLGI initiation, only one section of General Chemistry I participated in the Friday small group sessions. However, in 2006, only four years after its launch, PLGI was implemented into all of the daytime sections. Presently all our Monday, Wednesday, and Friday sections of General Chemistry I have Friday small groups sessions led by peer leaders.

Participants

There are two groups of students being observed in this study. Undergraduate students who are taking General Chemistry I, and undergraduate students who have already taken General Chemistry I and are now leading other undergraduate students who are taking the course. The undergraduate students who are leading other undergraduate students will be referred to as peer leaders throughout the rest of this study; they are the primary focus of this research. The term students will refer to the undergraduate students who are taking General Chemistry I.

Peer Leaders. Peer leaders are undergraduate students who have successfully completed General Chemistry I and II. Peer leaders are selected by the General Chemistry I coordinator via an examination of their transcripts and a screening interview with the General Chemistry coordinator. Peer leaders lead the Friday sessions, facilitating group work and class discussions. While employed to lead the Friday sessions, peer leaders sign up to take a three-credit peer leader training class from the General Chemistry I coordinator, which better enables them to lead students through inquiry activities. In addition to receiving college credit hours for the training course, peer leaders receive a small stipend. Peer leaders lead students who are working together in cooperative learning groups, through inquiry-based activities, while simultaneously helping students to develop process skills.

In the total peer leader population from 2004-2006 there was a 2:3 ratio of male students to female students, ranging between 18-24 years in age. The peer leader population consisted primarily of White and Asian students, with a couple of Black peer leaders. This study revolved around thirteen different peer leaders. Eight of these peer leaders were female: six white and two Asian, with the remaining five being male: three white and two Asian (Table 3.1). This sample is a close representation of the entire peer leader population in term of sex, but not necessarily race/ethnicity.

Table 3.1

Peer Leader Demographics

Name*	Sex	Age	Race	Years Participating in Study	No. of Videos
Alice	F	18-19	A	2	2
Chantel	F	20	W	1	2
Derron	M	20-21	W	2	4
Donna	F	20-21	W	2	4
James	M	20	W	1	2
Jerleen	F	20-21	W	2	2
Keith	M	19	W	1	2
Lydia	F	20-21	W	2	2
Michael	M	19	A	1	3
Nina	F	21	W	1	4
Samantha	F	24	A	1	3
Selena	F	19-20	A	2	2
Steven	M	18	A	1	2

*Names are pseudonyms.

General Chemistry I undergraduate students. In addition to the peer leaders, the other participants are the undergraduate students that are taking the General Chemistry I classes. While the students are not the main focus of this study, it would not have been possible to study peer leader behaviors and questions without observing student comments and questions, as well as their reactions to peer leader questions.

Average General Chemistry I populations consist of slightly more than 50% first year students and 26% second year, with the remaining 24% being third and fourth year students combined. Slightly more than half of the students are female. About 50% of a typical General Chemistry I class is White, and approximately 10% Black, 10% Hispanic, and 10% Asian. Students who have signed up for this course must have scored at least a 530 on the SAT quantitative portion and completed college Algebra with a grade of at least a C. It is also suggested that they have at least one year of high school chemistry or have taken Chemistry for Today, an introductory college chemistry class.

Friday Small Group Operations

General Chemistry I class sections are divided into sections of twenty students; each of these sections are lead by a peer leader. In each of these sections, students are further subdivided into five cooperative learning groups of four. Students stay in these groups for the entire semester. Upon entering the classroom, it is essential that students have completed the pre-assigned homework problems from the workbook. If students do not have their completed homework assignments, peer leaders have been told to ask students to leave. Once in class and seated, students begin a Friday class section by taking a three-question multiple choice quiz based on the activity that they worked on last week. Students have approximately five minutes to complete the quiz. After completing their quizzes, students break into their small groups.

The group receives a folder from the peer leader with the roles assigned to each student for that class period (Appendix A). There are four roles used in these sections; these roles are borrowed from the POGIL Project (http://www.pcrest.com/PC/pub/POGIL.htm). Roles are rotated on a weekly basis to encourage participation between group members, vary individual accountability, and aid in the functioning of a group (Cohen, 1994). The manager receives the folder and is responsible for encouraging students to fulfill the obligations of their roles and time management. The manager is also responsible for asking all group questions to the peer leader. The recorder is responsible for recording the group answers in one place and for filling out any group papers on behalf of the group. All group members are responsible for recording answers, but the recorder's book is where a peer leader would look to find the group consensus. The presenter, on behalf of the group, answers questions to the using the recorder's book, either orally or by writing an answer on the board. All students should be prepared to answer questions when the peer leader calls on them. The reflector or strategy analyst observes group interactions and reports to the group how well a group is (or is not) functioning.

After the quiz and looking at the roles for the day, students go over each other's homework problems in their small groups. After finishing this process, students go on to work on additional questions from the assigned activity. During this process students, discuss between themselves answers and concepts presented in an inquiry format. These activities are designed to use the learning cycle phases: exploration, concept invention, and application (Abraham, 2005).

Inside the folder is a worksheet labeled “weekly group record” (WGR). This form is to be filled out by the recorder, who writes down the group’s answers during the last five minutes of class (Appendix B). Cohen “suggest[s] that groups should become aware of their interpersonal and work processes as they work and take time to discuss how they are doing as a group” (Cohen, 1994 p.26). The Weekly Group Records used in this setting are designed to promote such processes. Some peer leaders provide feedback to these comments, while others do not. There are usually four to five questions on a Weekly Group Record; two dealing with content and two or three dealing with process skills (Appendix C) such as what is a strength of your group today, how did you utilize the skill of rephrasing in class today and what are the advantages of using such a skill in your group.

Data Collection

The primary data source for this study is video recordings of the peer leaders in their Friday small group sessions. Secondary data consist of quiz scores, chemical concept inventories, journal assignments, self-evaluations, interviews, researcher notes, and end of semester student evaluations. An explanation of each data source and the availability of each will be discussed further under Researcher’s Role. The secondary data sources were used to check observer interpretations of video observations.

Institutional Review Board

In order to work with human subjects the university requires that researchers obtain approval from the Institutional Review Board (IRB). The IRB deals with matters concerning the protection of human research subjects and ethical practices. Initially, before beginning any research dealing with human subjects, the researcher took a mandatory computer-based training course on Protecting Human Research Participants, sponsored by the National Institutes of Health Office of Human Subjects Research (Appendix D). Then an application for initial review from the Social and Behavioral division of the IRB was completed and approved. The application asks for the names of the researchers involved in the study, a research plan, procedures for recruiting subjects, and the ethnic backgrounds and ages of participants. The primary concern is assessing possibilities of harm that could come to the participants involved in this study. This study was approved; there were no possibilities of harm other than being slightly uncomfortable in front of a camera (Appendix E). Informed consents were obtained from all participants (Appendix F). A continuing review application and informed consent form were updated each year as long as the study was in progress.

All participants, peer leaders and students, were informed of their right to refuse to participate in this study and were asked to sign informed consent forms demonstrating that they were aware of their rights. The researcher informed students that she herself was a student and was interested in observing their peer leader and their relationship with their peer leader. Each student was given two copies of the informed consent form, one to sign and return and one to keep for future reference and contact information. Peer leaders were also asked to sign informed consent forms using the same protocol. No students refused to sign the informed consent forms. No students withdrew from this study; however, a few students dropped the class throughout the semester.

Peer Leader Recruitment in Data Collection.

Peer leaders were enrolled in a training course to help them learn how to lead guided inquiry activities. On the course syllabus, points are assigned for participation in class activities and a portion of that consisted of participating in the recording of one of their classes, regardless of whether they consented to be in the study. The fall semester of 2004 had only one section of General Chemistry I with Friday small groups. Each peer leader was video recorded at least once during that semester. The following fall semester of 2005 had one section of general chemistry with Friday sessions. During this semester, each peer leader was video recorded at least once. In addition to having one peer leader videotaped each week, three other randomly selected peer leaders were being videotaped on a revolving three-week schedule. Not all videotapes were part of the study; sampling procedures will be discussed in next section on sampling.

The peer leaders were not paid for participating in this study. The process, however, had many benefits for all involved. First, the individual peer leader videos were viewed together by the peer leader and researcher, and edited into a 7-9 minute video to play during the next training session of the course. This provided an opportunity for peer leaders to see themselves in action, while simultaneously providing an opportunity for individual reflection in a quiet and safe environment free from judgment. Immediately following the taping of a class, a peer leader would take a few moments to self-evaluate his/her individual session using the Strength, Improvement, and Insight (SII) protocol (Apple, 2004 p.74). Each SII consists of three strengths, two areas for improvement, and one insight gained from the video (Appendix G). Then the peer leader would view his/her video. After watching the video, the peer leader would again reflect on his/her actions using the SII format. The researcher and student would then orally discuss the two SII forms. The written SII's (self-evaluations) and the audio recordings of these sessions were noted in secondary data sources as interviews/notes.

The whole group of peer leaders benefited from the videotaped sessions because all peer leading sections occurred at the same time. The videotapes permitted peer leaders to see other peer leaders in their actual classroom settings. After viewing the short video clips during the training class, peer leaders, together in groups of four would write SII's of the video just viewed. This process provided the participating peer leader some feedback from his/her peers as well as providing the other students with an opportunity to assess other peer leading practices. The practice of showing video clips permitted the General Chemistry faculty coordinator to view each of the peer leaders in action more than once. Without the use of these recordings, it would not be possible to observe more than one peer leader per week, since all sections ran at the same time.

The fall semester of 2006 was quite different because by this time peer-led guided inquiry had become a welcome addition to the way this university taught undergraduate beginning chemistry students; all Monday-Wednesday daytime sections of General Chemistry I had Friday small groups. Because of the increase in numbers of needed peer leaders and the overlap in the times that Friday sessions were being taught, it was not possible to video record each peer leader equal number of times. Several peer leaders were video recorded more than once. During this semester it was not possible to have peer leaders producing the small video clips to show during the peer leader training sessions because of an increase in the number of peer leaders and an increase in the number of training sessions held each week. This is one reason why there are unequal numbers of videotapes for peer leaders and limited interviews for the fall 2006 semester. This does not, however, jeopardize the results of this study because the question being asked involves the specific behaviors that create productive whole-class discussions, not which peer leaders. The behaviors stemmed from actual comparisons made from multiple peer leaders with multiple taped sessions. A peer leader with two taped sessions did not have any kind of advantage/disadvantage over a peer leader with three or more taped sessions because each video was explored separately from the others. Peer leaders were not given a composite rating of all their videos.

Sampling

The main unit of analyses for this inductive research consists of video recordings collected during the Friday small group sessions. The videos were recorded over the course of three years, which looked at classroom activities of peer leaders. There were fifty-seven videos taped of thirty-six different peer leaders. From the population of videos the researcher chose to explore the behaviors of thirteen peer leaders throughout thirty-four videos. The videos were selected from the existing collection of videotapes made during this time-period based on whether or not a peer leader had been video recorded more than once. Peer leaders with multiple recordings were selected in order to address potential anomalies in peer leader behaviors during whole-class discussions that one video might not explain and to fully permit the researcher to see the range of behaviors exhibited by one peer leader in at least two different settings. Were the very good discussions a result of specific traits of an individual peer leader or were they more of a happen stance occurrence? The decision to use peer leaders with multiple videos resulted in an uneven distribution in the number of videos per peer leader and per year (Table 3.1).

Of the thirteen peer leaders used in this study, four were from 2004; all four of these peer leaders were peer leaders during the fall of 2005 (Table 3.2). In addition to the four peer leaders from 2004, seven additional peer leaders were also recorded more than one time in 2005, making a total of 11 peer leaders videos used from this year. Two of these peer leaders were repeat peer leaders during the fall of 2006 along with two additional new peer leaders who were videotaped more than once. There were eight female peer leaders and five male peer leaders, which closely resembles the ratio of female to male peer leaders, 3:2 found in our peer leading sessions.

Table 3.2

Number of Videos in this Study

Year	2004	2005	2006	Total
No. of Videos Recorded	4	21	9	34
No. of 1st Year Peer leaders	4	7	2	13
Total No. of Peer leaders	4	11	4	*
Male Videos	0	9	4	13
Female Videos	4	12	5	21

*All 4 PLs from 2004 recorded in 2005. 2 Pls from 2005 recorded in 2006.

Video Transcripts

Thirty-four videos were transcribed for this study (Table 3.3). The transcription process took roughly ten hours per video and averaged between 25 to 45 pages in length. The software used was InqScribe, which permitted the researcher to view the video and transcribe using one program rather than using two programs such as, QuickTime and a word document. Each video was viewed multiple times noting peer-leader and student dialog and mannerisms. The transcription process included verbal and nonverbal behaviors exhibited on tape. For example, did students have their heads down, were they rolling their eyes, did they turn their backs; these kinds of behaviors were also transcribed in addition to any verbal exchanges. According to Eisner (1998) words can only be used to portray one meaning; to fully build a clear picture requires attention to tone and mannerisms. Just knowing the words spoken is not enough to fully develop the classroom events (Eisner, 1998). In addition to mannerisms specific attention was given to questions asked by students and peer leaders and the kinds of response elicited by the questions. The names used are pseudonyms, but their references towards sex remain the same. A typical transcript ran between 25 - 45 pages. Completely transcribed and coded videos were exported to text files and then imported into Excel files for frequency counts and for reviewing and analyzing emergent patterns. Coding will be discussed in a later section.

Table 3.3

Peer Leader Names and Number of Times Video Taped During Each Year[1]

Name	Interviewed	2004	2005	2006	Total Taped Sessions
Alice	F[2]	1	1		2
Chantel	F		2		2
Derron	F		2	2	4
Donna	F		2	2	4
James	IF[3]			2	2
Jerleen	F	1	1		2
Keith	F		2		2
Lydia	F	1	1		2
Michael	F		3		3
Nina	F			4	4
Samantha	F		3		3
Selena	F	1	1		2
Steven	F		2		2
Total	13	4	20	10	34

Secondary Data Sources

[1] All peer leaders involved in this study were taped at least once during their first semester peer leading.
[2] F stands for "formal interview," IF stands for "informal interview."
[3] All the peer leaders in this study met with the researcher to view their video except for James. James was involved in several informal interviews discussing the entries made in his journal but never watched one of his videos due to scheduling problems.

Weekly, peer-leader reflective journal entries were used as secondary data sources to enhance interpretations of peer leader actions viewed in the videos. Peer leaders were required to submit sixteen journal entries a semester, once before the semester began describing their expectations of the semester and one per week answering focus questions and describing what occurred in the individual peer leading sections. In addition to the journals, interviews/notes made while peer leaders viewed their videos with the researcher and reflected on their personal behaviors using the SII format were examined. The notes and audio recordings were reviewed to help the researcher understand more of the peer leaders' behind-the-scene-thoughts on particular issues.

During the fall of 2006, the researcher had a more active role in peer leader training and therefore additional data is available from that period. A Chemistry Concept Learning Inventory (CCLI) was given to peer leaders at the beginning and the end of the semester in order to see any gains made in peer leader understanding throughout the semester. Peer leaders also took weekly quizzes during the training sessions, which could be looked at to see if peer leaders fully understood the concepts being presented.

During all three years the researcher had access to the end of the year evaluations that students did on their peer leaders and the overall PLGI experience. Students filled out these forms on the last day that peer-leading classes were held. These forms were filled out anonymously, but still provided the researcher with a general feel for how the students who stayed till the end felt. Points were received during each peer leading section for completing the assigned homework and taking a quiz, so all the students present of the last day were not necessarily lovers of peer leading; their evaluations signify this point.

Researcher's Role and Availability of Data Sources

The researcher, a white female graduate student in her mid forties, has sixteen years of experience teaching at the secondary level. She is state certified to teach secondary science education in chemistry, biology, and physical science. She taught high school, middle school, and high school again, before returning to school as a student to further her own education. She has a master's degree in chemistry and is presently working on her doctoral degree in chemistry.

The researcher entered into this study first as a student observer, interested in a new pedagogical process for beginning chemistry courses, peer-led guided inquiry. Her involvement in this reform took on a more active role for each of the first four successive years after this reform was initiated. Gradually the researcher's perspective shifted to how to improve peer leader experiences during their individual teaching episodes. During the first year (2003), she sat in the training classes and substituted a couple of times for absent peer leaders.

During the second year (2004), she again sat in each training class, taught the training class on a few occasions, and observed peer-led sessions. During this time, different peer leaders were observed and provided with written assessments known as SII's that consisted of (1) descriptions of the positive behaviors observed - strengths, (2) ideas about things that could be improved - improvements, (3) personal insights about what the researcher learned from this experience that she could use in her own classes - insights. Gradually the researcher's classroom observations moved from this traditional assessment practice to a more active approach, which involved videotaping the peer leaders and reviewing each video with the individual peer leader in a one-on-one setting.

The peer leader and researcher then produced a seven to ten minute clip to show the other peer leaders during the next training session.

During the third year (2005), the researcher was again in each training session, and was responsible for all peer leader supplies, forms, and quizzes. She also coordinated the Friday sessions by being available during the small sessions for support and encouragement. She passed out quizzes for peer leaders, made sure peer leaders showed up for their sessions, checked in on peer leaders and students, set up the video cameras for the other graduate students that were taping. She sat with each peer leader once while they viewed his/her video, informally interviewing each peer leader through this process. The interviews were audio recorded as peer leaders verbally discussed the contrasts between their SII's written before and after viewing their video.

The fourth year (2006), the researcher attended training classes occurring on Wednesdays and Thursdays (two classes were necessary due to the expansion of the program). She also made the quizzes and other weekly forms used in the peer leading session, checked on the students during their sessions, passed out quizzes, and trained a new graduate student to take over these responsibilities the following year. She wrote the weekly journal assignments and assisted with grading them. She continued to video-record peer leaders during this semester. All peer leader were not taped during this year. A decision was made at the beginning of this semester to videotape as many peer leaders as possible while taping one peer leader every third week to see if patterns were more evident in classes visited on multiple occasions. During this semester it was not optional for peer leaders to view their videos with the researchers; all peer leaders participated in the interview process and viewed his/her video except for James (he could not manage the time). In addition to these responsibilities, the researcher was a lecturer for one of the General Chemistry I sections.

The researcher's role and availability of data sources is explained here to bring about awareness of the differences that occurred from year to year, and the reasons that each year does not consist of the exact same data sources (Table 3.3). Through this involved process, the researcher became aware of some real differences in the level of student participation in the different rooms. This awareness became the impetus for the study.

Operationalizing Discussions

This research did not begin with a definition for what a discussion actually is or with a manner to measure discussion productivity. The need for a consistent definition evolved as the study progressed, along with the necessity to develop a tool to rank whole-class discussions so that they could be directly compared with each other.

Development of Discussion Definition

The analysis of the data began with the formation of a list showing when and where in a videotape that a whole-class discussion occurred. For each videotape several things were noted: the number of whole-class discussions, the length of each discussion, the number of problems discussed during each discussion, and who was using the board during a discussion (student or peer leader), or if the board was utilized at all. This led to the need to operationalize what was meant by the term "whole-class discussion".

What is meant by the term whole-class discussion? The definition used in this study is that a whole-class discussion is any time the peer leader is addressing the whole class and at least one student responds. Along the same lines, a small-group discussion is any conversation between the peer leader and one group of students at their desks. For a discussion, the peer leader and the students both need to talk; it is different from the peer leader just giving a suggestion or telling students which problem they need to do next. The definition of a whole-class discussion evolved as the study progressed and differences between the various discussions emerged. Several examples of these differences are discussed below.

It was easy to tell when a peer leader was addressing the class, but it was not always so easy to tell if a student response was dialogue or not. For example, one peer leader made cards for a process skill and would have students read the cards to the class. The peer leader would then interject something signaling the end of discussion. Should this be counted as a whole-class discussion? The next peer leader would ask students to read off a sheet, but this time the peer leader would ask for someone in the class to rephrase, which seemed more like a whole-class discussion. This kind of problem presented itself on five different occasions. A decision was made to count the discussions where students were reading, because this behavior still followed the specifics of the definition, the peer leader asked a question and a student responded. The specific techniques practiced by the peer leader during these five whole-class discussions were indicative of the kind of discussions that followed, lending support to this decision.

Another issue that arose in trying to define what was meant by whole-class discussions is when one ends and another one starts. Seven different peer leaders had discussions that led right into their closure activities. This led to the difficulty of knowing when one whole-class discussion ended and another one began and if they should be counted as one or two discussions. In these seven different episodes, the discussions and closure activities were only separated by one to twelve seconds. These were, however, still counted as separate discussions because the flow of the discussion changed from students discussing specific problems to the peer leader asking each group what they had learned. There was no doubt in the mind of the researcher that the peer leader had moved on to a different activity. The decision was made to count closure activities as separate whole-class discussions because of the differences that occurred in the flow of the discussions. Students no longer had to explain their thoughts; they were merely being asked to say what they had learned in a couple of words. The decision to count closure activities as separate whole-class discussions meant that all of the videos were coded using the same guidelines without counting a good closure activity as a separate whole-class discussion and a poor closure activity as a combined whole-class discussion. The decision to count these as separate whole-class discussions made it easier to rank the activities later in the study and reduced variability in the coding process.

Development of Discussion-Rating Tool

From looking at the number of class discussions held, the length of each discussion, the number of problems solved, who was using the board, and who was doing most of the talking, one could subjectively rate the discussions as *fair*, *not so bad*, *really good*, *excellent*, *poor*, *great*, *not really a discussion*, and various other descriptive terms. As more and more videos were viewed it became increasingly difficult to rate the discussions in any kind of order concerning effectiveness or with any kind of consistency. It was extremely difficult to compare each of the discussions with each other because there were so many different things to focus on within each discussion. The development of a definition for a whole-class discussion did not permit a direct comparison between discussions, creating the need to find or develop an instrument to compare whole-class discussions.

As a result of using an instrument developed to measure reform efforts occurring in classrooms, the Reformed Teaching Observation Protocol (RTOP) and scoring reform efforts, the idea emerged that perhaps a similar tool would be helpful to rate discussions. The observed discussion characteristics were grouped together and the end product was a Discussion-Rating Tool that was used while observing these discussions. This rating tool was used for each of the discussions, it was not used once per video but once per discussion and then averaged based on the number of discussions held during a single class period. This number is referred to as the Average Discussion Rating (ADR). Each discussion has a Discussion-Rating and each video has an Average Discussion Rating.

Whole-class discussions were rated using the Discussion-Rating Tool based on how much student-student interaction occurred (Table 3.4). The kinds of interactions that occurred between students and peer leaders during a discussion such as who was asking the questions, who was providing the answers, and who was doing most of the talking were also noted. During the discussions, frequencies were kept concerning the number of discussions held in each class and the quality of the discussions.

Instruments

Two instruments were used in this research to aid in evaluating the degree of "goodness" or productivity of whole-class discussions. The first tool was borrowed from Arizona State University and led to the development of the second tool, created to help separate the varying degrees of productive discussions.

Reformed Teaching Observation Protocol (RTOP)

After each video had been transcribed, an instrument known as the Reformed Teaching Observation Protocol (RTOP) was used to rate each session taped (Appendix H). The RTOP, developed at Arizona State University, is an observation instrument developed to measure how much reform is occurring in a classroom setting (Sawada, 2000). The instrument is divided into five major sections. The first two sections deal with who was being observed, how much advance notice was given before the observation, and what kind of activity being observed. Neither of these sections was pertinent for this study because group work activities are done in all general chemistry peer-leading sessions in this university setting. No advance notice was needed because RTOP scores were calculated from video-recordings, not in class observations.

The next three sections of the RTOP consist of twenty-five items, divided into three units: lesson design and implementation, content knowledge (propositional and procedural) and classroom culture (communicative interactions and student-Instructor relationships). Within the last three sections of the RTOP are twenty-five descriptive items that are rated on a Likert scale between 0 and 4, zero represented a behavior that never occurred, while a four described a behavior that was very descriptive in terms of the observed teacher's behavior.

The procedural content scale (items 11-15) measures the degree to which students are engaged as scientists doing inquiry. An example of an item from this section is:

11. Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena.

Never Occurred				*Very Descriptive*
0	*1*	*2*	*3*	*4*

Classroom culture (items 16–25) measures the extent of student-centered activities as compared to instructor-centered activities (Roehrig, 2007). An example of a question from this section is:

16. Students were involved in the communication of their ideas to others using a variety of media.

This instrument is shared openly for all to use but it is encouraged that individuals who desire to use this tool first undergo training, which involves watching videos of classrooms using various kinds of reform and then ranking the classes by using the RTOP. There is a training guide available to increase user reliability. The on-line training tool consists of short excerpts from videotaped classes; researchers (or anyone interested in learning this) can score pre-selected videos and compare their scores with the authors of the instrument. Several iterations are necessary to understand how to score a video and to understand what an actual item is measuring. It takes practice not to count something in more than one category, and to not read between the lines. Raters were instructed to only score an individual, based on what was actually observed.

The RTOP had to be altered slightly to fit the reform efforts that were taking place in this setting and to be more closely related to the research question. For example, the researcher looked at *student/peer leader* relationships instead of *student/teacher*. More substantive changes were also necessary and occurred in five in items 5, 6, 12, 22, and 25. These five items were altered to be more helpful in determining what creates productive whole-class discussions. Listed below are the actual RTOP items (numbered according to the placement on the RTOP) followed by an explanation concerning how the item was altered:

5. *"The focus and direction of the lesson was often determined by ideas originating with students."* Item 5 refers to whether or not students determined the lesson, the coders (researcher and two additional graduate students) decided to change *lesson* to *discussion*.
6. *"The lesson involved fundamental concepts of the subject."* The activities used in the peer leading sessions all involve fundamental concepts of the subject and are selected by the course coordinator; in the early training sessions, the raters agreed that each peer leader would receive a "4" (very descriptive) for this item.
12. *"Students made predictions, estimations and/or hypotheses and devised means for testing them."* Item 12 although not directly changed, was scored differently from the way the RTOP training manual suggested. In this setting, students do not collect data or make hypothesis so it was agreed to mark this question according to how much information a peer leader gave the students before they began to work problems. Did the peer leader begin an activity by directly telling students what was going to happen or did he/she provide students with time to discuss the new materials?

22. *“Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence.”* Item 22 deals with a shift in class responsibility from being teacher-centered to student-centered. When applying a score for item 22 it was agreed by the three coders a score would be given to this item in regards to student levels of encouragement during whole-class discussions. Four points were allotted if the discussion was student directed, three points if peer leader directed, two points if the peer leader was calling on students to explain something, one point if the peer leader was calling on students for answers only, and zero points if there were no whole-class discussions.

25. ”The metaphor ‘teacher as listener’ was very characteristic of this classroom.” Item 25 was changed teacher to peer leader and operationalized the term listener according to the following scale, which differed from the RTOP manual. Four points were given if a peer leader did not dominate group interactions, three points if the peer leader listened and intervened when asked, two points if the peer leader asked unprompted questions, one point if the peer leader provided too much direction (or lectures), zero points if the peer leader did not intervene with any kind of assistance at all (in other words, if a peer leader just left students to “figure it out” on their own throughout the entire class period.)

The author and two additional graduate students in chemical education went through the training together and continued to clarify what was meant by each of the criteria and how they related to the peer leaders given this specific setting and circumstances. Training continued until consistency was achieved and the coders had agreed on the changes necessary in the RTOP to help sort through the discussions. After agreement between coders was achieved and a high degree of consistency occurred, the process of rating the videos began. The individual scores were averaged to represent the average RTOP score for this sample, with possible scores ranging from 0 to 100, with "0" representing no reform methods observed and "100" representing high levels of reform occurring. The RTOP scores were transferred to Excel files for further analyses and compared with the data collected concerning questions.

Discussion Rating Tool

The Discussion-Rating Tool was developed after the RTOP had been applied to all the videos. The RTOP, while helpful in establishing the need for the development of the Discussion-Rating Tool, was not designed to measure whole-class discussions. The RTOP was essentially developed to measure varying degrees of reform occurring in a classroom. The Discussion-Ratings separate whole-class discussions based on the amounts of peer leader involvement compared to student involvement. The Discussion-Ratings range from zero to five, with zero representing no whole-class discussion and five representing more participation on the part of students in whole-class discussions with limited peer leader promptings. Each whole-class discussion occurring in a video was given a Discussion-Rating. From the total number of discussions occurring during a single class period, an average discussion rating (ADR) was calculated and assigned to each video.

Table 3.4

Instrument Developed to Aid in Rating Peer-led Discussions

Discussion-Rating Tool

5	Superb	▪ Lots of student/student discussions occurring ▪ Discussion occurs as a result of student questions ▪ Student/student interactions lead to development of concepts ▪ Most students participate
4	Excellent	▪ Some student/student discussions occurring ▪ Discussion occurs as a result of peer leader asking for detailed explanations ▪ Student/peer leader interactions lead to development of concepts ▪ Many students participate
3	Good	▪ Few student/student discussions occurring ▪ Discussions occur as a result of peer leader prompting with questions ▪ Peer leader development of concepts with questions that encourage student explanations and participation ▪ A few students participate as a result of peer leader encouragement
2	Fair	▪ Minimal peer leader/student discussions occurring ▪ Peer leader calls on students to give answers with nominal explanations ▪ Peer leader development of concepts ▪ A few students participate, peer leader does not encourage student participation
1	Poor	▪ No discussions occurring ▪ Peer leader calls on students to give answers with no explanations ▪ No development of concepts ▪ No students participate, all peer leader centered
0	Bad	▪ No whole class discussions attempted

The Discussion-Rating tool helped to validate a decision made previously concerning the definition of a whole-class discussion. The problem dealt with counting a discussion that overlapped with a closure activity. The use of the Discussion-Rating Tool helped the researcher to feel confident about the definition and her decision to count closure activities as separate discussions. If the seven closure activities were counted as separate discussions, two slight changes occurred, the average number of discussions per class changed from 2.2 to 2.4 and the average discussion rating (ADR) went from 2.4 to 2.3. Both of these changes seem obvious since we are adding seven lower rated discussions; it only makes sense that the average would go down. None of the seven videos with the run-on closures were in the top or bottom five videos used for the final analysis, and therefore do not affect the final analyses. The decision, however, to count the closure activities as separate whole-class discussions did help to separate the kinds of behaviors that occurred in good whole-class discussions from poor whole-class discussions due to the fact that there were extreme differences between the good and poor closure activities in terms of being peer leader centered.

Coding

Student participation in this cooperative learning environment involved social interactions between students and peer leaders. The differences in these interactions became the focus, as different videotapes were carefully examined for reasons leading to different levels of student participation. What created productive whole-class discussions and the various degrees of student interactions? Was it the students that created such an environment? Could productive whole-class discussions be due to peer leaders behaviors, and if so, what in particular about the peer leaders? The researcher was not sure if the differences between classes were due to contributions made by the students or peer leaders, consequently each area was coded for.

The initial phases of coding in a grounded theory approach call for an open coding method (Glaser and Strauss, 1967). Open coding is described as coding the data in every way justifiable (Glaser, 1978), meaning that one does not start with a list of codes and then labels for them. Instead, open coding means that the codes evolve as different issues arise from the data. Open coding permits the researcher to fully examine the data without any preconceived codes, before becoming too focused on a particular idea or context. Only after several passes of open coding does the researcher begin to narrow the focus. In this manner, the researcher can be sure that the ideas that are narrowed down emerge from the data and not from modified images coming from within the researcher. Coding does not occur in a linear fashion, but rather in a forward, backward, forward fashion as new ideas emerge throughout the process. In this study, four major factors arose from the open coding process. These factors consisted of student behaviors, peer leader behaviors, student and peer leader questions, and discussion techniques.

The factor, discussion techniques, was not coded any further due to the replication of codes in this category; each code specifically described a peer leader behavior. This observation became apparent when noticing that most of the coded discussion techniques were coded twice. This coding pass was not however a waste of time, because from this coding pass a baseline of behaviors observed specifically during whole-class and small-group discussions were formed. This list helped to frame the list of behaviors in terms of positive and negative behaviors.

Three separate focused coding passes followed the initial open coding process for the remaining three factors: student behaviors, peer leader behaviors, and student and peer leader questions. Focused coding is the next phase in coding which sorts through the data using a kind of filter (or focus) established during the open coding process (Charmaz, 2006). The focus of the three distinct coding passes at this stage consisted of student behaviors, peer leader behaviors, and questions. The first focused coding pass was on student behaviors that occurred anytime during a video recorded segment. The second coding pass was for peer leader behaviors, followed by a third coding pass that looked at peer leader and student questions. Each of the resulting codes was downloaded into one large Excel file, so that the various codes could be compared to see if there was any kind of interactions occurring. In other words, to see if patterns could be seen or imposed on one another; was it possible to say that when peer leaders did "this" students reacted by doing "this?" Each focused coding process occurred multiple times for each of the three areas being explored until the researcher researched a point of saturation with no new codes appearing. All thirty-four of the videos were coded for student behaviors, peer leader behaviors, and questions.

The data were analyzed inductively throughout the coding process, allowing categories to emerge via constant comparison analysis (Glaser & Strauss, 1967) [p103]. Through the focused coding process, and constantly comparing codes to each other, patterns began to emerge in peer leader behaviors and questions, but not for student behaviors. The researcher decided not to do any additional coding after the focused coding on student behaviors because the results demonstrated that students acted differently when the peer leaders exhibited different behaviors. More will be explained about student behaviors in the following section.

The third coding pass (axial coding) followed up on peer leader behaviors and questions. Axial coding looks at associations around an "axis" (Charmaz, 2006). Through the process of axial coding, clustering the data around an axis based on similar qualities, five broad categories of peer leader behaviors were created and seven types of questions arose (Miles and Huberman, 1994). The whole process of using the constant comparative method of analysis can be summarized into integrated steps involving coding, comparing, categorizing, and finally theorizing.

The fourth and final coding pass in this study is the theoretical coding pass, which looks at how the codes relate to each other. It is in this final process that the study becomes coherent and comprehensible to others. The focus gradually moves away from specific codes, and moves more towards the meaning behind the codes. The resulting understandings "are neither exhaustive or mutually exclusive" of each other and will therefore be explained independently in relation to the individual coding passes (Charmaz, 2006).

Student Behaviors

A focused coding pass was made through the videos looking at student behaviors during whole-class discussions to see if students were behaving differently in different whole-class discussions. Student behaviors were also examined in order to see if productive whole-class discussions were a result of student behaviors. The more students are participating in whole-class discussions, the higher they are rated, so it seemed logical to start by examining student behaviors. Positive and negative behaviors were coded for simultaneously, while also noting peer leader behaviors as a result of student behaviors.

Peer Leader Behaviors

The second item noted during focused coding were peer leader behaviors. Initially a focused kind of coding was made based on the codes found in the earlier open coding passes. This resulted in the formation of a list of observed behaviors, but this did not aid in revealing any patterns in peer leaders behavior, it just provided a list of peer leader behaviors. Coding is not a linear process and as such the researcher returned to an open coding process on a specific and focused topic, peer leader behaviors. It was decided to try line-by-line coding in an effort to look at the familiar videos in a new light (Charmaz, 2006; Lincoln and Guba, 1985).

In line-by-line open coding, the videos were watched and re-watched for different peer leader behaviors until a point of saturation was reached and no new codes emerged (Markic, 2008). These codes were not merely assigned to the portions that dealt with whole-class discussions but instead they were assigned to the entire video. This process was repeated four times for each video due to the emerging list of codes that developed (Charmaz, 2006). Due to the repetitive process, 244 codes were created and assigned. Gradually the code list was refined, where multiple codes that meant the same thing were reduced to a single code. When the researcher was fully saturated in the data and no new ideas emerged, the codes were printed out and cut into individual pieces, to be moved and sorted according to how connected they appeared to be to each other.

This moving and sorting of codes is referred to as axial coding by Strauss and Corbin (1990, 1998). Axial coding is an inductive process where codes are linked to each other based on similar qualities. The codes were grouped together based on commonalities into 153 more inclusive subcategories.

After reviewing the subcategories, the subcategories were further grouped together around a central theme. The themes were not immediately apparent as the subcategories began to be shifted from one column to another and back and forth. Themes, later known as categories, became ever more salient as the subcategories were moved around and grouped together. This process is often referred to as selective or focused coding (Markic, 2008; Charmaz, 2006). This process ended with five main categories of peer leader behaviors: Procedural Practices, Supervisory Qualities, Questioning Techniques, Feedback/Responses and Interpersonal (or Social) Skills.

Questions

During the third focused coding pass the transcripts were again read while simultaneously viewing the videos, noting each time a question was asked by either a peer leader or a student. First it was noted that a question was being asked. Then the questions were coded according to the type of question that was asked. In this study, questions were coded according to the conversations that occurred around the questions (Nystrand, 2003). Questions were coded based on the kinds of answer that were given; this process provided the researcher with a clearer picture about the desired function of a question (Webb, 2006). For example, if a peer leader asked, "Is this right*?"* and then went on about her business with no answer from a student; the question would be coded as a rhetorical question, questions requiring no responses. If, however, the peer leader accepted a simple yes or no response, then the question would be coded as a verification question.

Each set of transcripts were coded multiple times, until the kinds of question categories became saturated and changes no longer occurred during the coding process. At the end of this emerging process, all videos were coded using the same unchanging criteria. At that time, two additional coders were asked to code the types of questions found in the transcripts, in order to corroborate the coding schema. Three different coders coded seven videos in order to determine if the definitions assigned to the various categories of questions was reliable and to see if others could follow the researcher's logic behind each code. Inter-rater reliability was calculated by dividing the number of agreements between coders by the sum total of agreements and disagreements (Miles and Huberman, 1994).

After looking carefully at the differences between the number of questions asked and seeing that just asking questions did not determine if a whole-class discussion was productive, a decision was made to look a little closer at the specific kinds of questions being asked by the peer leaders and students. The key to a productive whole-class discussion was in the type of questions being asked, rather than the number of questions being asked. Each question was coded based on the type of response that was elicited.

The process of coding the questions consisted of several different iterations. The first few passes at coding for specific questions involved coding for dichotomies. The questions were originally coded as good or bad, gradually changing to working or not working, and eventually as open or closed type of questions. As the coding process progressed the questions were coded according to the type of responses that were provided; still using dichotomous keys consisting of codes such as long answers or short answers, academic or procedural, descriptive or prescriptive, high or low cognitive levels. This process did very little in terms of distinguishing the different kinds of questions being asked by the peer leaders. It did shed light on the fact that there were multiple types of questions being asked and it laid the foundation for the importance of looking at student responses in the process of coding the many different kinds of questions being asked by the peer leaders.

The next steps in the process of coding involved looking at the question being asked and the kind of response it elicited. This phase of coding questions began by looking at eight different types of questions: procedural, factual, rhetorical, verification, elaboration, reflective/metacognitive, conceptual, and other. These categories were the result of looking at role of a question being asked. From observations of what happened after a question was asked, it was possible to understand its role.

In yet another pass through the transcripts, some of these categories were combined together resulting in three categories. Information questions which were comprised of the earlier procedural and factual questions; understanding questions from the previous verification, elaboration, and conceptual questions; and reflective/metacognitive questions, which remained the same as the earlier passes. Due to the large number of questions in the informational category, it was decided to further separate these questions into procedural and informational questions. This permitted the researcher to differentiate between questions regarding classroom practices and chemistry topics and to glimpse into the peer leader’s primary concerns.

As the videos were being coded, a lack of discriminatory ability developed as a result of the combined category of understanding, so this category was split into three more descriptive divisions: verification, clarity/elaboration, and understanding, resulting in the final division consisting of seven kinds of questions asked by peer leaders in this sample (See Table 3.5). All of the coded questions fell into one of these seven categories and so it was not necessary to have the code previously labeled ‘others’.

Table 3.5

Iterations for Multiple Question Categories

1st	2nd	3rd	4th
Procedural		Procedural	Procedural
Factual	Informational	Informational	Informational
Rhetorical			Rhetorical
Verification			Verification
	Understanding	Understanding	Clarity/Elaboration
Elaboration			
			Understanding
Reflective/ Metacognitive	Reflective/ Metacognitive	Reflective/ Metacognitive	Reflective/ Metacognitive
Conceptual			
Other			

Each of the videos was coded using these seven categories; all of the questions fell into a category based on the kind of answer that was elicited. In addition to categorizing a question based on the student answer given, the peer leader’s follow up response was used to determine if an answer was satisfactory or not. For example, if a student was asked a question and a number answer was given like “2” how would the peer leader respond? If the peer leader moved on, then it would appear that the answer of 2 was satisfactory and it would be coded as an information question. If, however, the peer leader followed up on the answer, 2, by asking if anyone else got a different answer, then it would be coded as a procedural question helping to unify the class. And if the peer leader asked how an answer was obtained, then it would be coded as a clarity/ elaboration question. If further questions were asked that pushed students to explain how they visualized something, then it would be coded as an understanding question.

The process of coding the types of questions based on the answer is the reason that at first glance you may see the same question falling into two different categories. For example, “Can you rephrase that” a question seen on several occasions, is classified as a procedural question when it is being used to control the way the class is running. Perhaps students are not listening: they are talking or working on another task. Asking students to rephrase an answer politely nudges them to pay attention. The students know that the peer leader is aware that they are not doing what they were asked to do and the negative behaviors change. On other occasions, you will hear the peer leader ask a student “can you rephrase that” but this time you will notice that the peer leader is talking directly to a student that is already engaged. These questions are coded as “clarity/elaboration” questions because the peer leader is asking for further clarification of a previously given answer.

After coming up with a coding scheme that distinguished between the various kinds of questions being asked during whole-class discussions, frequencies for each kind were tabulated. The kinds of questions asked were then compared, in order to see if any patterns existed between the more productive whole-class discussions and the less productive whole-class discussions.

In summary, the focused coding passes resulted in positive and negative codes for student and peer leader behaviors and revealed seven different kinds of questions. These descriptive analyses did little however, in terms of answering the research question: *What behaviors are associated with productive whole-class discussions?* By this point in the study, it was apparent that the factors associated with productive whole-class discussions were not just the result of a few behaviors that occurred only during discussions. A single class discussion only revealed a small part of the goings on in a classroom, this became apparent when attempting to code just the whole-class discussions. It was fairly obvious from watching a whole-class discussion if a peer leader had developed a rapport with his/her students, but omitted specific details concerning what the peer leader did to develop or break down this trust with his/her class. It became obvious that the whole class and all of its behaviors needed to be examined.

Evaluating Interactions

Frequencies

The next step of analysis involved watching the videos and taking frequency counts for observed behaviors occurring in each of the five categories. Frequency counts were made for all whole-class discussions during an entire class session from the five videos with the highest and lowest average discussion ratings (ADR). This decision was made due to the nature of the research question concerning behaviors that create productive whole-class discussions. The top and bottom five videos were selected in order to exemplify the differences between classes with productive and unproductive discussions. These ten videos were used for frequency counts in order to examine the major differences between each of the different categories of behaviors in diverse whole-class discussions. Positive and negative behaviors were noted for each category and recorded separately.

Time-Ordered Matrices

None of the individual categories of peer leader behaviors or the frequencies associated with each category, seemed to satisfactorily answer the question about what creates productive whole-class discussions. An individual category did not stand out on its own as a stand-alone answer to what behaviors create productive whole-class discussions. Through the process of writing memos and coding, the idea gradually became obvious that there were interactions occurring between several of the various categories, but which ones? Combinations of behaviors were explored next. Time-ordered matrices were used to help distinguish reoccurring patterns between the various categories of behavior. Time-ordered matrices can be used when a researcher desires to look at the bigger picture rather than single isolated events (Miles and Huberman, 1994). These particular matrices organize events chronologically, permitting a snapshot view of the many different kinds of interactions occurring simultaneously

Sets of time-ordered matrices were formed which consisted of columns for each of the five behaviors divided horizontally into one-minute segments (Table 3.6). A Time-ordered matrix was made for the highest Discussion-Ratings in the class sessions with the top five average discussion ratings (ADR) and for the lowest Discussion-Ratings in class sessions with the bottom five average discussion ratings (ADR). Whole-class discussions were coded one-minute before the discussion because of changes that occurred in some of the classes prior to the start of a discussion

Table 3.6

Matrix Format

	Procedural Practices	Supervisory Qualities	Questioning Techniques	Feedback/ Responses	Interpersonal Skills
Minute before discussion					
1st minute					
2nd minute					
3rd minute					
4th minute					

Summary of Methods

The data sources for this study were video recordings of peer leaders facilitating cooperative learning groups. Dialog between students and peer leaders was transcribed, coded, and sorted for analysis. Particular attention was paid to whole-class discussions, although the rest of the behaviors exhibited before, during, and after these discussions was also noted. The videos were viewed and coded multiple times for student behaviors, peer leader behaviors, and questions. Discussions were examined for peer leader behaviors and compared to other discussions within the same class, and then again with other discussions in different classes. An existing tool used to rank reform efforts, the Reformed Teaching Observation Protocol (RTOP) was used to measure reform occurring in each class. A Discussion-Rating Tool resulted from this analysis, permitting a more objective comparison to be made between discussions.

This study resulted in:

- Operationalizing a whole-class discussion based on student levels of participation.
- Developing a tool to rate whole-class discussions in order that they may be compared to one another.
- Revealing five categories of positive and negative peer leader behaviors.
- Revealing interactions between each of the five categories to individualize peer leader strengths to increase productive whole-class discussions.
- Identifying seven categories of questions asked by peer leaders, based on the answers supplied by students were identified.
- Creating five hypotheses to be examined in future research.

Chapter 4: Analysis and Results

"Given the importance of questions in science, one might argue that those who teach chemistry should pay attention to helping students learn to ask questions as well as helping them learn to answer them."
.... Middlecamp and Nickel (2005)

Introduction

The intent of this chapter is to convey the results of the study. The data will be presented in the order of the research questions listed in Chapter 3. First, in order to be clear about what is meant by a discussion, this chapter begins with the definition of whole-class and small group discussions followed by descriptive data describing the discussions in this sample. Second, the instruments used to rate the discussions will be presented to facilitate comparisons between the different whole-class discussions based on similar criteria. Third, the codes that resulted from three different coding passes examining student behaviors, peer leader behaviors, and kinds of questions will be presented. Fourth, the four assumptions that were uncovered by contradictions during the coding processes will be discussed and debunked. Fifth, the five hypotheses that developed as a result of becoming aware of the assumptions and coding results will be examined. Lastly, the frequencies and interactions between the categories of peer leader behaviors that led to the development of the theory in this grounded theory study will be examined using Time-ordered matrices.

Discussions Defined

In order to be clear about what a discussion was, a definition had to be developed. The definition used in this study to describe a whole-class discussion is any time the peer leader is addressing the whole class and at least one student responds. This definition applies no matter the topic of discussion. Any time the peer leader is addressing a small group of students sitting together and at least one student responds, the interaction was labeled as a small group discussion rather than a whole-class discussion. While one may assume that the definition is simple and therefore unnecessary, this assumption would be faulty. It was not always obvious whether a peer leader was addressing a class or a small group and became difficult to code. Sometimes it was easy to tell if a peer leader was addressing the whole class because he/she would raise his/her hand and wait for a class to become quiet before talking. Other times, a peer leader would just start talking and the class would get quiet. On some occasions, however, a peer leader would direct a question to the class and then go from group to group answering questions, presenting the need for a consistent definition to be used throughout the study.

With a succinct definition in place, the videos were viewed, tabulating the following six items: (1) number of whole-class discussions, (2) length of time a discussion occurred, (3) number of times the board was used and by whom (student or peer leader), (4) number of homework/classwork chemistry problems orally presented per discussion, (5) if closure (wrap up) activities occurred at the end of class, and (6) the effectiveness of a discussion based on the Discussion-Rating Tool. There were eighty-four whole-class discussions in the thirty-four videos used in this study. The number of whole-class discussions in each video ran from 1-6, with an average of 2.4 whole-class discussions per class. A discussion consisted of an average of two homework/classwork chemistry problems, or the new process skill for the day, or wrap-up activities bringing closure to a class. Closure activities only occurred thirteen times out of the thirty-four videos. Out of the eighty-four discussions observed, the board was used fifty-three times: twelve times by peer leaders and forty-one times by students. The average length of a discussion was approximately four minutes and twenty-seven seconds; that is almost nine minutes per class, one-fifth of a class period. With discussions taking up such a large part of a class, the significance of studying whole-class discussions becomes apparent.

Instruments for Measuring Productive Whole-Class Discussions

Reformed Teaching Observation Protocol (RTOP)

The resulting scores of the Reformed Teaching Observation Protocol (RTOP) itself were not ultimately useful in this study, however, the use of this instrument led to the operationalization of a productive whole-class discussion and the development of the Discussion-Rating Tool. The modifications made to the RTOP and the resulting scores are described because of the significance they played in the processes that led to the development of the Discussion-Rating Tool. For example, the RTOP operationalizes classroom reform and assigns a value to desired traits that are observable. The Discussion-Rating Tool operationalizes a whole-class discussion and then rates whole-class discussions based on observed behaviors, an idea that resulted from using the RTOP.

The averaged RTOP scores of peer leaders ranked from 56 - 87, on a scale of 1 to 100 (Figure 4.1). Three raters coded twenty-one percent of the videos independently.

There was an 81 percent inter-rater reliability between the three sets of RTOP scores when calculating reliability based on the number of agreements, which is considered acceptable parameters (Huberman, 1994; Marques, 2005).

$$\text{Reliability} = \frac{\text{total number of points that were in agreement of each other}}{\text{total number of points possible (agreements and disagreements)}}$$

$$81\ \% = \left(\frac{(82 + 174 + 169)}{(82 + 23) + (174 + 36) + (169 + 41)} \right)$$

Table 4.1

RTOP Scores for Multiple Coders (1-3)

	Alice-1	Donna-2	James-1	Jerleen-1	Nina-2	Samantha-3	Steven-2
#1	70	68	66	73	87	74	64
#2	70	73	69	73	83	78	69
#3	71	65	68	73	86	69	68
Average	70	69	68	73	85	74	67

When looking closely at Figure 4.1, four peer leaders stand out having scores higher and lower than the rest of the peer leaders. The top five peer leaders according to the RTOP system of scoring are Nina-2, Nina-4, Nina-3, Alice-2, and Nina-1. The top five peer leaders according to the average discussion rating (ADR) are Nina-1, Keith-1, Nina-2, Alice-1, and Nina-3. Three of the top and bottom scores are similar using either tool. The RTOP is not a perfect fit for this study, but it did provide a kind of template to compare Discussion-Rating scores too. The RTOP was designed to measure levels of reform occurring in a classroom and did not advance this study in terms of what is actually happening in the classes that create productive whole-class discussions. Under these circumstances this instrument was not measuring what it was created to measure, nor was it answering the questions being asked in this study. The RTOP did, however, help in the development of the instrument used to measure whole-class discussions by organizing the observations and aiding in the operationalization of whole-class discussions and also providing a template to compare the Discussion-Rating scores.

Figure 4.1 Peer leader RTOP scores sorted from lowest to highest

Discussion-Rating Tool

As a result of using the RTOP arose the idea to develop an instrument specifically designed to rate whole-class discussions on a more consistent basis. Although this rating system suggests distinct boundaries, whole-class discussions actually exist along a continuum based on student and peer leader participation. The Discussion-Rating tool is divided into six major categories, which are defined by four descriptors per category (Table 3.4). A discussion does not always fall neatly into one of the six categories as defined in the Discussion-Rating Tool. In many cases a video falls halfway between two categories; in order to numerically assign numbers to reflect productivity, each of the four descriptors in each category represent 0.25 points. For example, if a peer leader exhibits all of the descriptors listed under *Fair* (2) and two of the descriptors found in *Good* (3), then his/her rating would be *Fair-Good* or 2.5. If on the other hand a peer leader exhibited all the descriptors under *Fair* and only one behavior under *Good*, his/her score would still be *Fair-Good*, numerically represented as a 2.25.

Each whole-class discussion has a Discussion-Rating and each class session has a calculated average discussion rating (ADR) from the accumulated discussions on a single video during one class session. Discussion-Ratings and average discussion ratings (ADR) run from *Bad* (0) to *Good-Excellent* (3.5) (Figure 4.2). The average ADR is *Fair* (2.0). No discussions were rated as Superb (5) or Excellent (4). The five highest scores consist of scores between *Good-Excellent* (3.5 to 4.45) and *Fair-Good* (2.5 to 3.45), while the lowest seven scores were *Bad-Poor* (under 1.5). The majority of the videos (twenty-two) ranged between *Poor-Fair (*1.45 to 2.45) and formed a division between the videos with above and below average whole-class discussions. The top and bottom five videos are used to contrast good whole-class discussions with poor whole-class discussions because it was here that the researcher expected to see the biggest differences in peer leader behaviors.

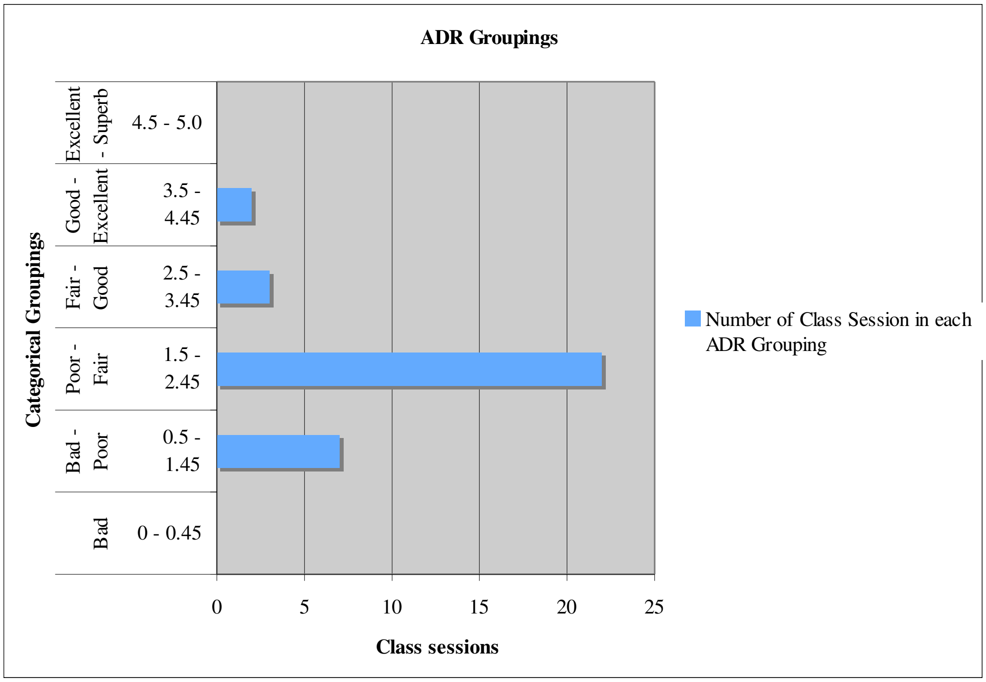

Figure 4.2 Number of class sessions that are in each of the six categorical grouping based of average discussion ratings (ADR).

Careful examination of the average discussion ratings (ADR) for each of the class sessions reveals that peer leader ratings between different class sessions are generally consistent and only fluctuate, at most, up or down one category (or one number). There is, however, one peer leader whose score fluctuated between two categorical groupings, Keith, with both the highest and lowest average discussion ratings (ADR) in this sample of peer leaders (Table 4.2). Reasons for the diverse scores will be explained in participant profiles in the next chapter. Keith's whole-class discussions are used in this study despite the discrepancies between his two class sessions because of the differences that were observed in the peer leader's behaviors. The differences in peer leader behaviors are a major focus of this study.

The average discussion ratings (ADR) for each class session were ranked from highest to lowest and compared side-by-side with the RTOP scores revealing differences between the two instruments (Table 4.2). While the RTOP was not directly used for analysis of whole-class discussions, it was reassuring to observe a minor trend in the RTOP numbers when listed beside the average discussion ratings (ADR) for each class session. For example, the top half of the average discussion ratings (ADR) has the highest RTOP scores, while the lowest average discussion ratings (ADR) have the lowest RTOP scores. The two highest RTOP scores, do not match the two highest average discussion ratings (ADR), however, they do belong to Nina and Alice, peer leaders in that do hold good whole-class discussions. When comparing the number of whole-class discussions per video with the average discussion ratings (ADR) no patterns were revealed. Peer leaders with the five highest average discussion ratings (ADR) have more positive behaviors exhibited in more categories then class sessions with lower ratings.

Legend for Table 4.2

PP – Procedural Practices
SQ – Supervisory Qualities
QT – Questioning Techniques
F/R – Feedback/Response
IP – Interpersonal Skills
√ – Indicates behavioral category exhibited

Table 4.2

Average Discussion Ratings (ADR) and Behavioral Categories

Class Session	Average RTOP	No. of Discussions	ADR	PP	SQ	QT	F/R	IP
Nina-1	78	1.5	3.5		√	√	√	√
Keith-1	71	1	3.5		√	√		√
Nina-2	87	1	3.25		√		√	√
Alice-1	70	2	2.75	√		√		√
Nina-3	85	4	2.7	√		√	√	√
Selena-2	64	3	2.31	√		√		
Derron-4	74	1	2.25		√	√		
Chantel-2	70	3	2.25		√	√		√
Steven-1	65.5	4	2.25		√	√		
Samantha-3	74	3	2.08	√				
Nina-4	87	2	2		√			√
Alice-2	85	2	2					√
Derron-1	77	3	2		√			
Lydia-1	77	6	2	√				
Michael-2	75	1	2		√			
Lydia-2	71.5	3	2	√				√
Chantel-1	69	2	2	√				
Derron-3	69	1	2		√	√		
Donna-4	68	3	2	√				
James-2	68	1	2					
James-1	65.5	1	2					√
Selena-1	63	2	1.88	√				
Samantha-2	76	3	1.67	√				
Donna-1	67	3	1.67	√				
Michael-1	62.5	3	1.58		√			
Jerleen-2	74	2	1.5	√				
Donna-2	67	3	1.5	√				
Jerleen-1	73	2	1.33	√				
Michael-3	65	2	1.25			√		
Steven-2	64	2	1			√		
Keith-2	60	1	1		√			
Samantha-1	59	2	1	√				√
Derron-2	56	1	1			√		
Donna-3	70	1	0.5					
Class Session	RTOP	No. of Discussions	ADR	PP	SQ	QT	F/R	IP

After rating each of the class sessions, a question emerged concerning the relationship between the number of whole-class discussions and the average discussion rating (ADR) for a class session. The question arose from thinking that maybe the more whole-class discussions a peer leader held, the more productive the discussions would be or maybe even the opposite, fewer discussions would mean they were more productive. There were no visible patterns between the number of discussions held in one class period and the average discussion rating (Figure 4.3). The number of discussions and ratings are staggered, without exhibiting any kind of pattern. Class sessions with only one whole-class discussion had *Bad-Poor* to *Good-Excellent* ratings, with two whole-class discussions had *Poor* to *Fair-Good* ratings, with three to six whole-class discussions had *Poor-Fair* to *Fair-Good* average discussion ratings (ADR). No relationships could be established between the numbers of discussions a peer leader chooses to hold during a single class period and the resulting average discussion rating (ADR). The solid line in Figure 4.3 shows the gradual increase in the average discussion rating (ADR) for all thirty-four videos with no visible pattern connected to the numbers of whole-class discussions.

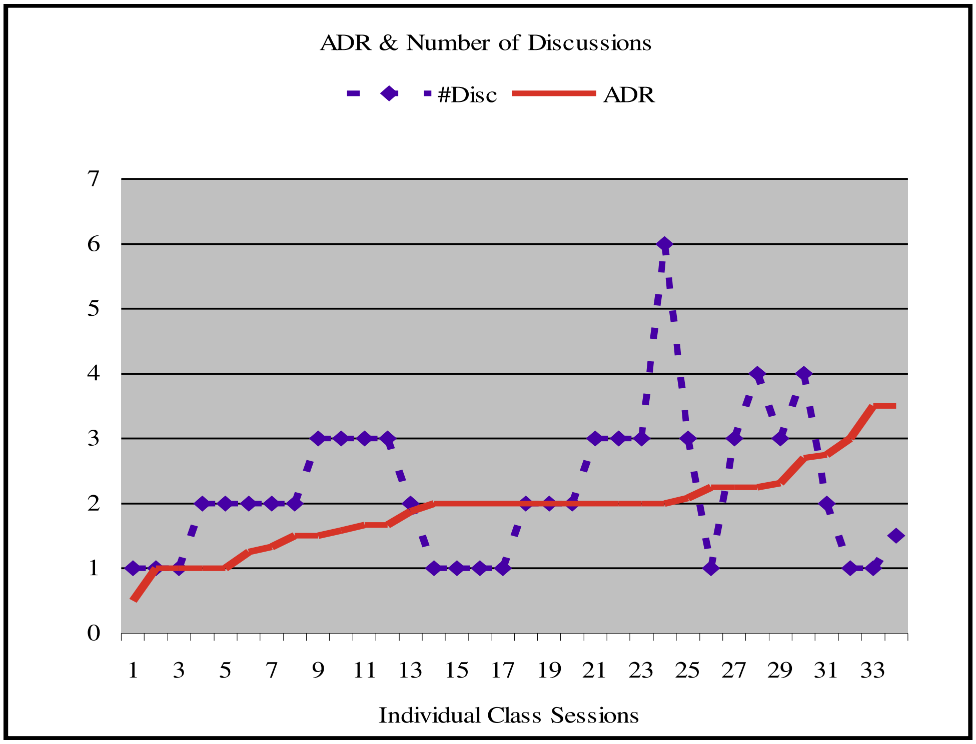

Figure 4.3 ADR compared to number of whole-class discussions held.

Coding Results

After operationalizing what was meant by the term whole-class discussion and developing an instrument to measure the productivity of a whole-class discussion, it became necessary to further examine the codes. Three factors that became prominent as a result of coding and needed further examination were student behaviors, peer leader behaviors, and types of questions. Each of the three factors was coded for using a focused (or second) coding phase, resulting in the production of several smaller categories. Each of the categories from the focused coding phase was further explored in the third or axial coding phase. During the axial coding process each of the categories was further subdivided into subcategories and then linked together to explain relationships found within the codes. The different categories that resulted from the axial coding passes will be described below with frequency counts for peer leader behaviors and types of questions.

The types of student behaviors coded will be presented without frequency counts. The decision not to record frequencies for student behaviors was based on the observation that the same kinds of behaviors were observed in classes with both: good and bad whole-class discussions. Peer leaders in class sessions with productive whole-class discussions treated negative student behaviors differently, emphasizing the need to examine peer leader behaviors closely.

The strength of a grounded theory comes from the active involvement and interpretation of the many different coding processes (Charmaz, 2006). It is from the codes that categories are formed; from the coding processes and categories that hypotheses are formed; and from the analysis of these categories and hypotheses that the theory emerges. A sample of codes are provided for each section in order for the reader to have a clear idea about what each category represents, in terms of student or peer leader questions. The codes, however, are not the important factors here. It is the relationship between the various categories (developed from the codes) that leads to the development of the theory, in this grounded theory study, that is important. The codes are given to further strengthen the categorical behaviors. The interpretations and significance of these findings will be presented. Each of the categories resulting from the different coding passes will be examined beginning with student behaviors.

Student Behaviors

Since productive whole-class discussions are rated on how student centered they are, how many students are involved, and how many student-student interactions occur, it only seemed logical to ask if whole-class discussions are productive because of the students in each classroom setting. Each of the videos was coded for student behaviors in order to determine if it was the students that determined how productive whole-class discussions were. The results of this coding process produced two lists: positive and negative observed student behaviors (Table 4.3). Generally speaking, positive student behaviors were about things that students were doing, while negative student behaviors were more about things students were not doing. Positive behaviors consisted of students following directions, asking questions, explaining answers, and rephrasing other students. Additionally, whole-class discussions that were rated productive include observations that deal with multiple students participating. Negative observations concerning student behaviors consisted of students not following directions, not asking questions, not explaining (just giving answers), and not rephrasing others (inattentive). Whole-class discussions that were rated unproductive had only a few students participating (usually the same students over and over).

Table 4.3

Examples of Codes for Student Behaviors

Student behaviors	
Positive Behaviors	*Negative Behaviors*
▪ Asking questions	▪ Asking for answers
▪ Answering questions	▪ Not answering questions
▪ Explaining how an answer was derived	▪ Just giving answers
▪ Rephrasing	▪ Non-attentive
▪ Continue to explain despite difficulties	▪ Do not hear answers and do not ask for explanations to be repeated
▪ Appear to catch on (get it)	▪ Shutting down
▪ Multiple students participate	▪ Only a few student participate
▪ Shouting out answers	▪ Shouting out answers

Both positive and negative student attributes were found to occur in classes with productive whole-class discussions as well as classes with poor whole-class discussions. Students were observed working together or working individually, explaining how an answer was given or just giving an answer, participating or not participating. These codes did not uncover any hidden behaviors, nor did they lead to any greater understandings of the workings of productive whole-class discussions. However, these codes did serve to reinforce the conclusions drawn from the Discussion-Rating Tool (Table 3.4). In the classes with productive whole-class discussions (rated *Excellent*, *Good*, *Fair*, and the various stages in between) there were both positive and negative student behaviors observed, similar findings occurred in the less productive (*Fair* to *Poor*) sections. The implication from seeing both positive and negative behaviors in class sessions regardless of the Discussion-Rating indicate that student behaviors do not determine if whole-class discussion are productive. The conclusion that students are not responsible for productivity levels is based on classroom observations and in knowing that all classrooms contained a cross-section of student abilities. Groups were formed by first pairing students up with someone of equal status, such as grouping two high-level students together, or two medium-high students, or two low-level students. Then pairs were matched with a category of students' one category lower. For example, two high-level students would be paired up with two medium-level students, or two medium-level students would be matched up with two low-level students, or high-levels with medium-high students. Then after all the students were grouped together the various groups were divided up between each of the classes trying to put different combinations of students in each class providing a range of abilities in all rooms. Student placement led to the conclusion that it was not random luck of students that led to productive whole-class discussions, especially since most of the student behaviors occurred in each setting.

The coding passes concerning student behaviors did not suggest that productive whole-class discussions were the results of specific student behaviors, but instead that positive student behaviors were the result of peer leader behaviors. The class sessions with the higher-rated discussions had peer leaders that were either encouraging the positive behaviors or trying to steer students away from the negative behaviors. For example, in the class sessions with productive whole-class discussions peer leaders would be observed calling on a variety of different students throughout the rooms. In class sessions with poor whole-class discussions peer leaders would be observed calling on the same students over and over. This kind of observation helps to explain why class sessions with productive whole-class discussions would observe students working hard together in small groups; everyone had to be prepared to explain something at any given time. Class sessions where peer leaders continuously called on the same predictable people did not motivate students to be prepared to explain. Class sessions with high and low Average Discussion Ratings (ADR) exhibited both positive and negative kinds of student behaviors, just not to the same degrees.

The Discussion-Rating Tool operationalizes a whole-class discussion based on the level of student-student interactions occurring. It only seemed logical to examine student behaviors to contrast the behaviors between good and poor discussions. The results from coding student behaviors did not reveal any significant differences occurring in good or poor discussions. The differences between these various categories of whole-class discussions were more about what the peer leaders were doing differently in each setting.

Peer Leader Behaviors

In addition to coding for student behaviors, peer leader behaviors were also coded. Thirty-four videos were coded for peer leader behaviors resulting in 244 codes, 153 subcategories, and 5 categories of behaviors (Table 4.4). The name assigned to each category of behavior is the one that most accurately encompasses the subcategories and codes. Each category consists of several subcategories consisting of positive and negative behaviors. The five resulting categories of peer leader behaviors were: Procedural Practices, Supervisory Qualities, Questioning Techniques, Feedback/Responses, and Interpersonal Skills. The summary table of peer leader behaviors (Table 4.4) provides an overview of each category with examples of positive and negative subcategories (represented by bullets) and individual codes (presented in italics). Each of the categories will be presented in greater detail immediately following the summary table. The summary table is provided to give an overview of the five resulting categories of peer leader behaviors.

Table 4.4

5 Main Categories of Peer Leader Behaviors

Summary Table of Peer Leader Behaviors

Procedural Practices - classroom practices and rules describing how a class operates

- Routines Established: Organized, Consistent method of getting class's attention, Uses roles, Follows rules, Uses process skills, Orderly, Prepared, Smooth transitions, Routines (training) established, Clear expectations set
- Unorganized: No order, Not prepared, No established routines, Sabotaged system, Hides behind system, Vague expectations

Supervisory Qualities – leadership skills (behaviors a peer leader demonstrates)

- Competent Leadership Skills: Good classroom management, Attentive, Teamwork encouraged, Authority, Professional, Prepared, Multi-tasking, Responsible, Conscientious, Good time management
- Weak Leadership Skills: Poor Class Management. Directions unclear, Bad behavior ignored, Rewards bad behavior, Non-authoritative (wimpy), Dictatorial, Easily distracted, Interrupts students

Questioning Techniques– types of questions asked by students and peer leaders

- Variety of Questions Asked: Procedural, Informational, Clarity & Elaboration, Understanding, Verification, Rhetorical, Reflective & Meta-cognitive
- No Questions asked: Missed opportunity to ask a question

Feedback/Responses - remarks made to students after questions, answers, or comments

- Effective Responses: Gives Responses that promote understanding, Neutral responses that do not tell answers, Positive nonverbal communications, Repeats student answers, Asks student questions, Asks students to repeat replies, Builds on student answers, Summarizes student answers
- Ineffective Responses: Responses that hinder understanding, Tells students answer or implies answer is right or wrong, Does not ask for elaboration – just asks for answers, Misses opportunities to ask questions, Does not help students move towards understanding

Interpersonal (or social) Skills – dynamic personality attributes and practices exhibited when working with others

- Dynamic Personality Behaviors: Cheerful, Playful, Humorous, Friendly, Positive, Encouraging, Polite, Acknowledges mistakes
- Unpleasant Personality Behaviors: Arrogant, Rude, Cocky, Overlooks mistakes, Unfriendly, Not cheerful, Negative, Condescending

Procedural Practices. The first category of peer leader behavior to be described is Procedural Practices. These behaviors are one of the easiest things to observe in a classroom. Many Procedural Practices are occurring before the class actually gets started. Procedural Practices describe peer leader behaviors dealing with the routines that an instructor uses to make a class run smoothly (Table 4.5).

Table 4.5

Codes for Procedural Practices

Procedural Practices	
Positive (+)	Negative (-)
Routines Established/ organizational	Unorganized / No routines visible
Prepared	Doesn't appear prepared
Cohesiveness, orderly	Doesn't flow smooth, disorganized
Smooth transitions	Disconnected activities
Clear Expectations	Vague Expectations
Works w/in System	Works outside of system
Consistently follows rules	Does not abide by rules
Creates environment conducive to learning	Oblivious to distractions
Speaks well of system (professionalism)	Sabotages System
Understanding about how Ss learn	Lack of understanding about Ss learning
Makes system work for their personality	Hiding behind system
Ss Involvement techniques: Ss kept alert	Calls on same students each time
Ss doing the work	Peer leader doing most of the work
Listens	Interrupts students while talking
Attention (to start discussion)	Just starts talking

Positive Procedural Practices consist of traits that describe the day-to-day operations within a class setting. The coding for this category began by noting behaviors that dealt with classroom practices and demonstrated thought on the part of the peer leader before class. Procedural Practices answers questions about the kinds of procedures occurring in a class setting, which includes routines, organization, cohesiveness, and consistency.

Varying degrees of positive and negative occurrences of Procedural Practices are observed throughout the class sessions (Table 4.6).

Table 4.6

Examples of Specific Positive and Negative Behaviors

Procedural Practices	
Positive (+)	*Negative (-)*
Works w/in System	**Sabotages System**
• Uses Roles	* Does not use Roles
• Uses Rules	* Does not abide by Rules
• Uses WGR's	* Does not utilize WGR's
	* Hiding behind system
Creates environment conducive to learning	**No concern for class environment**
• Closes door to cut down on hallway noises	* Oblivious to outside noises
• Ask students to repeat themselves so all can hear	* Does not ask for soft spoken answers to be repeated
• Organizes desks so Ss can work together and PL can walk around.	* Room disorganized, hard to walk around.
• Dresses appropriately	* Inappropriate attire
Understanding about how Ss learn	**Lack of understanding about how Ss learn**
Provides hints to move Ss forward	* Can be overheard saying "if only they would study more."
	* Tells Ss something and expects Ss to "know it"

The open coding passes resulted in the formation of lists of codes that formed subcategories. During axial coding, the subcategories specified the components forming the category Procedural Practices. This category consists of five subcategories: operational practices, peer leader operations within the system, clear expectations, learning environment created, and attitude about student learning (Table 4.7).

Operational practices is the largest of the subcategories comprised of ten codes describing a class's (1) cohesiveness, (2) organization, (3) routines, (4) class flow, (5) transitions between activities, (6) closure activities, and (7) daily procedures. The remaining three subcategories deal with peer leader behaviors concerning (8) getting the class's attention, (9) personalizing peer-leading guidelines, and (10) preparing before class.

If examined carefully some of the codes have a fine line between them and may seem redundant. This redundancy does not affect the results because frequencies of individual codes do not play a role in helping to understand the larger picture. For example, cohesiveness and transitions; both are concerned with the flow of the class and how the peer leader connects various activities to each other in order to develop bridges between concepts. Another example is orderly and organizational; the smoothness of a class (orderliness) frequently depends on the organizational skills of a peer leader and again the ideas appear to be redundant or closely related to Procedural Practices. Care was taken to combine codes that referred to the same kind of behavior, but a single behavior may serve two purposes. It is suggested that the reader does not become bogged down trying to distinguish between the codes, but instead tries to follow the development of the categories. The perceived redundancies are not significant because the list of codes do not answer the question about what leads to productive whole-class discussions. The codes are important and do lead to the development of the subcategories which lead to the development of the categories. The interactions between categories lead to a more global understanding about what is happening (and is not happening) in the peer leading sections that leads to productive whole-class discussions.

Table 4.7

Development of Procedural Practices Category

Codes	Subcategories	Categories
Attitude	Attitude about Ss learning	Procedural
Cohesiveness Getting class's attention Hiding Orderly Organizational Preparative Procedural Routines established Transitions Use of Closure	Operational Practices	Procedural
Audible answers Desk arrangement Distractive Sounds Dress	Learning Environment Created	Procedural
Process Skills Roles Rules Sabotages System Weekly Group Records	Works within Established System	Procedural
Directions Clear Limits Set Procedural Explanations Purpose Given	Clear Expectations	Procedural
Monitors Group Behaviors Time Management Timing of Interventions		Supervisory

An example of an observation labeled as Procedural can be found in an excerpt below. Scene ID Segment Lydia-2 video [00:00:18.28]:

Before class begins and only a few students have arrived, the peer leader is writing on the board:

1. *the schedule for the day, very detailed with exact times;*
2. *student roles according to groups with directions so students know exactly where to sit. (All managers sit facing front, presenters on left, recorders with backs to boards, and reflectors on the right).*
3. *the skill for the day (management).*

Students automatically turn in their homework in the front of the room. Activity books (where homework is found) are open and placed on the table in stacks (I assume according to groups). Then students pick up a scantron sheet for today's quiz and begin filling it out while everyone waits for class to start. Peer leader begins checking off student homework and returns student workbooks before class even begins.

A class session such as this will have many procedural notes recorded before class even begins. From the opening few minutes of video 20, Lydia-2, an observer begins to gather ideas about how this class will operate. The peer leader is organized as demonstrated by the schedule on the board, roles pre-assigned before arriving to class, procedures for turning in homework assignments. It is clear that these practices are not things that the leader is doing because she is being observed because she does not give any oral directions to students about where to turn in their homework, students just do it. The student's behavior indicates that these are routines performed on a regular basis in this class.

At first glance the category of Procedural Practices may seem closely related to the next category, Supervisory Qualities. Procedural Practices describe the operations and the routines that occur within a classroom setting. Supervisory Qualities, however, describe what the peer leader does in order to be perceived as an authority figure. In order to use Procedural Practices well, a peer leader will need to have good Supervisory Qualities.

Supervisory Qualities. Supervisory Qualities refer to the managerial and administrative sort of issues that peer leaders face each time they enter into a classroom to lead a session. Behaviors that describe the leadership skills observed in peer leaders are coded as Supervisory Qualities, addressing issues regarding peer leader attitudes about who is in charge (Table 4.8). Peer leader behavior ranges from being extremely accommodating to unyielding authoritarians, and varying degrees in between concerning compromise.

In a classroom setting where a peer leader is demonstrating positive Supervisory Qualities, you will see an individual that is an authority figure and is in control of the class. You will not see someone who thinks he/she is above the class, but instead someone who knows what needs to be done and how to get it done. Peer leaders exhibiting positive Supervisory Qualities will often give students a choice, not concerning whether or not the student will do something, but rather how it will be done. For example, a peer leader may be overheard giving a shy student a choice by saying, “You may stand up and explain it, or write it on the board.” Giving a shy student a choice is a compromise: the shy student still has to get out of his/her comfort zone and share an answer but is not forced to say it aloud if he/she is too shy. Peer leaders with good Supervisory Qualities empower students by permitting them to say an answer aloud or write it on the board or some alternative method of sharing their work. Peer leaders are still in charge because students are still presenting answers; it is a win-win environment benefiting all those involved, without the power struggle.

Having good Supervisory Qualities implies that a peer leader is attentive to the needs of his/her students. Peer leaders with strong Supervisory Qualities will monitor group interactions both within group settings and within whole-class settings, while keeping the momentum of student work moving. At the same time, peer leaders will help a group move from working together in a dysfunctional manner to a more functional manner. Exhibiting positive Supervisory Qualities means that a peer leader manages time as efficiently as possible, but maintains a balance between understanding the material and getting through the material.

In addition to managing time, there is also an effective time to intervene and help, and a time to wait and let students move through the material. For example, in Alice-2 video, if Alice had told students that there are the same number of moles of an element on both sides of an equation, instead of letting them grapple with the material and move back and forth, arguing for a few minutes, it would not have been nearly as effective as permitting students to come up with this idea on their own. At the same time though, a peer leader should not just sit and watch students argue or discuss for an extended period of time; for example in the Lydia-2 video, where students were not sure if water or oxygen should be listed first in a combustion equation. It does not matter and is therefore not a valuable use of class time. So knowing when to intervene and when to let students work things out on their own is a valuable Supervisory Quality. In order to know when to intervene or not, a peer leader would need to have a level of competence about the material and the pedagogical processes at hand. A peer leader needs to understand the material and also recall the kinds of difficulties originally encountered when he/she were initially learning the new material for the first time.

Scene ID Segment from Nina-4 video:

Line	*Speaker*	*Words or Description*
(181)	Ss [00:23:12.21]:	By the way we switched roles
(182)	PL [00:23:13.17]:	Oh you did?
(183)	Ss [00:23:14.01]:	So I am going to be the manager and recorder.
(184)	PL [00:23:18.19]:	Okay
(185)	Ss [00:23:16.21]:	Because she likes to speak and I don't.
(186)	PL [00:23:19.21]:	That is fine. It is good to have roles though. Could you just stay with it? Cause…I…cause whenever you have been a presenter you have done a great job.
(187)	Ss [00:23:20.29]:	But I am really... I am rrreally bad at talking. I don't...
(188)	PL [00:23:23.20]:	What do you guys think? She is not bad at talking? She does a good job of communicating. [PL is addressing the whole group.]
(189)	Ss [00:23:34.00] :	I talk all the time when it is meaningless.
(190)	PL [00:23:36.21] :	It will be good for you to do that. That is why there is roles. Okay?
(191)	Ss	Ooookaaaay
(192)	PL	Thank you

Peer leaders exhibiting positive Supervisory Qualities portray a balance between being too authoritative and being too permissive; they are not bossy, neither are they lenient. The excerpt from Nina-4 demonstrates the balance between these two behaviors. In line 186, Nina explains that having roles is a good thing, then she turns to the group in line 188 to solicit the help of the entire group, and then she asks the student “okay” in line 190, empowering her to make the decision. Nina even says “thank you” in line 192, giving the student credit for making a good decision. No power struggle, no controlling, just good administrative and management skills. Peer leaders do not need to be too authoritarian, yet they do need to have control in the classroom. A peer leader’s use of

Supervisory Qualities influences student willingness to participate, which often determines the kinds of questions that will be asked and answered in the classroom.

Table 4.8

Positive and Negative Codes for Supervisory Qualities

Supervisory Qualities	
Positive (+)	Negative (-)
Competent Leadership skills	Weak Leadership skills
Good classroom management	Poor Class management
Authority	Wimpy, Buddy with students
Teamwork encouraged	Answers encouraged
Continuous monitoring of groups	Does not monitor group interactions
Compromising & bending	Dictatorial
Attentive & observant	Inattentive & not observant
Stays focused & maintains momentum	Easily distracted or gets off topic
Uses time wisely	Poor time management
Good timing of interventions (waits)	Poor timing of interventions (interrupts)
Attention (to start discussion)	Just starts talking

Questioning Techniques. The category of Questioning Techniques emerged from the differences between peer leader behaviors in terms of asking questions. This category includes different aspects of asking questions including the types of questions asked, the purposes of the questions, the timing of the questions, and the helpfulness of the questions (Table 4.9). In this focused-coding pass involving peer leader behaviors, the use of questions were coded in relation to their perceived intentions, there were however, so many questions that a separate coding pass was made to determine the specific types of questions. The development and results of specific types of questions will be discussed in greater detail in the focused-coding pass describing kinds of questions. In this coding pass, questions are being examined in relation to how peer leaders use different kinds of questions and different Questioning Techniques. After determining that there were seven different types of questions (in a different focused coding pass) being asked by peer leaders in this study, the questions themselves were again coded according to type; the behavioral results presently being discussed include the seven types of questions, plus the peer leader behavioral techniques that went along with their use.

This coding pass revealed several differences involving peer leader use of questions. Some peer leaders use questions to lead students to understanding while others just help students to obtain answers. Other issues involving questions deal with timing, such as, does the peer leader interject with questions right from the beginning or are students permitted time to wrestle with the information before the peer leader interrupts the process? And still other issues deal with wait time, the length of time after asking a question and calling on someone to answer. The most common negative trait observed in this category dealt with missed opportunities to ask questions. In other words, a peer leader would either call on someone else to answer if a wrong answer was given or say is that what everyone thinks and walk off. This type of question does not help move a group any closer to understanding.

After coding for behaviors specific to a peer leaders use of questions the codes were reviewed and analyzed in hope of distinguishing characteristics that might offer an explanation about what creates productive whole-class discussions. Eight characteristics specific to questions and differences between peer leaders became prominent as a result of looking at Questioning Techniques specific to each peer leader.

1. The majority of the questions coded are procedural questions designed to help the group function autonomously.
2. Many of the questions coded are low-level informative questions asked in an effort to evaluate what students know or do not know about a particular topic. In other words, the Peer Leader is information-seeking, asking questions at the recall or lower-order cognitive levels.
3. Rather than merely asking students to read an answer off their papers or from their workbooks, some peer leader questions are more stimulating and challenging.
4. Peer Leader questions direct whole-class discussions, making sure that students are on track and understanding fundamental concepts from the lessons.
5. When a wrong answer was given, instead of asking if anyone else has a different answer, the peer leader would ask if anyone else thought about it differently or came about it from a different angle. Then they would go back to the wrong answer and figure out as a class why one angle of attack was more useful than the other. Not only did the whole class know the right answer when the discussion was over, but they also knew why the wrong answer was not right.
6. Some peer leaders encourage students to continue to ask questions until they understand.
7. Peer leaders seldom push students to explain their thinking or to ask specific questions. For example, peer leaders can be heard asking, “What don’t you understand?” A student will reply “everything” and so the PL taking a deep breath begins to explain the whole thing over. While other times, a few Peer Leaders will

ask if anyone else has the same answer, but can explain it another way or they will request that students explain their thought processes rather than just the answers.

8. Sometimes it appears as though the questions are part of an agenda or scripted, and even though an answer may be close to what the peer leader was expecting, they continue or persevere until they get the exact phrase or answer they seemed to be looking for. This is often confusing for the students and exhausting for the peer leaders, oftentimes being similar to a game of charades where the peer leader is be overheard saying, "Forget about those hints, let's start over."

Similar to the first two categories, Procedural Practices and Supervisory Qualities, Questioning Techniques is also made up of positive and negative behaviors that work together to strengthen the relationships between peer leaders and their students.
The following excerpt from Selena's video, demonstrates negative behaviors in relation to questions. Selena demonstrates a very rigid kind of questioning technique that does little to move students toward understanding.

Scene ID Segment from Selena-2 video:

		Class Discussion #2
(74) Procedural	PL [00:17:05.24]:	Can I have everyone's attention for like 10 seconds?
(75)	PL [00:17:08.19]:	Ok I did write number one over here I meant 3 the number 3 on CTQ # 3.
(76)	PL [00:17:16.01]:	And I also…would like umm I forgot to mention there is a rule sheet in the folder that everybody should have a copy of and I want everyone in number 3 for each element to find the oxidation number and write down which rules applies to the particular number.
(77)	PL [00:17:34.15]:	The rule sheet. OK take out the rule sheet, everyone should have a copy of it and then how let's say uhh for example let's do # the wery first one and uhh so the reactant over here right.

(78) Procedural	Ss	What rule sheet?
(79)	PL	The rule sheet that should be in the blue folder.
(80)	Ss [00:17:59.29]:	This is what it looks like
(81)	PL [00:17:59.16]:	Yea that is what that it looks like (points to Ss w/ paper held up)
(82)	Ss [00:18:01.15]:	There is only 1 copy,
(83)	Ss	Yea there's only 1 copy
(84) Information	PL [00:18:04.18]:	Ok then you should I guess try to refer to it like when you rotate and then for like CR3+ what's the oxidation number for that, Alex?
(85)	Ss [00:18:19.13]:	3
(86) Information	PL [00:18:19.28]:	+3 and what would be the rule that would apply to that?
(87)	Ss [00:18:26.14]:	Ummm uhh 2
(88) Procedural / Missed Opportun	PL [00:18:28.01]:	Rule number 2 right, did everyone hear Alex?
(89)	Ss	Nope
(90) Procedural	PL [00:18:34.09]:	Ok Alex can you please repeat one more time?
(91)	Ss [00:18:38.01]:	Uumm Cr is plus 3 that's rule 2.
(92) Information/ Missed Opportun	PL [00:18:42.15]:	Yeah, everyone got that?
(93)	Ss	....
(94) Information/ Missed Opportu	PL [00:18:47.14]:	The reason uh the reason for its plus 3 because... its umm....that..... comes.....that's the rule number. Is that understood, any questions?
(95)	Ss [00:19:00.23]:	Yes
(96) Procedural	PL [00:19:01.00]:	Uumm why don't your manager ask me the question?
(97)	Ss [00:19:07.23]:	Because I don't know what the question is.
(98)	PL [00:19:09.06]:	OK maybe you can tell her what's the question.
(99)	Ss	I don't get it
(100)	Observation	Class laughs and manager says:
(101)	Ss	He doesn't understand
(102) Clar/Elabor	PL	Ok, umm how about ... Brittany do you understand it? Can you explain it to him? Try.
(103)	Ss [00:19:20.29]:	Yea, I mean well ...
(104)	PL	Give it a try
(105)	Ss [00:19:25.19]:	Ok, if it shows the like if you if have an equation and it already gives you the charge right there then you just use the charge that it gives. You don't have to figure it out because it is already given.

Selena's Questioning Techniques do little in terms of helping students understand chemistry concepts. Selena's questions are robotic, leading students towards correct answers rather than conceptual understanding. By asking if everyone understands, immediately after an answer with no explanation is given, opportunities are missed to ask students to clarify and elaborate on their answers. The practice of asking if everyone understands a numerical answer demonstrates the beliefs that Selena has about student learning; her behaviors infer that students understand concepts by knowing the right answers. Lines 92 and 94 were coded as *missed opportunities* because the peer leader missed an opportunity to follow up with more questions to further ensure that her students understood. The kinds of Feedback/Responses given in reply to student questions and answers, influence student participation levels by promoting or hindering further understanding.

Table 4.9

Codes for Questioning Techniques

Questioning Techniques	
Positive (+)	Negative (-)
Type of question asked:	Missed opportunity:
Procedural	No questions asked
Informational	
Clarity/Elaboration	
Understanding	
Verification	
Rhetorical	
Reflective	
Wait time	No wait time
Follow through	Does not follow through
Students ask for help	Interrupts learning process
Directed questions	Vague and indirect questions

Feedback/Responses. Peer leaders are taught not to directly supply students with answers, but to ask questions that guide students towards understanding. Asking questions, instead of supplying answers, is often difficult for peer leaders. Comments made by peer leaders after students ask questions, give answers, or make comments are coded as Feedback/Responses. These codes answer questions such as: How do peer leaders respond to students? What kind of feedback do they give to students that are correct or incorrect? Is there a pattern in peer leader behavior that students can use to determine if their answers are correct or not? This category deals with the kinds of feedback that peer leaders provide in response to student questions, remarks, or answers (Table 4.10).

Similar to the last three categories of behavior, this category consists of both positive and negative codes that are based on whether feedback promotes student dialogue or shuts students down. For example, does a peer leader ask the class if an answer sounds right, or does the peer leader tell students an answer is right? The first method stimulates students to say yes or no, and possibly to add to an already given answer. From there, a discussion among students can be generated. The second method shuts students down. Students can check their answers off as right, or they can mark their answers wrong. Occasionally a student may ask for further explanations, but in most cases, telling a student that an answer is right or wrong devalues the contributions of students to a discussion.

Another example of an interaction that would be coded as a negative response deals with student understanding. "Does everyone get it now?" "Does everyone understand this?" Peer leaders in many of the videos are asking these kinds of questions, or similar ones. While this kind of question might be necessary for a peer leader to determine if they can go on to new material, or if they should stop and cover the material again, what does the peer leader really know about student understanding from a question like this? Exceptional peer leaders will take it a step further by asking a student or two, to rephrase an answer or to provide some kind of explanation that demonstrates understanding. Questions asked in response to students were coded twice, once in Feedback/Response and again in Questioning Techniques. A question such as, "does everyone get it now," would have been coded as a missed opportunity, as described in the previous section, because of the way that this kind of question does little to stimulate further student participation.

Table 4.10

Codes for Feedback/Responses

Feedback/Responses:

Positive (+)	*Negative (-)*
Gives responses that promote understanding	Gives responses that hinder understanding
Neutral responses, nonverbal communication	Tells students they are right or wrong
Repeats student questions & answers	Gives/ Tells Answers
Repeats student answers & asks Questions	Says, "I can't tell you"
Ask students to repeat their answers	Whole class cannot hear answers
Builds on Ss answer	Tells how to solve a problem
Summarizes using student terms	Summarizes in a show-off manner
Class active class	Students sitting passively
Encourages students to try even though they feel like they do not get it	Does not help Ss move towards understanding
Double checks for understanding	Accepts ok to mean they understand
Pushes Ss for clarity	Does not ask for explanations
Directs Ss w/ helpful hints	Teaching/ Telling

Interpersonal (or Social) Skills. Interpersonal Skills are an extension of all four of the previous categories of behavior, magnifying peer leader behaviors responsible for creating a classroom environment. Interpersonal Skills describe personality traits and social practices that peer leaders exhibit when working with individual students or a whole class. The five subcategories of behaviors that resulted from this coding process, describe the kind of Interpersonal Skills (both positive and negative) that the peer leaders displayed while working with students (Table 4.11). These categories describe a peer leader's personality, sensitivity to student problems, mannerisms, accessibility, and overall demeanor.

No peer leader had all positive or all negative attributes; Table 4.11 is the combination of all the peer leaders' Interpersonal Skills from different class sessions. A peer leader's Interpersonal Skills consist of an assortment of traits from each of the five subcategories: personality, sensitivity, mannerisms, accessibility, and demeanor. Each peer leader possesses different amounts of one quality than another, making each individual different and unique.

A peer leader that exhibits positive personality traits is one that is seen as friendly, likeable, pleasant, and sociable. Often, these peer leaders are cheerful, playful, humorous, full of positive energy, encouraging, and not afraid to make mistakes. They are sensitive to the needs of others and polite. It is easy to approach peer leaders who are personable because they do not sit back or separate themselves from the class; they are continuously walking around, making themselves available. Peer leaders with positive Interpersonal Skills seem to make a conscious effort to build relationships with their students. Being patient and establishing trust, while maintaining an open atmosphere by being sincere and real, helps to build peer leader-student relationships. These peer leaders are often heard saying after a class is over that they are proud of their students for the way a class went on a particular day, while still looking for ways to improve their peer leading sessions and student learning.

Table 4.11

Codes For Interpersonal Skills

Positive Behaviors	Negative Behaviors	Interpersonal Skills
Personable	Weird	
Cheerful		
Playful		
Humor		
Friendly	Unwelcoming	Personality
Encouraging	Arrogant	
Mistakes acknowledged	Mistakes unacknowledged	
Positive		
Comfortable	Uncomfortable	
Concerned		
Appreciative		
Empathizes		Sensitivity
Frustrations acknowledged	Frustrations unacknowledged	
Acknowledges Ss	Does not acknowledge Ss	
Depersonalizes	Personalizes issues	
Apologizes		
Courteous		Mannerisms
Requests	Demands	
Respectful	Rude	
Non-confrontational	Confrontational	
Non-judgmental	Judgmental	Accessibility
Non-threatening	Threatening	
Inviting	Non-inviting	
Building relationships	Negative behaviors	
Trust established	Inconsistent	
Patient		
Sincere	Defensive	
Real	Condescending	Demeanor
Listens	Inattentive	
	Disrespectful	
	Sends mixed messages	

Peer leaders coded as having negative Interpersonal Skills did not build trusting relationships with their students. These peer leaders often were seen as insensitive to student needs, disrespectful, and generally unfriendly. These peer leaders tainted relationships instead of building stronger relationships with their students. They are often defensive and do not generally admit when they have made a mistake. While no peer leader blatantly demonstrated all or even half of these negative behaviors, the presence of a few negative Interpersonal Skills seemed to undo the work of the positive behaviors.

Through the coding process several different kinds of interactions between peer leaders and their students were observed. The focused coding passes, specifically for peer leader behaviors, resulted in a list of 244 different kinds of observed behaviors. These behaviors were then grouped together into subcategories consisting of both positive and negative behaviors. From the subcategories emerged five categories of behaviors describing the interactions between peer leaders with their students. Each of the five categories of behaviors consisted of positive and negative behaviors. The categorization of each code was based on the kind of action that resulted; a code was classified as positive if it increased student participation and negative if the behavior did not promote student involvement.

Questioning Techniques was the most frequently coded category regardless of a class session's average discussion rating (ADR). The remaining four categories fluctuated in frequencies of occurrence. Individual frequency counts for each of the observed peer leader behaviors offered little in terms of answering the question, "What creates productive whole-class discussions?" Coding peer leader behaviors still turned out to be a very important component in answering the question about what creates productive whole-class discussions. It is through these codes that the categories emerged which lead to the development of five hypotheses and the resulting theory. The significance of each behavior became clearer as the interactions between the five categories were evaluated. The results of these interactions will be discussed in more detail in the Evaluating Interaction portion of this chapter.

Categories of Questions

A separate focused coding pass through the videos consisted of looking at the specific questions being asked by peer leaders and students. The questions were coded several times and categorized based on the kinds of responses that they elicited and the role the questions appeared to play in the classroom. 3820 questions were coded in total; 2965 asked by peer leaders and 855 asked by students (Table 4.12). During coding, first it was noted that a question was being asked, and then the question was classified according to the type of response that was given. The definition for each category is based on the role of the question.

Seven categories of questions emerged from this coding pass in this research (Table 4.13). They are listed in order of prevalence according to the number of times each kind of question was asked by a peer leader: informational, procedural, clarity/elaboration, rhetorical, understanding, reflective, and verification (Figure 4.4). Seventy-five percent of the questions asked by peer leaders and students consisted of information and procedural questions (Figure 4.5).

In addition to the researcher, two additional coders independently coded seven of the thirty-four videos for questions; twenty-one percent of the videos were coded multiple times. These seven videos were coded three times by three different coders. The calculated inter-rater reliability was eighty-five and eighty-nine percent for those seven videos recordings. These values are acceptable, and within the suggested values of eighty percent for such detailed coding (Miles & Huberman, 1994)

Each of the seven different kinds of questions will be defined in terms of their role, along with specific examples of the different breakdowns for each question type. Similar to what occurred in the coding pass involving peer leader behaviors, the reader is encouraged not to become caught up with the details of each subcategory and code. The important ideas here concern the different categories of behavior and the different kinds of questions that emerged from the coding process. The details are given here to answer questions about how a specific question might have been coded with regards to its role.

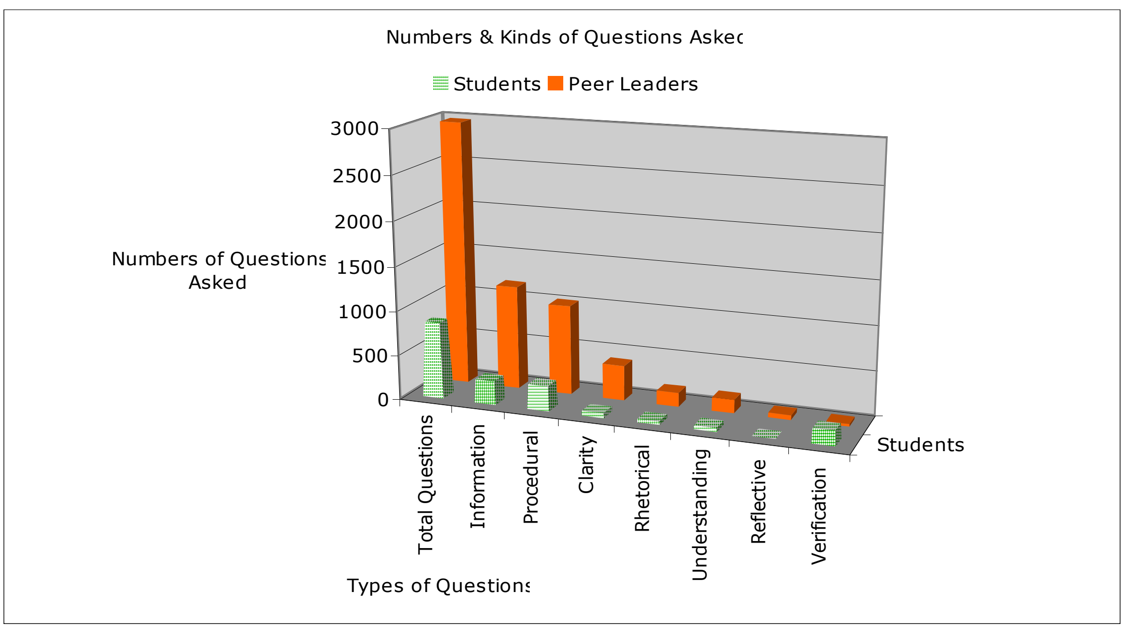

Figure 4.4 The kinds of questions asked by peer leaders and students and the number of times each question type was asked.

Information. Information questions are the largest single category of questions asked by peer leaders. They made up 41% of the questions asked by peer leaders and are classified primarily by the type of answer they elicit. Approximately 34 information questions are asked during each class period. Peer leaders often use information questions to draw out what a student already knows. This category consists of two major parts: questions that focus on recall of facts and information/understanding questions that require short one-word answers. Information questions can usually be answered with a simple yes or no answer, or just a few words. Information questions do not ask for any synthesis or integration. Peer leaders often use this category of questions to establish a foundation from which to move forward. Students are asked simple recall like: "what is the definition of electronegativity? What is the formula? What column is carbon in? Where did you get that formula?" If students cannot answer these questions, then peer leaders will have to back track a little before moving on, frequently asking other students to clarify a concept or idea.

Other times a peer leader will use this category of questions to tell when it is time to move on. For example, questions like: "Do you understand that? So everyone gets it now? Does anyone have any questions on that?" While the answer to this type of question may be "yes," in which case a peer leader can move on, a peer leader cannot be certain if student truly understand with this kind of question, but the implication is that it is okay to move onto the next problem. On the other hand, if a student replies "no" the peer leader will have to back track and ask further questions for clarity on what is not understood.

No pattern was found to exist between the number of informational questions asked and a class session's average discussion rating (ADR).

Procedural. Procedural questions are the second most common type of question asked by peer leaders. This type of question was asked 33% of the time, with an average of 28 times in a single class period. Procedural questions help peer leaders to guide classroom operations. There were four subdivisions within this category. First there were questions that establish classroom policy: "Why can't you take a quiz late? Why can't you receive or make up points for a class you are absent from?" Next were questions that established procedures: "What order do you need to do these in? Why does each person need to do each problem? How much more time do you need?" Still other questions helped to control group dynamics, enabling groups to work efficiently without the help of the peer leader. "Who is the presenter? Who is keeping track of time? How is your group doing?" And lastly, are the types of questions that aid in unifying a specific group or the whole class. "Did your group reach a consensus? Does any group have a different answer? Does anyone else have anything to add? Can you rephrase her answer?" All of the questions in this category facilitate effective class work and group work.

No pattern was found to exist between the number of procedural questions asked and a class session's average discussion rating (ADR).

Clarity/Elaboration. The third kind of question coded, clarity/elaboration questions, make up 13% of the total questions asked and are asked approximately 11 times per class period. Did the student say what the peer leader thinks he said? The peer leader thinks he/she understood but need to be sure. This category has two subcategories, clarity and elaboration. These kinds of questions ask students to explain more about what they mean, to restate their ideas by being more specific, in other words, for clarity. It becomes obvious when students cannot rephrase or repeat an answer that they do not understand. A peer leader can often use answers from Clarity/Elaboration questions to gather more information about student misconceptions, incorrect ideas, or lack of understanding. "Can you explain that in a different way for other group members to understand? Can you give me an example? What did you mean by… Why did you write it down like this?"

Clarity/Elaboration questions help the peer leader and students to understand what they do not understand. Talented peer leaders ask students to clarify and elaborate on a regular basis, regardless of whether students have 'the right' answer or not. Asking clarification types of questions does not imply that there is an error some way, although many of the peer leaders in the lower-rated discussions only use these kinds of questions when something wrong has been given as an answer. If Clarity/Elaboration questions are asked on a regular basis, students become accustomed to explaining the thinking processes behind their answers. If, however, students are only asked to clarify when an answer is incorrect, they quickly learn that clarification questions are an indication that something is wrong with the answer just given.

A general trend was found to exist between the number of clarity/elaboration questions asked and a class session's average discussion rating (ADR). The more students were asked to clarify answers on a regular basis the higher the average discussion rating (ADR).

Rhetorical. Rhetorical questions were next in frequency, with 149 total questions, and make up only 5% of the total questions asked. Questions were classified as rhetorical if a question did not need a response, or the peer leader did not wait for a response, then it was classified as rhetorical. No real answers were intended when these questions were asked. Rhetorical questions were frequently used to make a point in a non-confrontational manner. For example, "Who didn't do their homework?" The peer leader that asked this question knows that if you did not do your homework you would not be able to stay for class, and points would be lost. It was a humorous way to get class started because on the day that this question was asked – no homework had been assigned. Other rhetorical questions included simple statements like …"Okay?"

No pattern was found to exist between the number of rhetorical questions asked and a class session's average discussion rating (ADR).

Understanding. Questions categorized as understanding had the same frequency as rhetorical questions, 5%. Understanding questions are subdivided into four subcategories. First there are questions that help to reveal student understandings by asking students to explain what they picture in their minds. For example, "So what reactants would you have remaining?" The second subcategory aids in helping student to make connections. To make links between what they know and the new concepts that are being discussed. "What makes you think q1 is always positive?" The third subcategory helps to focus on the meanings behind content. "Why are most pots made of aluminum if copper and lead have higher specific heats?" And the fourth subcategory consists of questions that help students develop conceptual understanding. "You've got your reactants, your intermediates, and your products based on that equation, so the 438 gets you from where to where?"

No pattern was found to exist between the number of understanding questions asked and a class session's average discussion rating (ADR), although a very weak trend was found between the class sessions with high and low average discussion ratings (ADR). The peer leaders with lower average discussion ratings (ADR) generally asked fewer understanding questions than those peer leaders with higher ratings.

Reflective/Metacognitive. Reflective/Metacognitive questions are the second least common question asked by peer leaders, 1.85% of total questions asked. Reflective/ Metacognitive questions are intended to promote reflection by asking students to reflect on a variety of personal or group. Questions that were evaluative in nature were coded as Reflective/Metacognitive. This category of questions is subdivided into three parts. First, there are the questions that ask students to focus on past or future actions, such as: "What can you do to help your group next week? What was one strength of your group today? What did we learn today?" Next, there are questions that promote planning and organization in order to prepare students for possible challenges. "What do you do on a test if you do not have enough time? How can you organize this in a short amount of time?" Third, there are questions that aid in promoting the expression of attitudes, biases, and points of view (personal or otherwise). "Why do you feel the test was unfair? What could we do to make these Friday sessions more valuable to you? Why do we need to look for energy alternatives?"

No pattern was found to exist between the number of reflective/metacognitive questions asked and a class session's average discussion rating (ADR).

Verification. Finally, the least common type of question asked by peer leaders was verification questions; making up only 1% percent of the total questions being asked by peer leaders. Students asked five times as many verification questions as peer leaders. Peer leaders only asked 31 verification questions, while students asked 168. The perceived purpose or intention of this kind of question was to intentionally check to see if an answer was the same as someone else's. "Did you get plus 3? Is this right? Which number of significant figures is correct?" In order to determine if an answer was correct or not, verification questions would frequently be asked.

No pattern was found to exist between the number of verification questions asked and a class session's average discussion rating (ADR).

No distinctive patterns existed when looking at each of the various kinds of questions being asked by peer leaders and students. The only notable patterns revealed when looking at each of the frequencies of questions asked by peer leaders involved clarity/elaboration questions, and even then there were several exceptions that did not fit the general pattern. There was, however, a weak trend when combining clarity/elaboration, understanding, and reflective/metacognitive questions. Generally speaking the higher the number of questions asked from these three categories the higher the average discussion rating (ADR). Looking at the category of questions in isolation of the other categories did not lead to an answer concerning what peer leader behaviors create productive whole-class discussions, but instead gently hinted that questions were somehow connected.

Peer leaders asked 2965 questions, an average of eight-seven questions per class session, which means that peer leaders are asking at least one and a half questions every minute (Table 4.12). Students, on the other hand, asked 855 questions, an average of 25 questions per class, which means that students are asking a question every two minutes. With such a large part of class time being utilized by questions, the researcher was surprised at the weak trends exhibited by the different kinds of questions asked and thus decided to look at the interactions occurring between the various categories. With such a small percentage of the questions asked coming from clarity/elaboration, understanding, and reflective/metacognitive questions and these being the only questions that demonstrated a relationship with productive whole-class discussions, students would benefit from learning how to ask these kinds of questions (Figure 4.5). At this point in the study, the researcher began reading through her memos to see what perhaps needed recoding or what had been over looked. Through the process of reading the memos in succession, an awareness of several discrepancies between preconceived ideas and contradictions in the data became salient.

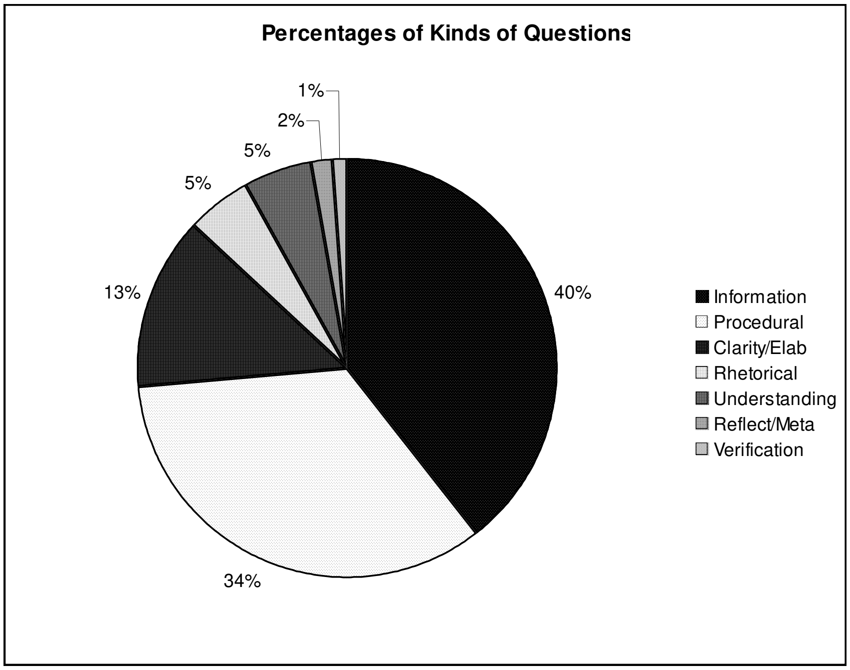

Figure 4.5 Pie chart demonstrating total percentages of all questions asked by peer leaders and students.

Table 4.12

Summary of Total Questions Asked by Peer Leaders and Students in 34 videos

		Information	*Procedural*	*Clar/Elab*	*Rhetorical*	*Understanding*	*Refl/Meta*	*Verification*
PL Total	2965	1169	1011	394	156	151	53	31
PL Average	87	34	30	12	5	4	2	1
PL %		39	34	13	5	5	2	1
SS Total	855	267	281	54	38	45	2	168
SS Average	87	34	30	12	5	4	2	1
SS %		31	33	6	4	5	0	20

Table 4.13

Categories, Definitions, and Examples of Questions Asked by Peer Leaders and Students

Question Category	Branch	Function	Example
Informational		Help to draw out what student already knows	
	Focus on Recall or Facts	Establish a foundation or to elicit information	Where did you get that formula? What column is carbon in?
	Yes/ No answers	Helps gauge understanding	Do you understand?
Procedural		Helps monitor & control the way class is run	
	Establish classroom policy	Helps class to run smoothly (establishes boundaries)	Why can't you receive points for a class you are absent from?
	Establish procedures	Helps with class productivity	Why does each person need to do each problem?
	Establish or help to control group dynamics	Helps the group run efficiently without constant input from the PL	Who is the manager? How is your group functioning?
	Aid in unifying the class or a group	Helps groups and the class to stay on the same track	Does anyone else have anything else to add? Can you rephrase her answer?
Clarity & Elaboration		Helps to be certain about what a student meant (Continues on with an idea mentioned by a student)	
	Press students to rethink or restate by being more specific.	Helps to understand what student meant	Why do you say that? Can you explain that in a different way for others to understand? Can you rephrase that?
	Ask students to explain more about what they mean.	Helps to understand To elaborate on an already given answer	What do you mean by…? Why would you…? What steps would you take? How did you guys do that?
Rhetorical		Helps to lighten class mood	
	Questions asked where no answer is intended.	Helps lighten the setting and to let students know PL is watching	Who didn't do their homework this week? Okay? You must have written in invisible ink, right?

Question Category	Branch	Function	Example
Understanding	Reveal understanding	Helps in determining the kind of mental picture students have	What kind of charge does a proton have? Which of these 2 answers do you think is most accurate?
	Focus on making connections	Helps students to link what they know to what they are trying to learn	What makes you think q1 is always positive? How did you determine this?
	Focus on meanings behind textual content.	Requires students to think beyond what was merely stated or implied	Why are most pots made of aluminum if copper or lead has a higher specific heat?
	Seek conceptual understanding	Helps to develop deeper conceptual understanding	How would you experimentally show that sulfur and oxygen combine is a 1:1 ratio to form the gaseous compound sulfur dioxide?
Reflective		Helps students to reflect on the steps they are taking, what they would do next (an idea not yet presented), and to explain why	
	Focus on future actions or projections.	Helps students to evaluate their setting	What can you do to help your group next week? What was a strength of your group today?
	Promote planning and organization.	Help students to prepare for possible challenges	What do you do on a test if you do not have enough time? How can you organize this in a short amount of time?
	Promote expression of attitudes, biases, and points of view.	Help students find and voice practical applications for the material they are learning	Why do you feel that the test was unfair? What could we do to make these Friday sessions more valuable to you? Why do we need to look for energy alternatives?
Verification		Helps students see if their answer is the same as someone else’s	
	Ask if an answer is correct or not.	Asked most often by students	Did you get plus 3? Is this right? Which number of sig figs is correct?

Assumptions

As the study progressed the researcher recognized four unwarranted assumptions she had brought to the research. These assumptions were revealed by results that contradicted them. Each of these assumptions became extremely important as this study progressed, with the first three assumptions leading to three of the final hypotheses. The assumptions are presented in the order in which they became cognizant.

The researcher originally believed that productive whole-class discussions:

… occurred most often in classes with established classroom policies.

… occurred as a result of the kinds of questions being asked.

… occurred as a result of peer leaders' content knowledge.

… should occur only when students are tackling difficult problems.

The first assumption was that the more *methodical* a peer leader was, the smoother the class, and the better the discussions. This was the first assumption the researcher became aware of, probably because these practices are the easiest to see. As discussed previously, one of the major categories resulting from the axial coding passes was procedural practice, which relates directly to the first assumption. The researcher became aware of her assumption when she watched Lydia and Samantha's videos. Both of these peer leaders followed all of the guidelines established in peer leader training. These two peer leaders took all the coordinator's suggestions and were very consistent and structured. They did not waver from the format. Lydia and Samantha had whole-class discussions that ranged between *Fair* and *Poor*. Their discussions were not productive in spite of them being so methodical and organized. This does not imply that Procedural

Practices are not important to the overall functioning of a class, but rather that Procedural Practices alone did not lead to productive whole-class discussions.

The second assumption that the researcher became aware of dealt with questions. She thought that the success of a discussion would be based on the variety of different kinds of questions, or even the number of questions being asked by the peer leader. This assumption is based on many observations of discussions and the understanding that all questions have a function. Asking lots of questions would encourage students to participate if by nothing other than answering the questions. The more different kinds of questions a peer leader used, the more likely the peer leader would be at reaching different levels of students.

As a result of looking at class sessions with the highest and lowest average discussion ratings (ADR) and comparing the number of questions asked and the number of different kinds of questions in each class, the assumption about questions was uncovered (Table 4.14). If the assumption were true, the numbers of question types being asked by a peer leader (column 3) would decrease as the average discussion rating (ADR) (column 2) decreased. Likewise, a similar pattern would be seen under the number of questions asked (column 4) and the ADR (column 2). This is not what is seen in the data; the numbers are straggled throughout the column with the most and least productive discussions consisting of peer leaders asking four to seven different kinds of questions. The class sessions with the third (*Good*) and fourth (*Good-Fair*) highest average discussion ratings (ADR) ask all seven of the different types of question, instead of the highest rated classes asking all seven types. To further reiterate that this assumption is false, look at the peer leaders who ask six different types of questions. Class sessions with six question types are found in one of the highest rated class sessions and four times in the bottom six classes. The varieties of questions asked do not determine the rating for a whole-class discussion. Similarly, the flaw in this assumption becomes even more obvious when a peer leader (Keith) with one of the highest average discussions (*Excellent-Good*) only asks 56 questions and four of the bottom six class sessions ask a minimum of 23 more questions more than that.

This does not imply that question types are not important to the overall functioning of a discussion; this only demonstrates that the number of questions asked and number of different kinds of questions are not the cause of productive whole-class discussions.

Table 4.14

Top & Bottom 6 Average Discussion Ratings (ADR) and Kinds of Questions Asked

Class Sessions	Average Discussion Rating (ADR)	Types of Questions	No. Questions Asked
Nina -1	Excellent - Good (3.5)	6	110
Keith -1	Excellent - Good (3.5)	4	56
Nina -2	Good (3)	7	140
Alice -1	Good - Fair (2.75)	7	164
Nina -3	Good - Fair (2.7)	6	69
Selena-2	Fair – Good (2.3)	5	92
… 22 more videos	…	…	…
Michael -3	Fair – Poor (1.25)	6	85
Keith -2	Poor (1)	6	84
Steven -2	Poor (1)	6	79
Derron -2	Poor (1)	6	99
Samantha -1	Poor (1)	4	25
Donna -3	Poor - Bad (0.5)	4	34

The third assumption dealt with content knowledge. The assumption is based on the idea that content knowledge alone determines the level of productivity that occurs in a whole-class discussion. The kind of responses that a peer leader gives to his/her students indicates whether a peer leader has a good understanding or limited understanding of the content. Once again, the data contradicted an assumption. It was apparent from the information that Michael gave his students and the responses that he made to their questions, that he had a very good grasp of the material, while Donna demonstrated very little understanding. Michael and Donna both answered conceptual questions from a Chemical Concepts Inventory published on-line by the Journal of Chemical Education. Donna scored 11/22, while Michael scored 19/22. In addition to the inventory, Donna was never heard explaining concepts or asking questions that helped lead students to concepts. Michael was always explaining concepts and sharing his knowledge with his students.

If the researcher's assumption concerning content were correct, one would expect Michael's discussions to be better than Donna's discussions. Michael and Donna's discussions, however, are very similar with discussion ratings between *Fair* to *Poor*. There is one exception with Donna-3 when she chose to stop working problems as a class. Donna incorporated more student-student interactions into her whole-class discussions and depended less on lecture forms of transmission, while Michael was always observed doing most of the talking in his whole-class discussions using a predominantly lecture format for transmission.

This does not imply that content knowledge is not important for peer leaders, but that content knowledge alone does not lead to productive whole-class discussions.

The fourth and final assumption dealt with which kinds of problems should be discussed in the class. The researcher's original assumption was that only problems that students were struggling with, or problems where different groups had different answers, should be given valuable class time, however, after viewing several videos, the incorrectness in this assumption became apparent. The assumption came from watching peer leaders ask each group for an answer to the same question, and each group giving the same answer; this seemed like an awful waste of time. However, after watching a few of the peer leaders going over problems that everyone had the same answers to, and then moving on to more difficult problems, the researcher became aware of the critical beginning first step that occurred as student confidence increased, while simultaneously permitting the peer leader to become sure that students understood before moving on to more difficult points.

Memo from Alice-2:

I was not particularly impressed with her round robin method of sharing group answers but it really worked for her. Each time (2) that she used this method, she would catch groups with different answers and a problem would be resolved. The first class discussion she spent too much time on something that I feel most students understood, but it ended up with her being sure everyone understood.

In Alice-2 the incorrectness of this assumption became salient. The researcher watched Alice go from group to group asking the same question. Then she observed a very lengthy whole-class discussion about something that seemed so simple and minor. The discussion went on and on, until finally a student asked what the class was talking about atoms or molecules (line 184). This one question seemed to change the dynamics of this discussion. Some students began to explain, while others shared the same difficulty; one student even asked if someone could draw it on the board for clarity. When this discussion was over, everyone seemed confident about differentiating between an atom and a molecule.

Scene Segment ID from Alice-2 Video:

(180)	Ss [00:31:48.18] :	It's number molecules that identical on the reactant and product side...
(181) Procedural	PL [00:31:54.28] :	All right, did you hear her?
(182)	Ss [00:31:57.07] :	Yeah
(183) Information	PL [00:31:59.25] :	What [male student] was telling you… What did he tell you?
(184)	Ss [00:32:03.09] :	He's actually confused with atom and molecule conception
(185) Information	PL [00:32:07.08] :	What did he tell you?
(186)	Ss [00:32:08.12] :	I don't think…now I'm confused that...(laughs).... carbon dioxide okay carbon dioxide...the one on the right side two molecules that not form like you say because that's four atoms for that two molecules…yes…one molecule...
(187) Information	PL [00:32:36.18] :	So what're we talking about in this question is it molecules we are talking about or atoms?
(188) SG: Information	Ss [00:32:43.20] :	Is the number of molecules identical on the product and reactant sides.
(189) Information	PL [00:32:52.11] :	Do you agree with what they say if we're talking about molecules?
(190)	Ss [00:32:54.07] :	...specific molecules this could be wrong I'm not exactly so sure...

From examples such as this, the idea became clearer that by working simple problems first, confidence and comfort levels of student increase, opening up opportunities for students to discuss other problems.

The researcher's four assumptions dealt with peer leaders' use of procedures, questions, content knowledge, and the timing of interventions. An awareness of these unwarranted assumptions gave rise to hypotheses concerning behaviors that may or may not lead to productive whole-class discussions.

Hypotheses

Five hypotheses emerged from the processes involved in coding videos, writing memos, and examining interactions between categories. The first four hypotheses branch off from the assumptions and cover topics concerning Procedural Practices, numbers of questions asked, specific kinds of questions such as clarity and elaboration, and content knowledge. The last hypothesis deals with peer leader Interpersonal Skills. Each of these hypotheses will be presented in the order above, using the same progression as the peer leader categories of behavior.

Hypothesis 1

If productive whole-class discussions are related to Procedural Practices, then peer leaders who focus on Procedural Practices will have more productive whole-class discussions.

Many beginning teacher programs stress the importance of Procedural Practices in a classroom (Bafumo, 2005). Procedural Practices refer to a peer leader's use of routines that help a class session to run smoothly. The observations made during this study do not demonstrate that productive whole-class discussions are related to the use of adhering to Procedural Practices. To illustrate why this hypothesis is incorrect peer leaders using Procedural Practices will be highlighted from portions of coded transcripts and memos written immediately after viewing a class session. Peer leaders who placed a strong emphasis on procedures are included below to demonstrate how this hypothesis emerged.

The first two peer leaders Selena and Chantel represent negative Procedural Practices, while the last two, Samantha and Lydia represent positive uses. After demonstrating how each of these peer leaders use Procedural Practices, average discussion ratings for each class session discussed will be reviewed.

One of the components of PLGI is that students will take on roles while working in their groups. Peer leaders are to encourage students to use roles and to rotate these roles between students each week. One of the manager's job responsibilities is asking questions on behalf of the group. All questions should be addressed to the peer leader through the manager. On occasion peer leaders will follow the rules with out any consideration about the function of a procedure.

Excerpt from researcher's journal concerning Selena-2:
"…Selena's use of speaking to the manager only is a non-productive use of this procedure. During a whole-class discussion, Selena will ask the class if they have questions immediately after an answer or concept has been shared and then only answer questions from the manager. This is faulty because students have not been given an opportunity to speak to each other, there is no way for the manager to know what the students questions are…"

In this excerpt we see a lack of procedural understanding on the part of the peer leader. Peer leaders have been advised to answer questions from the group managers only. This practice forces students to ask each other questions rather than just raising their hands and asking the peer leader. It forces group members to work together, and oftentimes as a result of this guideline students discover that someone else in the group knows the answer anyway. There are three benefits to answering manager questions only: (1) students are forced to work together as a team, (2) students are not waiting on the peer leader, and (3) students are provided with positive reinforcement when they know the answers.

In this situation, however, Selena explained something while her students sat quietly at their desks, and then asked the class if anyone had any questions; two people raised their hands. Selena's response to them was, "I am sorry, but I cannot take questions from anyone except the managers." The problem with adhering to this practice at this time was that no time had been given for students to exchange information and discuss within the groups. This mechanical use of a procedure learned in training happened repeatedly throughout this class period, causing lots of frustration for students. Eventually, the students quit listening when the peer leader was talking. Why should students listen when she was only going to ask questions to which they did not know the answers? The peer leader was trying to follow the guidelines, but, without fully understanding the intent behind the practice, was unable to appropriately put it to use.

Attitude is one of the codes and subcategories that make up the category of Procedural Practices. Attitude is placed in this category because the peer leader's ideas about how students learn impact the manner in which he/she leads, and the Procedural Practices that he/she chooses to follow (Kane, 2002; Hadjioannou, 2007). Chantel's lack of understanding about how students learn causes her to rely heavily on transmission as a means of teaching. The following memo demonstrates how Chantel's behavior reflects her understanding of how students learn.

Excerpt from researcher's journal concerning Chantel-2:

"Chantel is very cheerful and energetic. The class however does not run smoothly as far as discussions go. Whole-class discussions are very forced and rigid, consisting of one student reading or writing answers on the board. The peer leader does very little as far as helping students understand how to get an answer or solve a problem. Chantel believes that knowledge is transmitted from student to student. This is evident in the fact that she answers all student questions with wait until we discuss it. Chantel's self evaluation of this class is that it went especially well and that she felt that all students left with a better understanding."

Chantel does not ask questions or help students to develop answers while students are working in groups; instead she continuously puts off answering students' questions by letting them know they will be discussion it later. After someone in the class says an answer aloud for everyone to hear, Chantel acts as though everyone should now understand. This practice implies that she believes knowledge is obtained through transmission and now that you know the answer, you should understand it. The peer leader's self-evaluation of how the class went demonstrates that she is not aware of how her perception hinders student learning.

Chantel-2 Video:

Line	*Group 4 (2 male SS, 2 Female SS)*	
(13)	PL [00:03:57.28]:	Do you guys need me or?
(14)	Ss2 [00:03:58.15] :	No, I am sorry. I was just not sure how to...
(15)	PL [00:03:59.12] :	Oh, o.k. [female students name] we are gonna discuss as we go on.

Line	*Group 2 (1 Male Ss, 1 Female Ss)*	
(25)	PL [00:07:06.11] :	How are you guys doing?
(26)	Ss [00:07:08.03] :	We do not function well without our other group members.
(27)	PL [00:07:12.22] :	Come on, cut me a break Terry.
(28)	Ss [00:07:14.25] :	What's number 6?
(29)	PL [00:07:17.01] :	What's number 6?
(30)	Ss [00:07:18.19] :	Let's discuss number 6.
(31)	PL [00:07:21.24] :	For which one, for critical thinking? Oh, o.k. well, look at your periodic table and consider orbitals. And what they mean.
(32)	Ss [00:07:29.23] :	Is there only one more electron to add to be a happy octet rule?
(33)	PL[00:07:35.13] :	Ummm, it is a little bit deeper than that. I recommend you look at the periodic table, we can discuss, we are gonna discuss it too. What number is that? CTQ6? Yeah, we are gonna discuss it anyway, but look at the periodic table and consider where is it in the periodic table. Like with orbitals and hybridization. Try to think of it that way. Okay?
(34)	Ss [00:07:53.28] :	Okay.

…

Line	*Class Discussion*	
(358)	PL [00:36:40.28] :	Okay, so, third period down they have a d section. And that's why they can fit more. What about for number 6 why can they only fit 8?
(359)	Ss [00:36:54.03] :	Because they don't have a d.
(360)	PL [00:36:55.25] :	Because they don't have a d.
(361)	Ss [00:36:58.15] :	So, they can't fit more electrons.
(362)	PL [00:36:58.23] :	Okay. does anyone have a different answer?
(363)	Ss [00:37:02.29] :	[*student answer to soft to hear*]
(364)	PL [00:37:05.18] :	All right, umm, so everyone feels they have a good answer. This group is very silent, do you
(365)	Ss [00:37:13.06] :	Yeah.
(366)	PL [00:37:13.13] :	You agree. Absolutely understand it?
(367)	PL [00:37:16.00] :	All right, uhm, does that make sense?
(368)	Ss [00:37:22.20] :	To me, it does.

Line	*Graduate Student Taping Session to PL*	
(413)	GS [00:43:04.02] :	Just tell me, how do you think it went?
(414)	PL [00:43:03.26] :	It went good actually, I was nervous about the new groups that people would be fighting me, but they didn't so it's good. I got a few positive feedbacks so that made me happy.

The excerpt from Chantel-2 video demonstrates where the idea concerning Chantel's attitude about student learning came from. Students ask for help (Lines 14 and 30), Chantel informs the students that they will be discussing this later (Lines 15 and 33), and then she leaves students to flounder or figure it out on their own. Thirty-three to twenty-nine minutes later, students discuss this problem (Line 358). The class is almost over at this time, students that were not sure did not move forward while they waited, and the discussion consisted of nothing more than one student saying the answer and the peer leader repeating it (Line 360). To further demonstrate Chantel's idea about what constitutes as learning she asks everyone after the correct answer is given, if it all makes sense now (Line 366). Chantel's behavior demonstrates that she clearly understood that she was not supposed to give answers to students and that students were supposed to help each other, but her understanding about student learning and the use of whole-class discussions fell short of helping students move forward in a timely process. Chantel's lack of understanding of how the class session went was further demonstrated in her final comments to the graduate student (GS) that taped her class session, saying that everything went good. Students waited a half an hour to hear her say something about a d section and then they understood? How could she be sure? What kind of follow up questions did she ask to be sure that her students understood? This illustration was presented as an example of how attitudes about student learning can affect the procedures a peer leader chooses to operate by.

Another example of a peer leader strictly adhering to Procedural Practices is Samantha, who was videotaped in January on the first day of peer leading, a second time in February, and once again in March. A consistent theme can be seen when examining three different memos from three different videos.

Excerpt from researcher's journal concerning Samantha-1:

"Samantha is extremely nice to her students. She goes over and above her job description. If I had to use one word to describe her behavior, it would be 'mothering'. … Samantha brings in coffee, juice, snack cakes and cookies. She does what she has been taught concerning peer leading guidelines and process skills but with the limited amount of class time I am not sure if this is a good thing or not. …While some students may be uncomfortable or think it silly, no one is rude or disrespectful to Samantha concerning these. [Refers to raising hands and class being silent before peer leader talks.] It is as though the students respect her and permit her to go about it.

Samantha is clearly in charge and up to date about things that are going on, but nothing about her delivery is bossy or controlling. She tells students she is a student and shares her thoughts on her first few days of chemistry. She empathizes with students about their workloads and the difficulty of the subject matter. When students call themselves dumb she assures them that they are not dumb and that this stuff is really hard but she believes they can get it. When Donna talked about chemistry being hard she appeared to be trying to be cool and above the students. Samantha does not give the same impression; she is more positive and just says that she too remembers trying to learn it and that it was hard for her too.

Whole class discussions were not really discussions; the use of the roles and formality of things did not help to promote active student-student interactions. The peer leader called on some students at random and others she prepared, she asked why and how, but still things felt forced. I do think that she had predetermined which questions to discuss and maybe these were not necessary for discussions. They may have hindered how far the groups got without being very constructive. The peer leader worked in this video but she looked calm and collected, never rushed or in a jam. She remained calm and continued to push students on the process skills. She asked each group for at least two oral reflector reports during class today. She was constantly questioning student answers and asking them why or how. She does not give students answers but she does validate their answers and give praise when they are correct, instead of letting them prove that their answers are indeed right."

While this is an exceptionally long memo, it was included here to develop a picture of what was going on in this session. The peer leader was extremely nice, so much that she was described as "mothering." She provided morning refreshments for her class and was extremely well prepared for each class. At some point during this video, she displayed something from all five of the subcategories listed in the category of Procedural Practices and yet her discussions were NOT productive; perhaps it was because it was the first day of class.

Excerpt from researcher's journal concerning Samantha-2: (one month later)
"I am on my second video today with Samantha and as I code her videos it seems to me like although she follows most of the rules (the only guideline she doesn't follow is she lets students pick who will cover the roles for the absent students), however, she spends more time on process skills than chemistry. She is a great poster child for peer leading but does not help students move along conceptually. There is something about her manner that seems silly to the students and they do not fully cooperate."

There is not a lot of difference between the memo written during the first month and second month. The peer leader is following the same procedures and continues to bring breakfast snacks regularly to class, a fact made obvious because Samantha did not provide snacks today and this upset her students.

Excerpt from researcher's journal concerning Samantha-3: (one month later)
"Samantha does not do a lot to help students answer questions. She talks more about process skills. She does, however, ask students to explain their answers. She is frequently asking why. She does a lot of observing and walking between groups in a cyclical manner from Group 1 to 2 to 3 to 4 and again, around and around throughout the class period waiting on students to finish up so they can present. The students smile frequently like they are uncomfortable or like they think the process is silly but they are never rude or out of line with her. She kind of kills them with kindness. She is very sincere and very sweet. The class feels quite mechanical and does NOT flow from misunderstandings to understandings. One of the biggest things I feel that Samantha does not do, is she does not help students figure out answers for themselves. If they guess or say something right – she immediately tells them they are correct. While this may add strength to their class presentations it does little to help them build confidence to solve other problems or for test taking."

Three months have passed and the degree of student interaction has not changed. Long-term consistent use of Procedural Practices did not lead to productive whole-class discussions given these circumstances. Maybe students were not provided with enough opportunities to share.

In yet another class, where the peer leader, Lydia has frequent whole-class discussions - as many as six in one fifty-minute class session - a similar pattern of behavior is observed in student discussions. Lydia also places a strong focus on Procedural Practices.

Excerpt from researcher's journal concerning Lydia-2:

"This class ran very smoothly. Everything is in place. The peer leader follows all rules but is so nice that she seems to get away with it. The students really like her. While they may feel silly doing some of the roles and stuff, they are quite cooperative and things run smoothly. If I had to show someone using a checklist this would be a good example to use. The way Lydia answers questions for a group are most beneficial in involving students to work together. She has a way of taking a very soft-spoken, directed only to her question, and opens it up to invite the whole group in. Her responses to student questions are very useful without telling students 'I can't give you the answer'. Lydia doesn't just check in with a group but actually directs students and helps them to make progress each time she stops by their group and checks in with them. It is not a peer leader with a student but a peer leader with a group. Each time she talks, she is directing her comments to a whole group or to an entire class. Very active and involved class, lots of presentations, examples, and questions being asked. Students are on task and everyone seems to be working. Really good session. Whole-class discussions were a little weak, but overall class session went really well."

Even after so many Procedural Practices being implemented and the peer leader being so "nice," the average whole-class discussions were only *Fair*. There was not a lot of discussing going on, it was mainly students providing answers to the questions that the peer leader asked. As previously stated, these findings are different than the assumptions held by the researcher from her personal experiences and from her interpretation of the literature. The examples of Selena, Chantel, Samantha, and Lydia demonstrate that merely focusing on Procedural Practices does not necessarily lead to productive whole-class discussions.

Hypothesis 2

> *If productive whole-class discussions are related to the number of questions a peer leader asks, then peer leaders who ask a high number of questions will have more productive whole-class discussions.*

The researcher initially thought that one of the differences between productive and poor whole-class discussions was due to the numbers of questions being asked by the peer leader, as previously discussed in assumption #1. Frequencies were tabulated for each kind of question being asked by peer leaders and sorted on an Excel spreadsheet comparing the number of questions asked with the average discussion rating (ADR) for each video (Table 4.15). The results did not demonstrate that the number of questions asked or the number of different kinds of questions used would determine if a discussion was productive. When looking at the frequencies of questions asked by all the peer leaders during individual sessions, no discernible patterns were noted. If this assertion had been true, one would expect the peer leader who asked the most questions to have the highest average discussion rating (ADR), and likewise, the peer leader who asked the least amount of questions during a class session to have the lowest average discussions.

In video Alice-1, 164 questions were asked in a single class session; this was the highest number of questions asked by a single peer leader in a single class session. If the number of questions asked, determines if a whole-class discussion is productive, then Alice should have the highest Discussion-Rating. This was not the case; her average discussion rating (ADR) was *Fair-Good* (2.75). This is, however, above the sample average of *Fair* (2.0) and is one of the top five highest Discussion-Ratings in this sample of peer leaders; perhaps the number of questions played some part, but not to the degree that the researcher had expected.

Since the two peer leaders who asked the most questions did not have the highest average discussion ratings (ADR), the researcher decided to look for patterns in questions at the lower end of the spectrum, the peer leaders who asked the least number of questions. In the video Selena-1, Selena asked nineteen questions during part of a class period before the tape ran out. During this video two discussions were taped and rated with an average discussion rating of *Fair* (1.9). The assumption had been that this peer leader would have the lowest average discussion rating (ADR) since she asked the least amount of questions; contrary to this belief, there were twelve videos with lower average discussion ratings (ADR). Perhaps it was a fluke that Selena's average discussion rating (ADR) had been so much higher than expected, after all there were technical difficulties, so the video with the second lowest number of questions asked was explored.

In the video Samantha-1, Samantha asked twenty-five questions, and had an average discussion rating (ADR) of *Poor* (1). Four videos had an average discussion rating (ADR) of *Poor* (1.0), next to the lowest score. The numbers of questions asked by each peer leader in the next to the lowest four class sessions were 99, 84, 79, and 25. The numbers ranging from 99 to 25 were quite a diverse spread of numbers from a sample of videos with the same average discussion ratings (ADR). The same intriguing diversity was seen again when the numbers of questions asked were tabulated for the three peer leaders with average discussion ratings (ADR) of *Fair-Good* (2.25). The numbers of questions asked were 130, 98, and 46, again with no consistent pattern.

The combination of similar Discussion-Ratings with varied numbers of questions intrigued the researcher who in turn decided to look at the video with the lowest average discussion rating (ADR). In video Donna-3, Donna had the lowest average discussion rating (ADR) of *Bad* (0.5). The results from this video are unique in that Donna opted out of having whole-class discussions during the working portion of the class. Instead, Donna held a single closure activity at the end of class, so single "discussion." In this discussion, Donna asked one question and three students responded. This discussion is included below. Immediately after this "discussion" Donna went up to the researcher and began to provide an explanation concerning why she chose not to have any whole-class discussions. This justification was unprompted by the camera person/researcher.

Scene ID Segment from Donna-3:

CLOSURE

(401) Information	PL[00:45:20.05] :	O.k. (raising her hand, talking to the whole class) Um, we got about five minutes left. Can somebody tell me the uh formula how to calculate core charge?
(402)	Ss [00:45:32.18] :	The number of protons in the atom minus the uh all the charge of the electrons, excluding the ones in the valence shell. So, if you had like 3 shells it would be the protons, plus the charge of the electrons in the first 2 shells.
(404) Procedural	PL[00:45:47.18] :	Ok. Does anybody have anything else to add to that? Do you guys have anything else to add to that?
(405)	Ss[00:45:54.13] :	No maam. We concur.
(406) Procedural	PL[00:45:57.06] :	You concur? Ok. Group 3, did you guys hear that? Do you have any core charge questions? Anything to add to the core charge calculation definition?
(407)	PL[00:46:10.15] :	No.
(408)	Ss[00:46:10.00]:	Ok. He said it was like adding the number of protons minus the electrons except the ones in the outer most outer shell. [*Voice inflection makes this one appear like a question*]
(409)	PL[00:46:15.25] :	Uh, huh. Ok. Very good. All right. Go ahead and do your WGR's [*Weekly Group Records*] if you haven't already started on them. Okay.
(410)	Observation:	*Students begin packing up their belongings; peer leader turns to camera person and justifies here decision not to have whole-class discussions.*

(411)	PL[00:46:40.21] :	Oh, I am sorry. (Looking at the camera) That's pretty much done anyway. That was my bit for today. I hardly had to say a word. Isn't it beautiful? No, I mean I think that this method works, other people might disagree but I think it works pretty well. And, um, group five usually works really well, really quickly together so I usually make sure that they get their… in the back corner… make sure that they get their main concepts in And usually whenever somebody gets done ahead of time I make sure especially if the rate that they are progressing I can't really keep track of them sometimes so, I make sure they have their core concepts done. And everybody else, they were progressing and they were getting good acceptable answers so, as long as they understand where their answers are coming from - then I'm happy. That is my justification.

In the discussion presented above notice that the peer leader is doing the majority of the talking, the peer leader speaks six times compared to having students talk only three times. The level of the Discussion-Rating is *Bad to Poor* with the peer leader doing more talking than listening. In line 408, the student answered the question, stated almost verbatim what the first student replied, but his voice demonstrated that he was not sure. Had the peer leader been listening more intently, she may have noticed this lack of confidence and had other students rephrase or give examples, which would have created a better whole-class discussion as measured by the degree of student-student interactivity.

Table 4.15

Average Discussion Rating (ADR) *in Comparison to the Number of Questions Asked*

Peer Leader	ADR	PLQ
Nina-1	3.5	110
Keith-1	3.5	56
Nina-2	3	140
Alice-1	2.75	164
Nina-3	2.7	69
Selena-2	2.31	92
Steven-1	2.25	130
Chantel-2	2.25	98
Derron-4	2.25	46
Samantha-3	2.08	117
Lydia-2	2	162
Nina-4	2	131
Michael-2	2	131
Chantel-1	2	127
James-1	2	96
Alice-2	2	94
James-2	2	84
Derron-3	2	78
Lydia-1	2	72
Donna-4	2	55
Derron-1	2	55
Selena-1	1.88	19
Samantha-2	1.67	108
Donna-1	1.67	44
Michael-1	1.58	29
Donna-2	1.5	83
Jerleen-2	1.5	47
Jerleen-1	1.33	28
Michael-3	1.25	85
Derron-2	1	99
Keith-2	1	84
Steven-2	1	79
Samantha-1	1	25
Donna-3	0.5	34
Total	65.47	2871
Average	1.93	84.44
Median	2.00	84.00

Top 5

Middle 23

Bottom 5

Only discussion was a closure activity

The idea that the number of questions asked determined if a whole-class discussion was productive appeared to be incorrect when looking at the high and low numbers of questions and comparing them to the average discussion ratings (ADR)

(Table 4.15). The spread among the numbers of questions asked within each of the similar average discussion ratings (ADR) demonstrates that there is more than just the number of questions being asked or the number of different kinds of questions being asked. The number of questions asked did not clearly distinguish patterns between the various levels of whole-class discussions. There was, however, something different occurring in each of the sections with the higher average discussion ratings (ADR). The kinds of questions and varying degrees of student interaction demonstrated that more needed to be explored when looking for what creates productive whole-class discussions. Even with the frequencies presented thus far, the researcher could not eliminate the use of questions in these sections. There was something occurring in these rooms that created productive whole-class discussions and because the level of productivity was measured by student involvement, and student involvement is observed as dialog, the importance of questions could not be totally eliminated as having value.

Hypothesis 3

If productive whole-class discussion are related to the kinds of questions a peer leader asks, then peer leaders who ask a variety of different kinds of questions will have more productive whole-class discussions.

As a result of not seeing any patterns between the numbers of questions asked by a peer leader and the average whole-class discussion rating (ADR), the kinds of questions being asked was examined. There were no patterns revealed when looking at the variety of different kinds of questions asked by a peer leader and the average whole-class discussion ratings (ADR). Asking a variety of questions did not make discussions more productive. So a more careful look into the types and numbers of each kind of question was analyzed.

In addition to asking the greatest number of questions, in video Alice-1, Alice asked questions from all seven of the different question types coded for in this study. The majority of the questions asked by Alice during this class session are information, low-level questions (70). She asked more information questions than any other peer leader, which seems logical since she asked the highest number of questions.

The following is an excerpt from the video, Alice-1, and demonstrates the numerous information level questions asked, before students are asked to clarify and elaboration on their answers. Forty-three percent of the questions asked by Alice during this session were low-level information.

Scene ID Segment from a whole-class discussion in Alice-1:

(432) Information	PL:	How many charge clouds are there?
(433)	Ss [00:42:42.27]:	4 2
(434) Information	PL [00:42:44.17]:	How many total charge clouds are there?
(435)	Ss [00:42:46.23]:	4
(436) Information	PL:	There's 4. What's the hybridization?
(437)	Observation:	[Another student] raises her hand to answer.
(438)	PL:	She knows, she knows, shhhhhhh (PL turns back to student standing in the front)
(439) Information	PL-	What's the hybridization?
(440)	Ss-	I don't know.
(441) Information	PL-	Okay, that is fine. Does anybody in your group know? [PL whispers another students name]
(442)	Ss [00:42:59.28]: -	Sp3
(443) Clarity/Elab	PL-	Why?
(444)	Ss [00:43:01.25]:	Cause its four charge clouds. Core charge clouds.
(445) Procedural Clarity/Elab	PL	Can you explain it to him? Why Sp3 or 4?
(446)	Ss [00:43:07.20]:	I just do it counting. If there's 4 charge clouds, s is 1, plus 3 p's is 4. I just do it that way.
(447)	PL	Okay.
(448)	Ss (in front)	I got it.
(449) Understanding	PL [00"43:15.12]	What's the hybridization on yours? (Points to a different group, while involving whole class)

The results from the Alice-1 video suggest that there may be more to discussions than just questions, but does not totally dispute the importance of questions. Alice-1 does have one of the top five average discussion ratings (ADR). Several low-level information questions were asked in a sequence, with answers given each time. From an observer standpoint, it was not possible to tell from the answer if a student understood the chemistry concept. For example, in line 433, when the student first says four and then changes it to two, we cannot tell what the student is thinking. The peer leader asks the question just a little differently (line 434) and then repeats it for all to hear (line 436). After noticing that a student does not understand, group help is called on (line 441). When a correct answer is achieved the peer leader asks for some clarity, to help others understand where an answer came from (line 443). There is much more going on here than just asking questions. In addition to asking questions, the peer leader notices when a student becomes uncomfortable with the questioning process and asks for help from other students, she also rewords questions when students are not clear about what she is asking them, and lastly she asks for more than just correct answers – she follows up by asking why something is the answer. The video with the second highest number of questions was examined next.

In the video Lydia-2, Lydia asked 162 questions and had an average discussion rating (ADR) of *Fair* (2), but the video Lydia-2 only rated thirteenth in the study. Lydia asked questions from all seven of the different categories of questions, and again asked more information questions (60) than any other type of question. The total number of information questions asked by her in this video was the second highest number asked in all the videos. She also asked the second highest number of procedural and clarity/elaboration questions. These results support the hypothesis that just asking a variety of different kinds of questions does not determine if a whole-class discussion is productive.

Class Discussion number two from Lydia-2 video:

(186)	PL [00:21:27.04]:	Um huh, ok I am going to go ahead and get some presentations of the answers for your Hw
(187)	Observation	Peer Leader has hand raised and is waiting to get class's attention
(188)	PL [00:21:34.22]:	Guys, (*whispers*) Hey Guys
(189) Information	PL [00:21:44.07]:	Ok umm we have the presenter from this group, whoever is taking over that role. if you could tell me about number 2? (*There are only 3 people present in this group.*)
(190)	Ss [00:21:55.18]:	Umm number 2 is asking you how many valence electrons are in N atom and it has 5 and the way you can find that is by looking at the periodic table in the back and you can see that it is in column 5. Ummm Can I get up and do ....
(191)	PL[00:22:14.02]:	Yeah [PL calls Ss by name] you can get up and draw it. You can draw it here.
(192)	Observation	Student gets up and walks to front.
(193)	Ss [00:22:34.13]:	Ok that's the Lewis structure for Nitrogen. All you have to do is 2 dots here, and 1, 1, here cause you have to remember that you can't make a pair before each one of them has one, so and it needs 3 additional electrons. And for D, I have NH3, probably the most common. and since H has 1 so you have a pair. That means you have one lone pair.
(194) Procedural	PL [00:23:16.00]:	Do all the groups agree with his answers? Ok.
(195) Information	PL [00:23:19.07]:	Um huh, um Jessica back here if you could do, actually tell me what you all got for your checklist, for number 4.
(196)	Ss [00:23:35.00]:	Uummm we said that you basically count the electrons for each atom. And use the octet rule to determine the sole amount of electrons.
(197)	Observation	PL is writing on the board what Ss is saying.
(198) Procedural	PL [00:23:56.12]:	Ok, does any group have anything different…that they want to add to the checklist?
(199)	Ss [00:24:03.03]:	Really not to add cause it is kind of the same, ummm it is pretty much the same checklist as you go through in numbers 2 & 3.
(200) Information	PL [00:24:12.17]:	In your critical thinking questions?
(201) Information	PL [00:24:16.24]:	Ok anybody else… what electrons are you counting?
(202)	Ss [00:24:23.22]:	Valence
(203)	PL	Your valence electrons.
(204) Information	PL [00:24:27.09]:	Ok go ahead and oh umm we are going to. Michael present exercise number three.

(205)	Ss [00:24:38.18]:	Umm ex. #3 said I think it was how many valence electrons does SiH4 have? And my answer was 8. Umm and the way that i came up with that was that in Si you have 4 valence electrons, so you have 4 unpaired electrons and then you add 4 H atoms to each with each having 1 valence electron. So then it ... as a result it fills the outer energy level. So you have 4 plus 4 and you have a filled energy level of 8.
(206) Procedural	PL [00:25:22.13]:	Thank you. Did everybody get the same structure and number of valence electrons for 3? OK Go ahead and go back to you hw. Umm Start on CA #13 and over your hw 1-7.

****

In the Lydia-2 discussion the peer leader continuously bounces back and forth between procedural and informational questions. It should also be noted that the peer leader speaks twice as much (12 times) as the students (6 times), indicative of who is largely doing most of the work. A positive factor that stood out, as this was section was being analyzed, was the level of the student answers. Without any prompting, students were explaining the steps they took to arrive at their answers. The level of student explanations suggests that “something else” had occurred at sometime other than the discussion, indicating that more needed to be explored than just the actual class discussions.

The interesting factor that was uncovered here lies not in the number of questions asked, but in the frequency that students were asked to rephrase or clarify what they had said and to elaborate on how an answer was arrived at. This was not just important during whole-class discussions, but was observed throughout a class session. Classes where students were asked to clarify and elaborate on a regular basis have more productive whole-class discussions. In nine of the eleven discussions that were rated *Good*, or *Good-Excellent*, students where asked to clarify and elaborate on their answers, not just orally but on the board as well.

Scene ID Segment from Alice-1 video:

(402)	Ss [00:40:06.16]	We had H_2O. Looks like this. It has uhh 2 bonding and uhh 2 lone pairs. Looks like this (draws structure on board)
(403)	Ss [00:40:28.03]	Ummm the shape is bent uhhh we have the angle between the two hydrogens and oxygen is 103.5.
(404) Clarity/Elaboration	PL [00:40:37.24]	Where did you get 103.5?
(405) Rhetorical	Ss [00:40:40.21]	Huh?
(406) Clarity/Elaboration	PL	Where did you get 103.5? Where did you get that number?
(407)	Ss [00:40:42.23]	From the table.
(408) Understanding	PL [00:40:42.27]	From the table, okay. Without using the table and with using the amount of knowledge that you get just looking at the model and knowing that, what would you say it was approximate like?
(409) Clarity/Elaboration	PL [00:40:53.16]	Could you use that knowledge to show me how you would use it to get 103?
(410) Information	PL [00:41:00.23]	Do you remember what [female student] said about how this cloud pushes these down and that's why it's slightly less than 109? Perhaps you could use that kind of reasoning to explain it to me and the rest of the class?
(411)	Ss [00:41:11.05]	Same reasoning because the 2 charge clouds umm ... ahhh.... push the 2 hydrogen's uhh closer together starts less than that.
(412) Understanding	Ss [00:41:27.15]	Why do they push the hydrogens closer together?
(413)	Ss [00:41:27.15]	
(414) Understanding	PL	[Laughs] I am putting you on the spot. [Directed at student.] Can anybody tell me why those clouds, those loan pair clouds push the hydrogens closer together or any of the bonded things closer together?
(415) Student Question: Procedural	Ss	Can you repeat that? [This is a different student than the one standing in the front of the classroom.]
(416)	Ss [00:41:47.15]	It pushes them closer together, because it takes up more space
(417) Clarity/Elaboration	PL [00:41:55.01]	Takes up more space? [looking at student in the front now]?
(418)	Ss #3	The lone pair electrons take up more space so they push the other (using hands to draw bonds in the air)
(419) Clarity/Elaboration	PL [00:41:55.01]	Why do they take up more space than bonded electrons?
(420)	Ss [00:40:06.34]	Several students are talking [cannot make out what they are saying. they are talking loudly].
(421)	Ss [00:42:16.01]	It has something to do with, I was thinking about if you bond together you have a certain like distance between them because you know you know they kind of attract and repel. [waving hands in a back and forth kind of fashion demonstrating electrons coming together and apart]...
(422)	Observation	Pl interrupts
(423)	PL [00:42:17.29]	They have…
(424)	Observation	Student interrupts and continues
(425)	Ss [00:42:18.06]	The loan pairs are like free so it moves around.
(426) Procedural	PL [00:42:22.00]	Did everybody hear that? Okay. So now I am going to go around, this is a pop quiz question.
(427) Understanding	PL [00:42:26.15]	Tell me the hybridization on water? [Looks at student in front of room standing].

In the above passage, we see the peer leader asking a variety of questions and using a variety of different skills to help students understand the material. The peer leader fluctuates back and forth between the various kinds of questions, and is relentless in pushing students to explain what they mean. No word gets by her without her asking the students what does that mean, how do you know and what does it mean. Sometimes her question consists of nothing more than a repeat of the students answer with a little voice inflection (line 417). Knowing the correct answer is not enough in this class, the peer leader pushes her students to articulate and explain their answers in several different ways. In this discussion we see the student at the front of the room, writing at the board; students are doing most of the talking. The peer leader stands off to the side of the board and only speaks to ask questions. The student's task is to fully describe the shape of a water molecule and to explain how this answer was determined. The peer leader asks questions to help the student demonstrate the steps he took in this process. In lines 403 – 410 we see that just knowing the correct answer and knowing where you found it, is not enough. The peer leader pushes the student to think about what is going on and to compare it to examples previously stated in class. The student eventually gives an answer about how charge clouds push hydrogen atoms closer together (411) but again the peer leader pushes the student for more explanations. In line 412 the peer leader asks the dreaded question concerning why charge clouds do this. The peer leader is also sensitive to the student's emotional state and eventually asks the rest of the class to help the student standing up front (413). With the help of other classmates, the student up front finally says that non-bonded electrons take up more space, but once again (419) the peer leader wants to know why. She really presses her students to understand what is going on. Alice encourages her students to form pictures in their minds about the properties of charge clouds and how these properties are important in understanding the shape of molecules. After the answer, she asks if everyone heard (426), she did not ask if everyone understood, instead she went from group to group asking what she called “pop quiz” questions to help everyone see if they did indeed understand.

It is important that students are asked to clarify and elaborate on all their answers on a regular basis. If students are only asked to clarify answers when they are incorrect, they quickly learn that being asked to clarify an answer is a sign that their answer is wrong. The class environment is changed as a result of only being asked to clarify wrong answers, instead of having students explaining the thinking behind an answer, students turn to a search for the ‘right’ answer from others. The following excerpt is an example of what happens when students are only asked to clarify wrong answers.

Scene ID Segment from Keith-2 video:

(132) Procedural	PL [00:10:55.18]	So for number four they said [short pause] Can you say it again, [short pause and points to another group]? Loudly?
(133)	Ss#1 [00:11:00.28]	Energy will be required to separate the nuclei because they are being trapped together and held by electrons.
(134)	Ss#2 [00:11:06.27]	That doesn't answer the questi....
(135) Clarity/Elaborat	PL [00:11:14.01]	So what, what would you like to add to that?
(136) SQ: Verification	Ss#2 [00:11:17.00]	Well, usually when something separates it releases energy, right?
(137) Verification	PL [00:11:24.08]	Is that ... right, [female student’s name]?
(138)	Ss#3 [00:11:27.08]	To break a bond you need to add energy, like if you look at net...the energies
(139)	Ss#2 [00:11:32.03]	Oh, when something forms it releases energy
(140)	Observation:	Peer leader glances around room.
(141) Procedural	PL [00:11:38.05]	Ok, [student name] number five? Critical Thinking question number 5.

While there were three different students participating in this discussion: one student shouting out (lines 134, 136, 139) and two students answering questions when called on (lines 133, 138), this discussion was more about checking homework answers than learning the concepts. Students felt comfortable enough in this room to ask questions of each other (line 133, 136), but the emphasis was more on getting the answer than on understanding why. This conclusion is based on the observation that once the correct answer was given (line 138) the peer leader moved directly on to the next question (line 141). There were several alternative decisions that the peer leader could have made at this point. He could have asked someone to rephrase the answer. The peer leader could have asked another question to determine if other students understand this concept. A simple question like, what happens when you join atoms together may have helped the students that were not sure if they understood. After watching Keith's videos, it was easy to identify the pattern that his discussions followed. Keith continued to ask students for their answers until someone said the correct answer, when a correct answer was given, he moved on to the next question. If a student was not paying careful attention and listening to the last student then they would miss the 'correct' answer. This result concurs with the finding by Boyd (2006) who stated that is not the actual kind of question that is asked that stimulates student talk, but more a combined effect from building on student responses.

After analyzing the kinds of questions being asked by each of the different peer leaders in each of their different classes, whole-class discussions appeared to be more productive in classes where the peer leader continuously asked students to clarify and elaborate on their answers regardless of whether they were correct or not. However, the use of clarity/elaboration questions did not fully explain what was needed for a whole-class discussion to be productive.

Hypothesis 4

> *If productive whole-class discussions are related to a peer leader's content knowledge, then peer leaders with a high level of content knowledge will have more productive whole-class discussions.*

It is assumed that if a peer leader has passed General Chemistry I and has taken one additional class, that they understand the concepts learned in the earlier class, but this is not the only indication concerning a peer leader's content knowledge. Peer leaders are also required to take weekly quizzes over the material presented during the week before, so a kind of weekly progress is observed between the various concepts. Additionally, an observer can make inferences about a peer leader's content knowledge by listening to the kinds of questions that they ask and the kinds of responses that are given.

Michael had a good understanding of the material and frequently shared his knowledge with his students. He asked good questions and likewise gave good answers with details above the levels of his students. The following memo was written after observing Michael-3. This class had two discussions and an average discussion rating (ADR) of Poor. Michael's discussions were peer-leader centered, with the peer leader doing most of the work.

Excerpt from researcher's journal concerning Michael-3:

This peer leader is with out a doubt a very hardworking and conscientious young man. He has a very good understanding of General Chemistry I chemical concepts. He does not however understand his role as a peer leader. He is consistently telling students what they should know and thinks that once he tells them something, they should understand and own the knowledge. If they do not, then his actions imply that they should study harder. He asks very good questions and leads students to answers, but misses the stages in between where students get where they can ask themselves these questions. … Being able to find the answers is the biggest benefit of knowledge and these students are missing that step. Each week Michael's students leave with knowing the way to answer a question, but not how to figure out how to figure it out. When Michael summarizes or restates a student's answer he says it so much clearer, or in so much more detail that I would think that it would discourage students from talking. Why should students try to say it, when he is just going to tell them the right answer anyway? Michael tries to summarize student answers, but he always adds a whole bunch more information than what the student originally said. If I didn't know him, I would think he was very arrogant & show offs. On one occasion Michael stated the he just wants to sit in with a group and listen; he does not listen for more than 3 seconds before he jumps in and starts explaining the answer. During the whole-class discussions Michael would repeat a student's answer, add a lot of new information, and then say, "is that what you're saying?" Students would always say "yes."

In a different class, the peer leader Steven clearly understands the subject matter being discussed and provides excellent explanations of core concepts. The following excerpt is another example of a peer leader's understanding of chemistry and the effect that is observed in whole-class discussions. The average discussion rating (ADR) for Steven-2 was *Poor*.

Scene ID Segment from Steven-2 video:

	Group 2	(4 Male Ss)
(24)	Ss1 [00:08:59.17]:	This book doesn't explain anything it at all.
(25) Information	PL [00:09:05.25]:	What?
(26)	Ss	It did a really bad job
(27) Information	PL	Of what?
(28)	Ss	Explaining how to number 1.
(29) Information	PL [00:09:05.23]:	Explain how to do number 1, but don't they have an example right here? [PL points in Ss book]
(30)	Ss1 [00:09:09.06]:	Yeah but you can't tell how. It asks how.
(31)	PL	How?
(32) SQ: Information	Ss1 [00:09:13.29]:	How is the center positive charge for the extra molecule determined?
(33) Procedural	PL [00:09:17.03]:	Where, where do you think the center of positive charge is for that molecule?
(34)	Ss1[00:09:19.23]:	Oh it tells me where it is. But I have no idea how they figured that out.
(35)	Ss2	It's right there.
(36) Understand	PL [00:09:25.06]:	Well why is it right there though?
(37)	Ss [00:09:27.02]:	That's what I'm asking.
(38)	Ss4 [00:09:27.27]:	Cause you all said so
(39) Information	PL [00:09:30.00]:	No ... What's the, what is this say though?
(40)	Ss1 [00:09:35.13]:	It says its located midway between the 2 radii.
(41) Information	PL	Right? Okay and when you look at this where do you see like your partial charges?
(42)	Ss1 [00:09:42.28]:	Ohh
(43)	PL [00:09:43.15]:	The partial positive charges on the hydrogens right? So when its distributed like that you can thus say that your center of negative er positive charge is there.
(44)	Ss1 [00:09:54.03]:	Got it
(45) Information	PL [00:09:54.08]:	And also when you have this like final, right here, you see, do you understand how this was drawn? [PL points to Ss book]
(46)	Ss1	Yeah
(47)	PL [00:10:00.08]:	They uh, no

(48)	Ss1	No
(49) Information	PL [00:10:01.28]:	All right so you have a bond dipole going from this and you have a bond dipole going from this, Have you ever done vector addition? In uh no. You guys [pointing to 2 other group members] have done vector addition in physics?
(50)	Ob. [00:10:14.09]:	Ss1 shakes his head yes but not very confidently.
(51)	PL [00:10:14.22]:	So you know that when you have this like you do the head to tail method.
(52)	Ss1[00:10:17.25]:	I also did it in my freshman year of High school sooo... I don't really remember ...physics too well.
(53) Rhetorical	PL [00:10:25.06]:	All right, this is how you would do it okay?
(54)	Ob. [00:10:26.16]:	Pl begins to draw on the board closest to this group
(55)	PL [00:10:29.04]:	You have your oxygen and hydrogens and there's, when you bond draw these bond dipoles, they go from the center of partial positive charge to partial negative charge. It's where the electrons are basically being pulled to. Alright so then to find the overall dipole moment you take this, and you draw this from (writes on board) , this is your... head this is your tail. K so you draw that from head to tail and you draw this one from head to tail and then you go from the head of this one to the tail of the last one. And so this is your final ... dipole moment.
(56)	Ss1 [00:11:03.12]:	I remember that.
(57)	PL [00:11:05.27]:	So that's essentially the same because your center of positive charge is here and your center of negative charge is there. So in the end that's how the bond dipole goes as well. So there's 2 different ways that you can use to find out what your bond dipole is.
(58)	Ss1 [00:11:19.26]:	Okay
(59)	PL [00:11:21.29]:	Use whichever one suits you better by finding the centers of charge or just doing the uh vectors. [PL walks away]

From this discussion we see that the peer leader understands how to tell where a center of positive charge is (lines 43, 45, 49, 55, and 57). It should also be noted that in this small group discussion here the peer leader primarily asks low-level information questions, talks mainly to one student, and does more talking than his students. This method of ‘telling’ students how to get an answer was not productive in terms of developing student understanding; later during a whole-class discussion the same students could not explain this process to the class.

Scene ID Segment from Steven-2 video:

(210)		CLASS DISCUSSION #1
(211)	PL [00:23:51.13]:	All right All right. Guys Guys umm Quickly we are going to review CTQ's 3 & uhh 7.
(212) Procedural	PL [00:24:00.14]:	So umm all right CTQ #3, the Carbon Dioxide and uh OCS molecules are both linear, but both have both have polar bonds. CO2 does not have a dipole moment. Why does OCS have a dipole moment?
(213) Procedural	PL [00:24:19.11]:	Chris would you like to explain your answer? Although it's very clear up here.
(214)	Ss [00:24:24.19]:	The uh Oxygen pulls more than the sulfur making the uh center more towards the oxygen because the oxygen is more electronegative.
(215) Procedural	PL [00:24:33.14]:	Do you guys agree with that?
(216)	Ss group 1	Yes
(217) Procedural	PL [00:24:39.15]:	Do you guys all have the same answer?
(218)	Ss	No, I really didn't have reason.
(219)	Ob [00:24:43.23]:	Class laughs
(220) Information	PL [00:24:44.14]:	Well the point of the question was to ask you why. All right, where where's the center of negative, err where's which of these molecules is negatively charged? Partial negative charge, where would you find that in this molecule?
(221)	Ss	[Inaudible]
(222)	PL [00:24:59.24]:	Oxygen...
(223)	Ss group 1	Sulfur
(224) Clarity/Elab	PL	And sulfur, why?
(225)	SS [00:25:04.19]:	Because it's more electronegatively (several SS at once)
(226) Clarity/Elab	PL [00:25:07.16]:	Ele ele more electronegative compared to what?
(227)	Ss [00:25:10.02]:	Carbon
(228) Information	PL [00:25:10.00]:	Okay... now where's the center of positive err partial positive charge? Which one is partially positive?
(229)	Ss [00:25:16.26]:	Carbon
(230)	Ss	Carbon
(231) Information	PL	[Male students name], which one is partially positive?
(232)	Ss1 [00:25:20.25]:	The C
(233) Rhetorical	PL [00:25:21.04]:	The C, right?
(234)	Ob [00:25:25.14]:	Pl writes on board.
(235)	PL [00:25:24.18]:	Okay, so ... if you were to have like ... you know where your ... where would your center of positive charge be?
(236)	Ss1	On the C
(237)	PL [00:25:36.15]:	On the carbon right? But where would your center of negative charge be?
(238)	Multiple SS	On both.
(239)	Ss1	On the O
(240)	PL	On the O?
(241)	Ss [00:25:41.18]:	No between the O and C

(242) Information	PL [00:25:42.10]:	Towards the O? Right, it's it's going to be like your center of negative charges is going to be somewhere in between your Oxygen and your Sulfur but because Oxygen is so much more electronegative then Sulfur it pulls the electrons more towards it than sulfur would. So your center of negative charge is probably going to be somewhere around there. And because of that you have a dipole moment. These bonds aren't equivalent. Do you understand that?
(243)	PL [00:26:10.02]:	Okay and as for number 7, huh, [female student's name] could you explain that? Why is it the electronegative difference?
(244)	Ob	On the board this student from Group 3 had written 'electronegativity' when the Pl said that was not an answer she went up and added the word 'difference'. Now the answer reads "Electronegativity difference."
(245)	Ss [00:26:18.09]:	Ummm (laughs)
(246)	PL [00:26:22.27]:	Could... do you guys want to help her out?
(247)	Ss [00:26:24.29]:	____________ because it showed in the examples above.
(248)	PL [00:26:29.16]:	In the examples above?
(249)	Ss [00:26:30.16]:	Like the A, B, C, D, thing
(250)	PL [00:26:32.05]:	Well, they they ask you based on the dipole moments in table 1 so could you use the dipole moments
(251)	Ss	Oh, oh, oh oh
(252)	PL	In table 1? Maybe
(253)	Ss	They like decrease as uhh as er as the
(254)	Ob [00:26:43.22]:	I can over hear other groups talking. ie: I got an hours sleep, louder than the Ss asking the Question.
(255)	PL [00:26:50.21]:	As the as the atoms get larger so distance increases right? And while its also decreasing the EN is decreasing as well, right. Nod your heads and say yes.
(256)	SS (multiple)	Yes
(257)	PL [00:27:03.15]:	Come on you guys know this is just a little bit early in the morning. All right... exercises... Go ahead and work on your exercises... [Long pause] these will go by really fast. Believe me.

In this excerpt the students are getting right answers, but it seems like most of them are the result of guessing (lines 236, 238, 239). When a student gets an answer correct, the peer leader goes off on a lengthy explanation about why an answer is correct (line 242). As an observer it is not possible to tell if students understand the concepts; the peer leader shares his content knowledge and moves on without any kind of follow up. This whole-class discussion is rated *Poor* because the peer leader is doing most of the talking; the entire discussion is student-peer leader student-peer leader. The following journal entry was written after viewing the video and focusing on peer leader behaviors.

Excerpt from researcher's journal concerning Steven-2:

This class is so far opposite from the last one [refers to Steven's first video] and still a very ineffective peer leading class. While I can guess that students will learn more here than the one before, in this class it is the peer leader doing most of the work. Steven tells students how to do most of the things that they don't know. I can only make an inference here that he thinks they will not get it any other way if he doesn't tell them. He is opposite in personality traits [from a different peer leader video coded prior to this one] in that instead of being wimpy and soft-spoken [like the previous peer leader, Donna] he is loud and slightly arrogant. He talks down to students, but is not rude. Something really authoritarian about him, maybe it's his deep voice, his height, the manner of his icy jokes. Students do not stay on track for long and except for peer leader explanations we cannot see any benefits to having whole-class discussions in this room. Steven does not encourage a lot of group interactions. The majority of these students work alone with the peer leader coming around occasionally and explaining an answer. Steven talks mostly to one individual at a time, but is loud enough for all to hear. He did not explain anything to one of the groups (consisting of all girls) the entire class period. When looking at this peer leaders end of the year evaluations only 3 of Steven's students said that the Friday sessions were a complete waste of their time. The others were not real positive about the experience but they liked having small classes and they liked Steven.

Donna, however, has a lower level of chemistry understanding than Michael and Steven. This statement is based on a chemical concept inventory that she took at the beginning of her second semester, her weekly quiz scores, and the kinds of questions that she asked her students during class sections that were videotaped. Donna was videotaped on four different occasions and except for her very last tape, where she decided not to hold whole-class discussions, her whole-class discussions generally involved more student interactions than Michael or Steven's classes.

Excerpt from researcher's journal concerning Donna-2:

This class seems to run much smoother than the last 2 classes but Donna does not have much control over her students. Students have a silliness about them that borders close to rudeness. As an observer I can see both sides of the story, Donna is not sure of the material and students are very frustrated with the material. Students this semester were randomly put into the peer leading section and many are not happy about it. The lack of peer leader knowledge and the odd manner that she presents herself does not make for a successful combination. The peer leader does not ask any questions that help students to arrive at answers on their own. Even though she is constantly moving back and forth, and round and round, she is not aware of what is going on in each group. This is obvious by the questions she asks when she interrupts and the questions that she has students report out. This combination sabotages any of her efforts to 'lead' students successfully. Donna is available and approachable, but she does not have good questioning skills, she does not help to promote teamwork, nor does she give constructive feedback or responses to student comments and questions. It is almost like an air about her like 'I can't tell you too much… not supposed to. He-He-He.' I think she either doesn't know how to or she doesn't know the material.

Michael, Steven, and Donna had very different levels of subject knowledge (high, medium, and low) but when looking at an average of their average discussion ratings (ADR) there is not a whole lot of differences between 1.6, 1.6, and 1.9. Michael and Steven both displayed an understanding of many of the chemical concepts covered in General Chemistry I, however, there was something very authoritarian or arrogant in the way this knowledge was displayed. Other peer leaders understood the material too, but it was not displayed as flamboyantly. These observations, combined with Donna's lack of knowledge but similar Discussion-Ratings, led to the conclusion that creating productive whole-class discussions involves more than just content knowledge.

Hypothesis 5

If productive whole-class discussions are related to a peer leader's Interpersonal Skills, then peer leaders with a high level of positive Interpersonal Skills will have more productive whole-class discussions.

The category, Interpersonal Skills, refers to the portrayed attitude and social characteristics of a peer leader outside of the other four categories. In other words, the relationship building skills that do not involve Procedural Practices, Supervisory Qualities, Questioning Techniques, or Feedback/Responses. Interpersonal Skills consist of the social mannerisms pronounced in the way that a peer leader was involved in dialog, empathized with students, negotiated terms, carried his/her self, and were available to students; the sum total of who they portrayed themselves to be.

No two peer-leaders had exactly the same kinds of attributes or utilized any of the behaviors in the same ways. This is not any different from what one would expect to find;

no two people are exactly the same. What was noticed, however, is that the peer leaders who exhibited more positive than negative traits, had more productive whole-class discussions. This was true for many of the discussions that ranged between *Fair-Good*, and *Good-Excellent*. What was observed is that as the difference between positive and negative traits decreased, the average discussion rating (ADR) generally decreased. This was true for many of the videos; however, there were several peer leaders that exhibited positive Interpersonal Skills whose discussions were only *Fair*. This led to the conclusion that while a lack of Interpersonal Skills hinders the development of productive whole-class discussions, having positive Interpersonal Skills does not automatically mean that whole-class discussions will be productive. James is an example of positive Interpersonal Skills not leading to productive whole-class discussions.

James's strong suit was his personality. James was one of the most dynamic peer leaders observed during the entire four-year process. He was very vibrant and fun loving and had clearly acquired a rapport with his students. He had a great personality but did not "buy in" to the peer-leading program and chose not to rely on roles or the question answer format. He was very frustrated with the process of answering student questions with more questions, and made this very well known each week in his journals.

Excerpt from James's Journal:
A definite area for improvement lies within my understanding of what a peer leader is actually doing. I feel like a Jedi Master or Gandalf from *Lord of the Rings* sometimes because I'm forced to answer questions with more questions or riddles. I want so badly to help the students when they are confused and the other students can't help them. I really don't understand why I can't explain how to do a problem. It's weird that the students come to class without a real prior knowledge of the subject. I'm not sure how peer leading helps the students when I can't help them effectively. I know that research and statistics illustrate the effectiveness of Peer Leading in the big picture, but I do not see how confusing the life out of them right now by not explaining anything is helping them. I suppose my area for improvement could be resisting the urge to help them by explanation.

When observing James's classes it was clear that his students liked him and did not want to do anything that may make him "look" bad. They tried to do what he asked them to, but it was clear that the class was performing for the camera and did not function in this capacity each week. Students were very resistant to answering questions out loud; James would prompt students with comments like "come on just for today." James's enthusiastic mannerisms could not get students to participate in either their small groups or whole-class discussions. The peer leader merely went from group to group energetically asking how groups were doing and trying really hard to find questions that would help lead students to understanding. His discussions rated on the scale as *Fair*, but this occurred as a result of a lot of work and encouragement on his part. During whole-class discussions, James did most of the work. He was funny, but the whole attempt at a discussion was very forced with the peer leader oftentimes having to say the answer and then say "isn't that right?" In an interview with James after the class was over, he admitted to having the whole class work on problems together rather than in groups the week prior to being videotaped. This admission, his journals, and the observed classes suggested that personality alone did not lead to productive whole-class discussions. A memo written immediately after coding one of his videos describes some of the insights as they developed for the researcher.

Memo for James-2:

5/13/08 James

As I continue to observe James and code very slowly for each detail, I try to skip nothing even the things that seem obvious to me, I begin to add a few more codes to the category labeled discussion techniques. I hope that these details will help to separate codes from each other and aid in discerning patterns between the various peer leaders. As I look at the way that James plays, teases, and approaches his students I think about the trait of personality. James's students clearly like him (I got this information from reading his student evaluations). But they also reflected James's attitude concerning the usefulness of these peer-leading sessions. 9 students said they did not feel like they benefited from these small group sessions. 5 students felt like they did benefit and that the peer leader was helpful in trying to help students learn new concepts. What I am aware of from this is that personality if NOT enough to warrant good whole-class discussions or peer leading sessions. James was an extremely personable young man. He was vivacious, energetic, and funny but his condescending, sabotaging remarks hurt & hindered his peer leading sessions. They did not really seem effective for the most part. James seemed to be using the system to explain his own inabilities to help students understand. Most of his students reported that class would have been better if the peer leader had been allowed to GIVE answers. Students do not need to know that peer leaders do not give answers. They should be more helpful in helping students to arrive at getting answers. While I felt like the peer leader knew his chemistry, he was not sure about how to help students arrive at the right answers. He only knew what the correct answers were and he only had a limited understanding about why that was the correct answer.

What I observed in James's classes is that his students are dependent on him. They are not being asked questions that encourage or promote reflection. The questions are informational and have specific answers. James's whole-class discussion was really interesting; it was slow to take off but once students got it, James's enthusiasm and students' participation, showed that many students got it. I did notice however that it was the peer leader that was doing most of the work. Students were passively sitting and guessing at answers while the peer leader thought of questions to string students along. The peer leader did not require in depth explanations or students to follow up on student responses. The peer leader responded yea or nay to each student's response.

Another peer leader that comes to mind when thinking about personality traits is Alice. She was a peer leader for two sequential years. Alice is also very energetic and funny, but her attitude towards peer leading is very different from James's. Her ability to ask questions and push students towards understanding is also much better than James's.

Excerpt from memo concerning Alice-2:

Alice's whole-class discussions were very good. Alice talked very little, she did not come across as an authoritarian, but she was in control and that control although slightly challenged on two occasions was quickly put to rest by Alice's ability to take blame and laugh at herself.

I was not particularly impressed with her round robin method of sharing group answers but it really worked for her. Each time (2) that she used this method she would catch groups with different answers and a problem would be resolved. The first class discussion she spent too much time on something that I feel most student understood, but it ended up with her being sure everyone understood.

I read through Alice's evaluations and there was nothing unusual in them. The majority of her students liked her and a couple wished that she would give more answers. Guess what, the peer leaders say the same thing about their instructor on Wednesdays too. Alice's class is somewhat disorganized and she asks questions that she should know (like who's the manager) this may be part of her personality that makes her so approachable and real.

Two individuals with strong personalities and many dynamic traits, the discussions however were quite different from each other. James was up at the board the entire time and working very hard to "pull" the information from his students. Alice on the other hand, had many students up and at the board throughout the class period.

Students from every group spoke and gave an answer for every question that they orally discussed. Both peer leaders walked from group to group, worked with the groups, and held whole-class discussions, but when you compare these two peer leaders to each other, James is working hard to “make” the students understand. Alice calmly watches and continues to ask students to explain what they have written. She asks questions like she really needs them to explain it to her and they respond positively by explaining it to each other. Alice is the authority figure in this room, not by being bossy but by directing the students and flow of the class. James is the authority figure because he has all the answers. Both peer leaders display many positive Interpersonal Skills and had totally different ways to lead a whole-class discussion. The results of James’s whole-class discussions were *Fair*, while Alice’s were *Fair-Good*, slightly better.

Another peer leader, Donna, possessed a sensitivity level that was quite negative in terms of some of her other traits and her combination of Interpersonal Skills did not do a lot to encourage productive whole-class discussions. It was almost as if it was the peer leader against the class. The students were quite disrespectful to her and she responded defensively. The students and the peer leader were both frustrated but by being on opposite teams they could not manage to help each other. The whole-class discussions from this class section however were not as bad as one might be inclined to guess. In terms of using the Discussion-Rating system, these discussions averaged between *Fair* and *Good*. They consisted of the peer leader asking questions and moving from one group to the next with students answering questions when called on. Students were often talking and could not always hear the answers being shared. The peer leader did little in terms of asking questions and mostly relied on one student to answer questions when other students were stuck. On one occasion a student gave a rather lengthy explanation, when he finished Donna added a few words in a slightly arrogant kind of way, without giving any response to the student. You could hear the disappointed student snarl and see the disgruntled look on his face as he walked back to his seat after presenting his answer.

Excerpt from memo for Donna-2:
I could not see much student gain as a result of anything the peer leader did during today's class. She did not ask any questions that were useful, she did not have class control, but yet she was going back and forth from group to group, talking to the entire class, and working according to all of the "rules." She tried to have 3 class discussions and closure but the procedural things were such a mess and her organization skills were such that these were not very successful. Something was not right here and I cannot quite put my fingers on it except to say that she was mechanical and cocky. She is a pretty quiet young lady, but I didn't see that as being part of the problem. She blew off smart-alecky things that the students said, but then was cocky about simple things. She often acted like I cannot tell you the answers, because I do not know or understand enough myself to help. I can see things the students did in this video that would have been hard to blow off, but I can also see how little the peer leader did to help the students understand the material at hand today.

All of the peer leaders demonstrated traits from the subcategory labeled mannerisms, most of them positive. The peer leaders were generally courteous and respectful of their students, but a few displayed distinctive qualities that were a strong part of who the peer leader was. Nina is an example of this kind of peer leader. Nina's whole-class discussions were generally very good, ranging from *Fair*, to *Fair-Good*, and *Good-Excellent*. Nina's Interpersonal Skills came the closest to consisting of all five of the subcategories as any of the peer leaders. She was joked with her students, empathized with her students, and was accessible to her students. She was extremely courteous and always respectful and continuously made requests of her students, never was she demanding, but somehow her students mostly did what she asked. She really listened to what students said, and she had a great knack for pushing students to explain what they were doing and thinking.

Excerpt from memo for Nina-1:

As far as Nina goes…I think one of the things that I most admire me about Nina is her mannerisms. She is clearly in control, there is never a doubt about this, but yet she is not bossy, controlling, or pushy. She is very flexible and seems to go with the flow of her students. She does not give answers, and yet she never says I can't tell you. She has a way of asking questions that directs students to find the answers for themselves. She starts with a question that can lead directly to an answer and works backwards from there until students catch on for themselves. In the event that they don't catch on, she seeks out others with the same problem or someone else who can explain. She thinks out loud, and works through problems as a class with others directing each move. Her greatest strength, however, has to be about her responses to students. She does not get carried away with students that are playing; yet she always lets them know she hears them or sees them. Right or wrong she asks them to explain what they mean. And she always remains NEUTRAL until students decide for themselves which answer is correct and why. She does not permit students to struggle too long over things that are not important to today's lesson.

The comments from the above video are not just reflective of a good day for Nina, the same kind of comments and observations are made throughout each of her videos. Her behavior is very consistent and her whole-class discussions benefit from this consistency.

Excerpt from memo for Nina-3:

Nina is a very good peer leader. She is cordial, friendly, and in control without being intimidating or bossy. She is not their friend, but yet they all (or so it appears) like her. Students are willing to do what she asks. It appears that she has established trust with most of them. One student refuses to share orally with the class, but I really don't think he understands chemistry. He is embarrassed and states that he has already failed the course.

If I could take one thing from her and teach it to others it would have to be the manner in which she responds to her students, her tone. I can never tell from her voice or reply if an answer is right or wrong. She does not generally leave students without first giving them a concrete picture of what to do or where to go next. Her questions do not appear to be merely just a cluster of questions but more of a way to gently take what students are saying and moving forward from there. She responds to each student, but does not become engaged in activities that are not important to this class. She responds to each student in a way that appears to make them all feel special and important. She really listens and responds to every comment directed at her. She does not let anything slide past her.

I read over Nina's end of the year evaluations and every one of her students had positive things to say about her. All but 3 of her students said they would take chemistry II using small peer-led sessions again. They found the reporting out helpful and stated that she was very polite. Nina had to take over for a peer leader that was fired. In the evaluations from this class, all of the students mentioned that they liked peer leading with the new peer leader.

The peer leaders that participated in this study are all very conscientious, hard working students. Most of them are going to go into some kind of medical field. They generally become peer leaders for the experience of working with other students, to increase their understanding of chemistry, and to be able to use this experience on their résumés. Despite the fact that most of the peer leaders were hard working and reliable, many were not (at least not in terms of being able to lead productive whole-class discussions) successful. It appears as though the negative Interpersonal Skills undo the other positive traits that the peer leaders may have.

Excerpt from memo for Derron-1:

Just from watching Derron-1 I can conclude that effective whole-class discussions are a combination of questioning strategies and discussion techniques. A large part of the foundation for effective whole-class discussions is laid before a discussion ever begins, but even then the importance of Questioning Techniques combined with responses to students cannot be minimized. I say this because I see Derron as being very knowledgeable, very matter of fact, very attentive to groups, and professional in many respects. He has two areas of difficulty that affects the continuity of his whole-class discussions. He makes comments in a way that is a little condescending or matter of fact and he does not permit students to restate or rephrase each others work.

Derron had a very nice introduction in today's class. He went over the quizzes and reviewed last week's work. If I needed to pick a good, smooth running example of someone to look at – this would be it. What is missing, are student-student interactions. It appears that the peer leader was patient enough for it, but students needed more time to get from where they were at in understanding to where Derron was trying to take them.

Derron was an extraordinary student. He had a good understanding of chemistry, was dependable, and had whole-class discussions that continued to be *Fair*. He was not able to take his knowledge and lead students to discuss their ideas. Derron did most of the work. His actions demonstrated that he wanted students to get "it," what ever it was at the time. He did not loaf or cut up. He was lenient with his students and did permit students to stay without homework. He was not very successful at getting his students to interact with each other. Most of class time involved Derron asking one student a question, and then listening to that one student answering the question. This process of asking a single individual a question, answering and moving on was observed both when he was working with small groups and with the whole-class.

Michael had a slightly different kind of problem in terms of Interpersonal Skills; Michael was not really liked by his students. He was however very knowledgeable and hard working, this could be seen by the kinds of warm up problems that he would devise to get class started and to teach students about the process skill for the day.

Excerpt from memo for Michael-2:

Michael was extremely conscientious, never leaving a group alone for more than a couple of minutes. He asked many questions that went beyond just simple information questions. In fact, he only used those kinds of questions when he could not get his students to put the pieces together themselves or when he could not get them to understand any other way. He always began with understanding questions and worked backwards from there. There were very few statements labeled as personality and many labeled professionalism, which were linked to authority. Technically I guess this authoritative behavior could also be linked with personality, maybe connected with attitude. Michael is a very good peer leader and works very hard, but something about his demeanor was slightly judgmental and threatening. Students did not respond well to him. Michael asked lots and lots of questions. He wanted Students to explain why something was occurring.

The discussion was nice but a little overkill, but then again maybe overkill was necessary to bring up the group differences. It would have been nicer if more groups had presented instead of having 1 student present it all, or if more students had written on the board.

The peer leader worked too hard & didn't allow students to work through their own problems. He interrupted their thinking and talking process too soon, on a continuous basis. No closure was provided at the end of the activity.

Michael was clearly the expert and knew more than his students did. Michael never let a student answer be enough. He always added something to *every* answer given by a student. He would repeat their answer (a very good trait) and then add more to it and say is that what you meant (a very bad trait). Of course the reply was always, yes. As the researcher began to sift through the different behaviors combinations of traits began to surface.

Excerpt from memo for Alice-1:

As I sit and try to reflect on what I just coded on Alice-1 video, I am a little confused. I still do not feel like I am capturing the essence of the whole-class discussion with Interpersonal Skills alone, but I do feel like the coding categories make so much more sense or that they seem to flow a little better from sub-category to category. As far as Alice goes, her Questioning Techniques leave a little to work on, but her personality and enthusiasm seem to help compensate for what her questions lack. Alice is clearly a conscientious peer leader that cares about her students.

The idea that one behavior could compensate for a lack of another behavior led the researcher to explore interactions between the various categories of peer leader behaviors. In several of the memos the idea that one behavior is compensating for lack of something else is mentioned or that one negative trait overrides a positive trait. After carefully focusing in on the codes and comparing the different categories of behaviors to the kinds of whole-class discussions that were being held, the researcher feels like what she has accomplished up to this point is more a descriptive study of peer leader behaviors. But what actually leads to productive whole-class discussions? While there may be a hazy template visible up to this point, there is no answer to the question concerning what creates productive whole-class discussions, just lists of behaviors and their results.

Excerpt from memo for Friday June 27, 2008

As I am coding the third from the last video, for the second pass using this method, it occurs to me as I am typing the word "questioning" 17 min into the video, that this is the first time I have used this word to code with in this class session. Chantel-2 is very nice, follows the rules and formats, but almost hides behind them. She is not asking any questions except for how are you and will you present this one… The idea is coming to me that there is some kind of interaction or combination of things going on between constant questioning and personality:

Michael follows all the rules, asks lots of questions but has no personality or rapport with his students.

Samantha follows all the rules, uses process skills way too much, and does not make the process her own.

Lydia follows all the rules and uses process skills. Her students feel uncomfortable but somehow she makes the process her own. The process is useful to her students because they do get to check answers and leave with a sense of understanding

Chantel on the other hand, uses the process, but as a tool to hide behind. She responds to student questions by saying "I cannot tell you the answers because…" She asks very few questions that help her students move towards understanding.

Alice on the other hand adds personality and questioning to make the process her own. She has students at the front of the board trying to solve problems together as a class. Sometimes she gets rushed and has to 'do' the work for the class, other times this process works very well for her.

Gradually the idea that interactions between the different behaviors may play a part in answering the research question concerning what creates productive whole-class discussions. The idea that some kind of interactions were occurring gave rise to the next and final level of analysis, which involves looking at the frequency of occurrences and the interactions between each of the five behavioral categories in relation to each other.

Evaluating Interactions

Interactions between peer leader behaviors occurring in *Good* and *Poor* whole-class discussions were analyzed for patterns. First the videos were sorted from highest to lowest ADR scores, providing a continuum of positive and negative behaviors occurring in the class sessions. From the top and bottom five videos occurring in this ADR continuum, frequency counts of peer leader behaviors were made for each of the ten peer leaders for the entire class period. The decision was made to look at the top five class sessions with the highest average discussion rating (ADR) and the bottom six class sessions with the lowest average discussion ratings (ADR) because it was believed that they would show the greatest diversity in peer leader behaviors. The entire class session was looked at based on the belief that what happened before and after a discussion played a part in student levels of participation.

Frequencies

Frequency counts were not made for student behavior because there were not any differences between student behaviors in the various class sessions. Peer leader reacted differently to student behaviors, in classes with *Good* and *Poor* whole-class discussions. This observation was revealed through coding student behaviors.

While the frequencies of behaviors do not directly answer the question about what creates productive whole-class discussions, they do reveal differences between *Good* and *Poor* whole-class discussions. The frequencies permit a comparison between positive and negative behaviors in classes with high and low average discussion ratings (ADR).

The more productive the whole-class discussions were, the more positive behaviors were observed (Figure 4.6). The less productive, the more negative behaviors were observed (Figure 4.7). *Fair-Good* whole-class discussions occurred more often in classes where peer leaders exhibited more positive traits than negative traits. The observation concerning productive discussions having more positive behaviors than poor discussions supports the idea that negative actions have more power than positive actions.

The awareness concerning positive behaviors increasing productivity alludes to an answer about what creates productive whole-class discussions - peer leaders should practice positive behaviors. This answer, however, brings more questions: how do we apply this knowledge to peer leading, and how many positives? “Telling” peer leaders to be more positive and teaching peer leaders the positive codes will not create productive whole-class discussions. In addition to the problem of telling students to be more positive there are more questions to answer such as, how many positive traits would it take to create a good discussion? There were peer leaders that were very positive (Samantha, Lydia, and James) and yet their whole-class discussions were not student-centered or productive. These questions signify that further analysis of the data is still needed, leading to further examination of frequencies for coded behaviors.

Since classes were rated according to an average of all the discussions occurring during a single class period, frequency counts were made from all the whole-class discussions occurring during an entire class session (Table 4.16). Frequencies hinted at peer leader behaviors that helped or harmed productivity levels of whole-class discussions as patterns between the different behaviors are ordered. In the five class sessions with the highest average discussion ratings (ADR), the positive behaviors observed during whole class discussions were: Questioning Techniques, Interpersonal Skills, Supervisory Qualities, Feedback/Responses, and Procedural Practices. While the classes with the lowest average discussion rating (ADR) were observed using the following categories of behaviors most often: Questioning Techniques, Supervisory Qualities, Procedural Practices, Feedback/Responses, and Interpersonal Skills.

Procedural Practices were the least common kind of behavior observed during whole-class discussions in peer leading class sessions with productive whole-class discussions. These results do not support hypothesis 1, which states that peer leaders who focus on Procedural Practices will have more productive whole-class discussions.

The category "Questioning Techniques" occurred most often in both good and poor whole-class discussions. This would imply that the peer leaders have grasped the importance of asking questions in this type of learning environment; most have demonstrated that they understand their role of asking questions rather than merely giving answers. It seems logical to assume that Questioning Techniques had to be tied to productive whole-class discussions since it was the most commonly observed trait, but just asking questions did not create productive whole-class discussions. These results do not support hypothesis 2 or 3, concerning the greater number and kinds of questions being asked by peer leaders, the more productive whole-class discussions will be. The frequencies do reveal that when peer leaders ask students to clarify and elaborate on a regular basis the whole-class discussions are generally more productive.

Good or *Fair-Good* discussions had larger ratios of positive to negative behaviors in the category of Interpersonal Skills than *Poor* discussions. These results support hypothesis 5, which states that peer leaders with a high level of positive Interpersonal

Skills will have more productive whole-class discussions. The two sets of data are set next to each other in Table 4.16 for comparison; the major observed difference between the two sets of data is the ratio between positive and negative behaviors.

Table 4.16

Coded peer leaders behaviors during all discussions in top & bottom five classes

Top Five Whole-Class Discussions			Bottom Five Whole-Class Discussions		
Behavioral Category	*Positive*	*Negative*	*Behavioral Category*	*Positive*	*Negative*
1.Questioning Techniques	183	5	1.Questioning Techniques	110	32
2.Interpersonal Skills	150	3	2.Supervisory Qualities	66	50
3.Supervisory Qualities	148	11	3.Procedural Practices	52	36
4.Feedback/ Responses	86	14	4.Interpersonal Skills	41	48
5.Procedural Practices	71	14	5.Feedback/ Responses	13	96

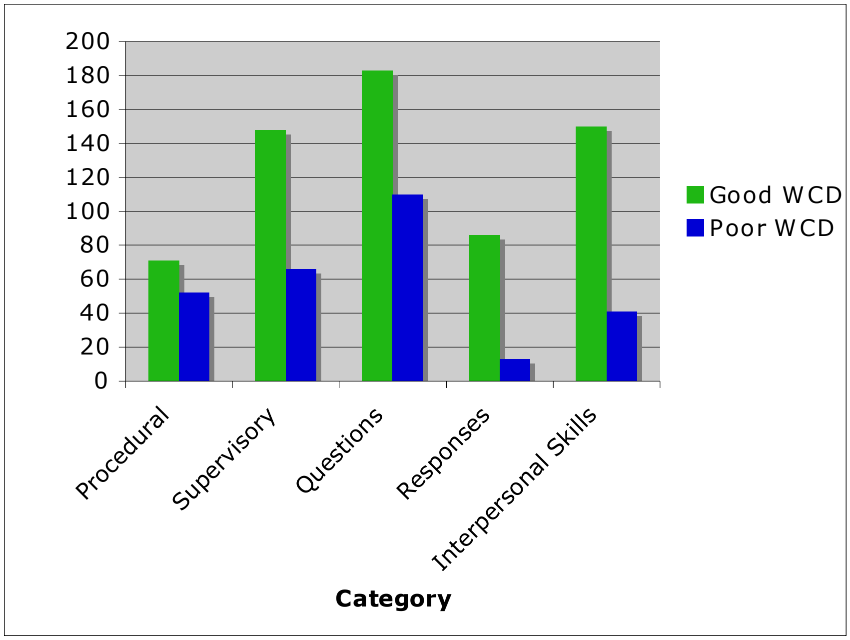

Figure 4.6 Positive behaviors during whole-class discussions.

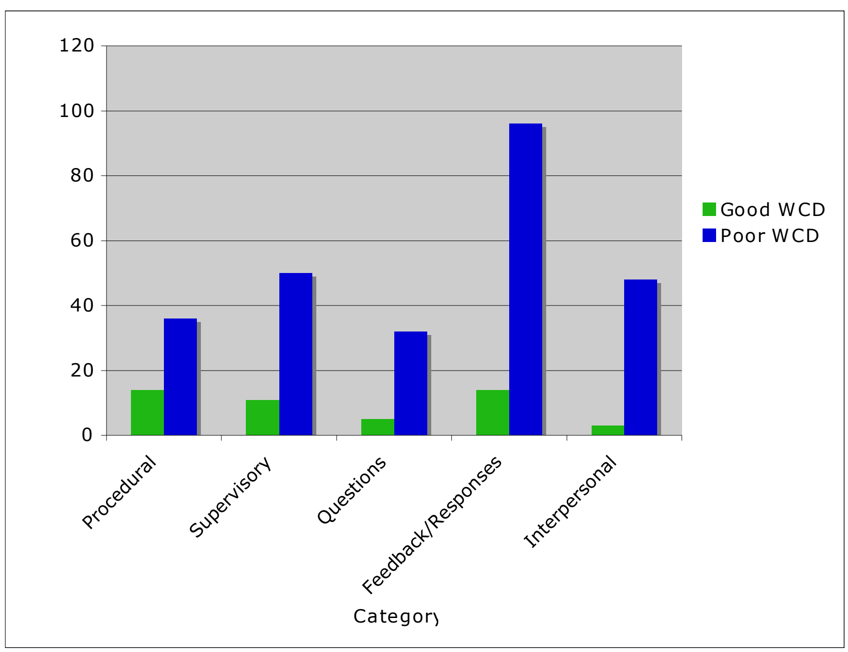

Figure 4.7 Negative behaviors during whole-class discussions

Looking at frequencies for positive and negative behaviors between each of the categories and comparing good whole-class discussions with *Poor* whole-class discussions reveals several things (Figure 4.6 and 4.7). First, the similarities between these two groups reveal that the top three categories for both *Good* and *Poor* whole-class discussions consistently include Questioning Techniques and Supervisory Qualities. Second, the major difference between the *Good* and *Poor* whole-class discussions is the ratios of positive and negative behaviors. *Good* whole class discussions have higher ratios for positive and negative behaviors, then *Poor* whole-class discussions. *Poor* whole-class discussions have more observed negative behaviors than *Good* whole-class discussions. Third, even in *Poor* whole-class discussions, peer leaders are observed practicing more positive behaviors than negative behaviors.

Looking at the frequencies of each category sheds light on discussions but does not quite answer the research question about what behaviors create productive whole-class discussions. At this point in the study, an inventory of the data collected thus far was taken. First, a clear definition of what a productive whole-class discussion is and an instrument to measure productivity has been established. Second, it has been established that peer leaders and students are asking seven different kinds of questions. Third, similar student behaviors are occurring in each class sessions regardless of the average discussion ratings (ADR). Fourth, peer leaders are exhibiting five different kinds of classroom behaviors. Fifth, positive behaviors occur at a higher rate than negative behaviors during *Good* whole-class discussions. What actually creates productive whole-class discussions is still not clear. Therefore, the next step in this iterative process involved examining the interactions between peer leader behaviors.

Time-Ordered Matrices

The next area for analysis was to look at the interactions occurring between each of the individual categories. Time-ordered matrices were created in order to reveal interactions among the different peer leader behaviors (Miles and Huberman, 1994). A Time-ordered matrix was made for the highest Discussion-Ratings in the class sessions with the top five average discussion ratings (ADR) and for the lowest Discussion-Ratings in class sessions with the bottom five average class discussions. Two matrices have been included below (Table 4.17 and 4.18). When comparing the time-ordered matrices with the highest and lowest Discussion-Ratings to each other, the interactions between the different peer leader behaviors become more obvious.

When making the first couple of runs through the transcripts using the time-ordered matrices, positive and negative codes were used for each minute of a whole-class discussion. The method of noting both positive and negative behaviors did not help to distinguish the interactions occurring in *Good* and *Poor* whole-class discussions; the data tables were too messy to decipher. Therefore, negative behaviors are not included in the time-ordered matrices used for this study. The time-ordered matrices with positive and negative behaviors did accentuate the difference between the frequencies of positive and negative behaviors in both levels of discussions; negative behaviors occurred more often in *Poor* whole-class discussions than *Good* whole-class discussions.

At first, the time-ordered matrices only revealed the kinds of behaviors occurring during a whole-class discussion, however, a comparison between a *Good* and *Poor* matrix revealed differences between peer leader behaviors during discussions. For example, in Table 4.17, during Michael's *Poor* discussion only one positive behavioral characteristic can be observed during any single minute (Table 4.17). This does not mean that Michael was not doing anything, but instead that his focus was rigid and not integrated with other positive behaviors; negative behaviors occurred in the absence of positive behaviors.

During Nina's *Good* discussion, however, she was observed using at least two behaviors at any minute and most often three or four behaviors simultaneously (Table 4.18). The five highest and lowest discussions reveal similar patterns to those presented in Table 4.17 and 4.18. Peer leaders in *Good* whole-class discussions demonstrated positive traits in two to three categories most of the time, while the peer leaders in *Poor* whole-class discussions generally only showed one or two positive behaviors during any single minute. These results led to a closer examination of the interacting behaviors in order to reveal closer relationships between these behaviors (Table 4.17 & 4.18).

Table 4.17

Time-Ordered Matrix for a Poor WCD

Peer Leaders Name: Michael-3 DR:1 ADR:1.25 Length of Disc: 6:58 # Disc: 2

	Procedural Practices	Supervisory Qualities	Questioning Techniques	Feedback/ Responses	Interpersonal Skills
Minute before discussion		S			
1st minute	p	S	Q Q Q Q		
2nd minute			Q Q Q Q Q Q Q Q Q Q	F/R F/R	
3rd minute			Q Q Q Q	FR	
4th minute			Q Q Q Q	F/R F/R	
5th minute			Q Q Q		
6th minute			Q		

Table 4.18

Time-Ordered Matrix for a Good WCD

Peer Leaders Name: Nina-1 DR:3.5 ADR:3.5 Length of Disc:3:09 # Disc:1

	Procedural Practices	Supervisory Qualities	Questioning Techniques	Feedback/ Responses	Interpersonal Skills
Minute before discussion		S			IP
		S			IP
		S			IP
1st minute	P	S	Q		IP
		S	Q	F/R	IP
			Q	F/R	IP
		S	Q		IP
2nd minute			Q	F/R	IP
			Q	F/R	IP
			Q	F/R	
			Q		IP
3rd minute			Q	F/R	IP
			Q	F/R	IP
			Q		
			Q		IP
		S	Q		
4th minute	P	S	Q		IP

When the results from each of the time-ordered matrices were tabulated, a pattern of interactions began to become apparent. The difference between high and low-rated discussions appears when looking at a matrix and comparing the different number of coded behaviors occurring in each. Three behavioral categories consistently dovetail in each of the five highest rated discussions (Table 4.18). The pattern observed in the higher rated discussions is quite different from the distribution of behaviors in the lower rated discussions where long lists of behaviors are occurring instead of an interaction between categories. Peer leaders are still working, however, they are doing more work than their students. Peer leaders in the higher rated discussions are also working, but working to encourage students to work. An example of dialog from a low and a high rated whole-class discussion is included below to further clarify this point. The first segment is from a video rated *Poor* and the second is from a video rated *Good-Excellent*. Each transcript includes the first two minutes of a whole-class discussion, and is divided into blocks according to the first and the second minutes of discussion.

Scene ID Segment Michael-3 Video:

Line	Coded Behavior	PL/ Ss	Transcripts
(71)	SQ, QT	PL [00:23:03.17] :	Alright I am going to get everyone to focus their attention to the board. Uh we have written here the answer to exercise 1, but for specifically 2 of the molecules. So for this one right here, I'm not going to try and figure it all out, but they got one with 5 valence electrons. does everyone else have the same answer or are there any different answers?
(72)	QT, QT	PL [00:23:26.12] :	No, well … what about for the ClO4 minus? Does anyone have a different answer? Okay. So we also have here the structure or the answer to number 2, so I am going to ask [Ss name] to explain to me how she wrote the Lewis structure for that molecule.
(73)		Ss [00:23:49.25] :	Okay, so nitrogen has 5 electrons and both oxygen's have 6 electrons. Soo... when you say that that um [pl interrupts]
(74)	QT	PL [00:24:04.13] :	Let me sort of sort of take this. [class laughs] You all remember the rules on that sheet of paper that you had right... How to draw Lewis dot structures? Okay I am going to assume you guys do because we have been using it for the last 3 weeks or whatever.
(75)	QT, QT, QT	PL [00:24:17.02] :	So the first step would be to determine how many valence electrons are in the whole thing. So how many valence electrons are in this molecule? ...How about group 1?... How many valence electrons are in this molecule?
(76)		Ss 1 G1 [00:24:30.13] :	For which one?
(77)	F/R	PL [00:24:30.08] :	This one right here.
(78)		Ss1 G1 [00:24:33.28] :	Oh 18, right?
(79)	F/R, QT, QT	PL [00:24:34.21] :	18, okay. So nitrogen is an essential atom in this molecule right here, right?... Yes, no...you guys give me some feedback here. Okay?
(80)		Ss1 G1	Repeat the question again.
(81)	QT	Pl	Nitrogen is an essential atom in this molecule, right?
(82)		Ss1 G1	Yes

(83)	QT, QT, QT	PL [00:24:51.23] :	Okay, so all you are left with then is with the oxygen atoms, right? So those have to go around the N atom. So, let's say if you were to do that you have N O and O but you used up 4 electrons right? so you just subtract 18 from 4 and you get... What do you get?
(84)		Ss	14
(85)	F/R, QT	PL [00:25:15.24] :	14? Okay. So you have 14 electrons left which you usually do is what with these 14 electrons?

Scene Segment ID from Nina-1 Video:

Line number	Coded Behaviors	PL/Ss	Transcripts
(261)	PP, SQ, IP	PL [00:26:31.21]:	Hey that was beautiful (almost every Ss raised their hand) [PL is smiling.]
(262)	SQ, IP, QT	PL [00:26:48.03]:	(Whispers "raise your hand") Awwww.....okay... so... chem activity 4, group 3 has so graciously put up umm ctq1, i saw that some of us have a little bit of a different answer like among the class, so is there anyone that got something different than this answer?... .. ...
(263)		SS	For which one?
(264)	F/R		CTQ....its Chem Activity 4 CTQ number 1,
(265)		Ss	Ohh that' s wrong.
(266)	QT	PL	And did you get [male Ss name]? What did your group get?
(267)		Ss [00:27:19.01]:	2.178 * 10^minus 18 divided by…
(268) (269) (270)	F/R, QT, IP, QT, SQ, IP,	PL [00:27:25.08]:	2.71 what? 2.178 times ten to the... ten to the what? Negative 18. Hold on..Hold on. Joules. Is that what you got? Did anyone else get this answer?... I saw.. I saw a couple more papers that have this answer on there. 24.... 24..and this is mega joules. Ok I saw some people have this answer and then some have this answer (circle the two answers on the board).
(271)	QT, IP	PL	And I'm wondering what's the difference of between these two? They both convert it to mega joules.
(272)		Ss	That's atoms, that's moles.
(273)	F/R, QT	PL [00:28:15.12]:	What is that [male Ss name]?"
(274)		Ss [00:28:16.21]:	The bottom one is per atom and the top is per mole
(275)	F/R, QT, IP	PL [00:28:20.20]:	Atom...per atom.. per mole.. (PL writes on the board) what do you guys think about that?
(276)	F/R, QT	PL [00:28:30.07]:	[Female Ss name] just asks why they multiply by 6.0022 times 10 to the 23. What number is that?"
(277)		Ss [00:28:36.28]:	Avogadro's number
(278)	F/R, QT, IP	PL [00:28:37.27]	Avogadro's number! So what is that? That the conversion factor from what to what?... molecules to moles (repeating after students) molecules to .....moles. okay.
(279)	QT	PL [00:28:52.07]	So what is the question asking?

There are several differences between the two sets of transcripts. In the first set of transcripts, from a video rated *Poor,* the lengths of each peer leader comment are quite long in comparison with all the student comments; the peer leader is clearly doing most of the talking. Michael interrupts students and makes it known that he can do a better job of explaining something then his students can (line 74). The peer leader asks lots of questions and is indeed working; however, he is working harder than his students. There are several behaviors occurring that are coded as negative behaviors in terms of getting students to participate. For example, in line 71 right off the start this peer leader begins talking without getting students attention, he just quietly says look here. Then (still in line 71) he begins to tell students that he will not try to figure out a part of an answer that one group has written up on the board, not sure if it was messy, wrong, or why he would not let his students explain it. He went from one question directly into another question with no pause or waiting for students. No wait time is observed in lines 71, 72, 75, every line that he asks a question in; he even gets upset in line 79 with no time between question and anger when he says "yes, no…you guys give me some feedback here. Okay?" All student answers except for line 73 are one-word answers. Michael talks down to the students in a slightly arrogant manner. As far as coding for this segment goes, it is obvious when a question is asked (QT) and when a response is given to a student (F/R). Supervisory and Procedural traits, however, are a little harder to distinguish. For example, line 71 is coded as a Procedural Practice (PP) this is the procedure the peer leader uses to get everyone's attention and Supervisory Quality (SQ) because the peer leader is acting in position of authority and telling students to look at the board.

In the second video, rated *Good-Excellent*, Nina begins after the entire class is quiet, and then she is very positive and appreciative of students raising their hands so quickly. She does not start until all students have raised their hand (line 262). Nina's questions are asked in a comfortable manner as if she is talking to her students and asking questions to make ideas clearer. She does not challenge her students in a confrontational manner, but instead asks them to explain why there are different answers or what something stands for (line 262, 270, 271, 276, 278). She is correcting wrong answers but it is in a non-challenging kind of way, as though she genuinely wants to understand all the differences that are going on in her room. Everything flows as a positive experience. When students do not answer her, she rewords a question and pauses until an answer is given (line 278 - 279). Coding for this segment begins in line 261 with a Procedural Practice code because of the procedure of raising her hand and waiting for everyone to raise their hands and quit talking. Supervisory Quality because the peer leader is in a position of authority, signaling for students to stop talking and listen. Interpersonal Skills (IP) because right from the beginning you can see her personality traits consisting of being friendly through her smile, and her sense of humor and encouragement through her telling students how beautiful that procedure was. Supervisory Qualities are again observed in line 262 as she tells students to raise their hands as the authority figure in the class, but not in a demanding or authoritative manner. Interpersonal Skills are again shown in her "awww" after everyone complies with her wishes and again in line 269 as students are getting excited and a little loud, she gently says "hold on, hold on, hold on" letting students know she knows there is a problem but to be patient. Interpersonal Skills show up three more times in lines 271, 275, and 278 in the form of questions. In all three examples she asks questions with her personality being displayed, it is as though she really cares about and wants to understand the answers. She continues to ask students to clarify and explain their answers while remaining neutral in terms of whether these answers are right or wrong.

When comparing the number of Feedback/Response answers in these four minutes of transcripts, notice that Michael responds to all student statements and questions. However, he is only asked two questions; one about which molecule the peer leader is referring to (line 76) and the other is a verification question wanting to know if 14, is the right answer (line 78). Nina provides feedback on six occasions; one where a student wants to know which problem the class is on (line 264) and three times where she just repeats a student's answer (lines 268, 273, and 275), and two additional times where she repeats a student's answer and follows it with a question (lines 276 and 278).

The results from the time-ordered matrices revealed four common themes. First, productive whole-class discussions have multiple interactions occurring between each of the five categories and that they are indeed the result of positive interactions. Second, positive behaviors encourage productive whole-class discussions. Third, there was a difference between the numbers of interactions occurring between the various categories when comparing high and low whole-class discussions. In other words, productive whole-class discussions had multiple interactions, whereas not so productive had one strong behavior present. Fourth, four specific triadic relationships were uncovered.

Triadic interactions between the behavioral categories became more salient when looking at the time-ordered matrices. Productive whole-class discussions had multiple behaviors occurring simultaneously (Table 4.17 and 4.18). There were at least three different kinds of behaviors occurring at any given minute resulting in four different combinations of interactions:

A. Interpersonal Skills - Supervisory Qualities - Feedback/Responses

B. Interpersonal Skills - Procedural Practices - Feedback/Responses

C. Interpersonal Skills - Procedural Practices - Questioning Techniques

D. Interpersonal Skills - Supervisory Qualities - Questioning Techniques

Figure 4.8 visually depicts how each of the categories are linked to each other with each triadic pattern consisting of Interpersonal Skills. It cannot be concluded from this work that Interpersonal Skills are more valuable than any other skills, but we can conclude that Interpersonal Skills most definitely are important to creating productive whole-class discussions in addition to having communication and leadership skills (Figure 4.9).

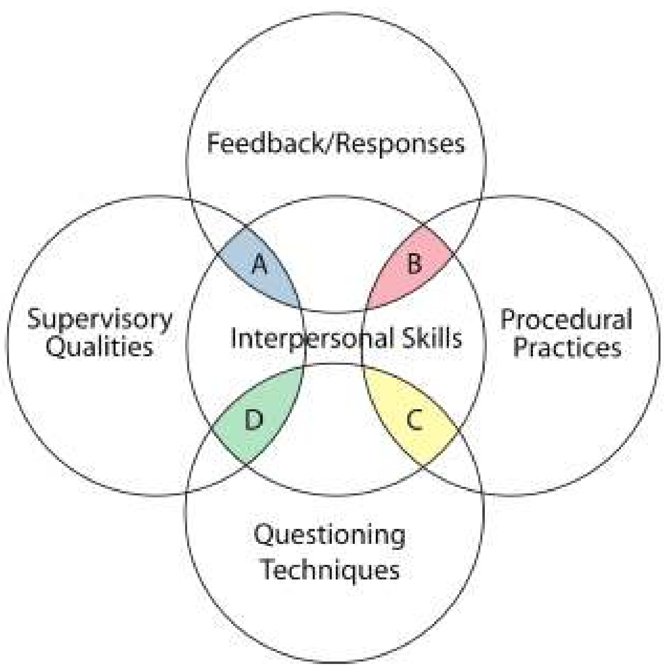

Figure 4.8 Triadic interactions of behavior in productive whole-class discussions.

Interpersonal Skills occur in each of the four different kinds of interactions (A – D) as an important constituent. When looking at the combinations of behaviors that did not occur in the time-ordered matrices, it becomes apparent that Questioning Techniques are ***not*** combined with Feedback/Responses and Procedural Practices are not combined with Supervisory Qualities. Upon further inspection, it became necessary to examine the categories that did not occur in the triad of behaviors (Figure 4.9). Questioning Techniques and Feedback/Responses are both forms of communication skills, while Supervisory Qualities and Procedural Practices are well known leadership skills. Together these three combined forms of behaviors form productive whole-class discussions.

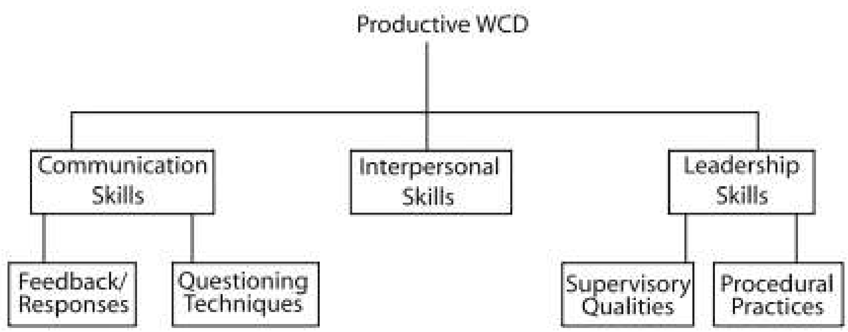

Figure 4.9. Flow chart demonstrating major constituents of a productive whole-class discussion.

In the poor whole-class discussions the same kind of triadic patterns of behavior were not observed. There were usually only one or two and occasionally even three major kinds of behavior occurring at any single moment. The triads of interacting behaviors that occurred at one time, however, occurred only in brief increments (usually less than a minute). In the poor whole-class discussions there were not as many positive interactions occurring between the different categories of behavior; instead each of the peer leaders displayed a particularly dominant form of behavior, rather than a mixture of behaviors.

The category Questioning Techniques had the most frequent occurrence of positive traits during good and poor whole-class discussions. In good discussions, however, questions were occurring at the same time as Interpersonal Skills and other behaviors. The interconnections between questions helped to reinforce the idea that more than one category is tied to another and networked together. The positive traits observed in poor whole-class discussions were not networked together in this same fashion, each category seemed to be related only to a single category and not linked to any other category. In poor whole-class discussions questions are combined with Supervisory Qualities, procedural skills, Feedback/Responses, or Interpersonal Skills, but each of these was not linked with any other category. The frequency of questions reinforces the assumption that questions are a common occurrence in whole-class discussions; however, there are two major differences between the way they are utilized in both *Good* and *Poor* whole-class discussions. One of the differences previously alluded to was based on Questioning Techniques concerning the types of questions asked (for example, clarity/elaboration questions), in addition to the new connection being shown here which deals with the interconnectedness of this trait with other positive traits.

The category, Feedback/Responses, had the most frequent occurrence of negative traits for both good and poor whole-class discussions. This would imply that all peer leaders need some additional work and training on the responses that they provide for students. The kinds of negative responses made by peer leaders consist of comments that do not redirect or lead students to understanding. Other forms of negative feedback consist of “telling” answers rather than helping students find answers. Still other responses hinder understanding by implying correctness of an answer and consist more of “teaching” than leading. And finally, there are the peer leaders that totally refrain from giving any kind of response at all and only walk away, leaving students to sort out their own answers. Responses were classified as positive responses when they were encouraging and positive, when they helped to move students towards understanding the material being discussed, when they double-checked for understanding, and pushed students to clarify their thinking about a particular topic.

When first looking at the positive/negative traits in good and poor whole-class discussions, they both have the category of responses tied to each of the other four categories as the top negative observations made. The difference however, lies more in the difference between how much more often these negative traits are observed in poor whole-class discussions compared to good whole-class discussions. The responses coded as negative occurred five times as often in poor whole-class discussions than good whole-class discussions.

At first it seemed like the more positive traits that occur in a given classroom the higher the whole-class discussions, however, after closer examination it became apparent that something else was occurring. When comparing positive traits exhibited by peer leaders during whole-class discussions, the outcome is quite different depending on whether you are looking at a single behavioral occurrence or an interaction between several categories of behavior. When looking at the interactions between all five categories, the results revealed that when at least three of the five categories had more positive observed behaviors than negative behaviors (at least four positives for every one negative) the whole-class discussions that followed were productive. This explains why Chantel, Samantha, Lydia, and James's average whole-class discussions were *Fair* and never seemed to encourage enough student participation to produce productive whole-class discussions. While there were many positive traits observed during these videos, each of these peer leaders were primarily operating from just one major category. For example Chantel, Samantha, and Lydia had a vast amount of positive codes mostly belonging to the category of Procedural, while James's positives were primarily from the category Interpersonal Skills. Neither of these four peer leaders demonstrated positive behaviors in more than one or two categories at the same time. The results from this study suggest that by teaching peer leaders to use a combination of skills, the levels of student involvement would go up, increasing productivity of whole-class discussions. In terms of Chantel, Samantha, Lydia, and James, they only to integrate one more category of skills to their discussion techniques.

In summary, after careful analysis of the combined frequencies and time-ordered matrices it becomes apparent that productive whole-class discussions are the results of three major categories of behaviors: Interpersonal Skills; Communication Skills, which consist of Questioning Techniques and Feedback/Responses; and Leadership Skills, which consist of Supervisory Qualities and Procedural Practices. It is not a matter of one category of behavior creating productive whole-class discussions, but instead a combination of three or more skills: Interpersonal Skills, along with at least one type of Communication Skill and at least one type of Leadership Skill.

Summary of Results

The purpose of this study was to determine what creates productive whole-class discussions. Numerous researchers in science and math education acknowledge that knowledge is constructed in a social setting (Bodner, 2003; Byrnes, 2001; Driver, 1994; Fergusion, 2007; Johnson, 1983; Kittleson, 2003). Cooperative learning groups have developed from constructivist ideas and their use is becoming increasingly popular within a diverse group of disciplines. Over the past ten years, several types of cooperative learning groups have developed (PBL, POGIL, PLTL, PLGI) to actively involve students in the construction of new knowledge. Whole-class discussions are being presented as a tool to enhance student learning and increase student productivity while working in cooperative learning groups. The enhancement involves the use of whole-class peer-led discussions to boost student learning. The intent of this study was to identify factors associated with productive whole-class discussions.

In order to answer the primary research question concerning what creates productive whole-class discussions several ideas needed to be operationalized leading to the development of five additional questions. Chapter 3 addresses the methods derived to answer each of these questions:

1. What is a *productive* whole-class discussion?
2. What behaviors are *students* exhibiting during whole-class discussions?
3. What behaviors are *peer leaders* exhibiting during whole-class discussions?
4. What kinds of *questions* are peer leaders asking?
5. Do the various peer leader *behaviors* interact with each other to create productive whole-class discussions?

After operationalizing what was meant by a productive whole-class discussion, the Discussion-Rating Tool was created in order to rate each of the eighty-four discussions. Each class session was then given an average discussion rating (ADR) and coded. In order to answer questions 2, 3, and 4, whole-class discussions were coded for (1) student behaviors, (2) peer leader behaviors, (3) and questions. A new instrument, Discussion-Rating Tool, was created to rate peer-led whole-class discussions. Lastly, time-ordered matrices were developed, providing a global snapshot of peer leader behaviors occurring each minute of a whole-class discussion leading to an explanation, answering question 5.

Whole-class discussions were coded a minute before they actually began due to the change in the class that occurred prior to the onset of a discussion. On some occasions a peer leader would look at their watch and a discussion would begin, other times, a peer leader would be observed going from group to group answering the same question and then stopping class to hold a discussion. Productivity was measured in terms of student involvement; the more students participated in the construction of knowledge and the less peer leader direction was needed, the higher the discussion rating. Discussion-Ratings ranged from *Bad* to *Good-Excellent*; no whole-class discussions were rated *Excellent* or *Superb.* Discussion-Ratings are not meant to label peer leaders as bad or good, only the productivity of their whole-class discussions. Since the Discussion-Rating increased with student participation, it seemed logical to look at student behaviors.

Student behaviors were coded throughout an entire class period. Codes consisted of visible activities that demonstrated levels of student involvement, such as asking questions, giving answers, shaking heads, talking, off task, and working together as teams. The behaviors observed consisted of both positive and negative behaviors. Two interesting findings resulted from this coding pass. First, it was interesting to note that the same kinds of behaviors were observed in all classes regardless of the average discussion ratings (ADR). Second, a notable difference in the classes was not so much student behaviors, as it was peer leader behaviors in each class. For example, in all classes there were students that freely volunteered to give answers, while others sat passively on the sidelines. In the classes with low average discussion ratings (ADR) peer leaders would continuously call on the few students that volunteered to speak orally. In the classes with higher average discussion ratings (ADR) peer leaders would call on everyone in the class at different times throughout the semester; all students were encouraged to participate instead of only a select few. The difference between classes was not student behavior, but peer leader behaviors in spite of student behaviors.

Five categories emerged from the coding process that described the kinds of behaviors exhibited by peer leaders during their peer leading sessions: Procedural Practices, Supervisory Qualities, Questioning Techniques, Feedback/Response, and Interpersonal Skills. Each category was made up of multiple subcategories, and each subcategory consisted of several different codes describing a similar activity. Each category consisted of positive behaviors and negative behaviors. Peer leaders exhibited behaviors in all five of the categories during each class session. Peer leaders either used routines, displaying positive Procedural Practices or they did not, in which case this would be coded as a negative Procedural Practices. Both positive and negative behaviors were observed for most of the peer leaders in all five categories. No patterns were revealed concerning a specific category of behavior. A pattern was, however, uncovered through coding peer leader behaviors, revealing that class sessions where positive behaviors out numbered negative behaviors resulted in whole-class discussions with higher Discussion-Ratings. While the pattern of more positive behaviors increasing Discussion-Ratings shed some light on the kinds of behaviors that are associated with productive whole-class discussions, it did not have enough substance. The category of Questioning Techniques was further analyzed to help tease out behavioral traits specific to productive whole-class discussions.

Coding for questions resulted in revealing seven kinds of questions being asked by peer leaders and students: information, procedural, clarity/elaboration, understanding, rhetorical, reflective, and verification, listed in order of peer leader use. Looking at the kinds of answers given by students and then listening to the peer leader's response to the student was helpful in identifying the intended goal of the question being asked. Coding peer leader questions aided in identifying reasons that questions were asked, while also revealing levels of peer leader understanding. Class sessions where students were asked to clarify and elaborate on a regular basis frequently had higher Discussion-Ratings. The researcher had expected peer leaders who frequently asked procedural questions, to have more productive whole-class discussions. This was not the case, and was the first of four personal assumptions to be revealed to the researcher.

Four assumptions were uncovered by contradictions during the coding processes. The assumptions arose from the categories created from coding peer leader behaviors and later developed into hypotheses. The combined hypotheses resulted in the construction of a framework predicting peer leader behaviors that create productive whole-class discussions (Charmaz, 2006).

Chapter 5: Discussion

Give a man a fish and you'll relieve his hunger for the day, teach a man to fish and you'll relieve his hunger for a lifetime.

Chinese proverb.

" A contemporary form of the proverb might read, Teach a student to memorize and you'll relieve his ignorance for a day; teach a student to understand and you'll relieve his ignorance for a lifetime."

.... Thomas Lord (2007)

Overview

The aim of this study was to identify the critical components needed to create productive whole-class discussions. Several books and articles are available for educators to read concerning lists of discussion rules stemming from individual experiences (Bligh, 1986; Neff and Weimer, 2003). There is also a vast amount of research on various types of discussions (Bligh, 1986; Dallimore, 2004; Neff, 2003), research on particular teacher practices (Furtak, 2005; King, 2002; Lin, 2008) and activities to bond students together (Johnson, 2005). There is, however, limited research on the critical components needed to create productive whole-class discussions. This study sought to fill the gap in the research on peer-led whole-class discussions and the behaviors needed to create productive whole-class discussions.

Classroom practices and behaviors of peer leaders directing small groups of students through General Chemistry I guided-inquiry activities were examined. The grounded theory analysis resulted in the development of a theory explaining the factors associated with productive whole-class discussions. The steps involved in this study led to: (1) the development of an instrument to rate peer-led whole-class discussions, (2) the identification and description of behaviors needed by peer leaders to lead productive discussions, and (3) the schema of how these behaviors flow together to create productive whole-class discussions. In this final chapter, the resulting theory will be discussed in relation to each of the five behavioral categories using participant profiles as examples of defining behaviors. During the discussion of each category, connections between each of the hypotheses will be summarized. Study results will be linked to findings from the literature and compared to the work of others. This chapter ends with a brief discussion of how the integration of these three categories can be used to enhance peer leader development and the implications these findings hold for future research.

The Theory in Grounded Theory

The purpose of the grounded theory methodology is to generate conceptual theory. That means that the grounded theory practitioner is in the business of finding patterns in data and naming them in a conceptual way that will bring together all of the variation and complexity that is in the data. Using the constant comparative method, analysts can create plausible theories that are grounded in the data, which can in turn be further analyzed by quantitative researchers (Glaser, 1965). A grounded theory study is not a verification study or a testing study. The purpose is to suggest a set of interrelated hypotheses about the main issue based on abstract conceptualizations, grounded in the data. Grounded theory is a predominantly inductive research method based on latent pattern analysis. The grounded theory method produces empirically grounded and robust propositions, hypotheses, or core variables. Grounded theories emerge every time the method is followed completely (Connell, 1997). The credibility of the theory, its substantive concepts, and the connectivity to the codes, depends on the fit to the data and the explanations that follow them. For this reason, in order to be clear and to show connectivity, the researcher took measures to describe each step and to explain each decision made throughout the study.

There is some disagreement as to exactly how one should go about doing grounded theory and what constitutes as a "theory." The disagreements concerning grounded theory processes surface from the unclear use of the word "theory". In this section what is meant by "theory" in Grounded Theory will be clarified. Social scientists with a positivist standpoint define a theory "as a statement of relationship between abstract concepts that cover a wide range of empirical observations" (Charmaz, 2006). Patton (2002) states that a theory has *explanatory* and *predictive* qualities. Lincoln and Guba (1985) use the term theory to depict an understanding that comes from the data instead of preceding them as seen when using conventional research methods (Lincoln and Guba, 1985).

The theory presented in this study reveals relationships, offers explanations, and comes from the data. It meets the criteria of Glaser (1978), Glaser and Strauss (1967), and Strauss and Corbin (1998). Glaser (1978) describes a theory as having four main parts: fit, work, relevance, and modifiability. Fit describes the manner in which the categories develop from the data. In other words, the categories are not proposed and then made to fit the data, but instead the categories arise from the data. Work refers to how well a theory provides explanations of what is occurring and forecasts what will transpire. Relevance or applicability arises automatically from grounded theory studies as the process emerges. The relevance of a researcher's focus comes from the data and does not need to be defended. Modifiability means that a theory must continuously be modified in order to fit to the data and this process should be on-going (Glaser, 1978).

Additionally, Glaser and Strauss (1967) state the purpose of a theory is to demonstrate relationships between what people are doing and offer explanations concerning the results of such behaviors. Theories developed according to their framework help to:

1) facilitate the prediction and explanations of behavior;
2) advance theoretical understandings about social interactions;
3) provide practitioners with an understanding that can be utilized;
4) provide a point of view on human behavior;
5) guide further research concerning specific foci of behavior.

In addition to looking at relationships between peer leader behaviors, this study looks at the relationships between categories. Strauss and Corbin (1998) place more emphasis on relationships among concepts than on storytelling. They define a theory as an array of interconnected categories (themes or concepts) that form a theoretical framework explaining some kind of phenomenon based on relationships occurring between events (Strauss and Corbin, 1998). A theory should not consist of just a group of findings, it should also offer explanations about the area being studied that can in turn advance knowledge and lead to further studies (Strauss and Corbin, 1998). Each of the definitions presented here illustrate the idea that theories arise from the data and offer explanations concerning social interactions. The theory presented in this study arises from the data and most definitely offers explanations concerning social interactions. This study uses the term theory according to Strauss and Corbin's interpretation, in that explanations are offered which answer the question regarding what creates productive whole-class discussions and can, in turn, spark further studies. The explanations in this study came directly from the data as a result of the coding process, which developed into categories, hypotheses, and in turn led to the resulting theory.

The theory that evolved from this grounded theory analysis states that productive whole-class discussions are not the results of one specific kind of behavior, but rather an integration of three sets of behaviors consisting of Communication skills, Interpersonal Skills, and Leadership Skills. This theory emerged from the process of observing video recorded peer-led class sessions, coding video transcripts, writing memos, and using time-ordered matrices to aid in visualizing behaviors occurring simultaneously.

Numerical Data

Although not part of the formal process, there were times when numbers, in the form of frequencies, were experimented with during this study. These frequencies were elaborated on in the methods and results sections. These numbers, however, did little to portray the different peer leader characteristics or to fully explain what was going on in each class. From the beginning of this study, there seemed to be a story to tell concerning what peer leader behaviors were necessary in order to create productive whole-class discussions. There were differences between each of the peer leaders, and the classes that had productive whole-class discussions were unlike those that did not. The classes with productive discussions were inviting, fun, more unified, and definitely louder. From the standpoint of an observer, there appeared to be more “work” going on in these classes and more “on topic” talking. The numbers resulting from questions or behaviors did not capture the real differences between the different discussions. The numbers did not completely inform the reader of the kinds of questions being asked, the kinds of procedures taking place in a room, or any of the many different kinds of distinctions occurring between the various peer leaders. Lost in the numbers were the sensitivities to how something was said, or the kind of facial smirks that followed comments, or the inadequacies of the eye contact (Eisner, 1998).

This does not mean that the work that involved numbers was a waste of time; on the contrary, the numbers reinforced the decision to do a qualitative study. The numbers, specifically in terms of how many questions each peer leader asked, helped to surface the idea that more was going on in each of these rooms than just asking questions. The numbers did demonstrate that questions were connected to productive whole-class discussions, while simultaneously acknowledging that there was more going on.

As a result of repeatedly viewing the videos and searching for patterns of peer leader behaviors in classes with productive whole-class discussions, several of the researcher’s preexisting beliefs became apparent. Disconfirming events brought about an awareness of these prior beliefs as well as revealing the incorrectness of them. The combined effect of the disconfirming events and the frequencies in peer leader behaviors led to the development of five hypotheses concerning the types of behaviors that do or do not lead to productive discussions. In the next section, participant profiles and literature supporting each of the five categories of behavior are presented; discrepancies between the participant profiles and the literature formalized the creation of the hypotheses.

Emerging Categories/ Hypotheses

Each of the five emerging categories will be briefly defined using profiles of peer leaders exhibiting strong traits specific to a single category to reinforce the resulting findings from this study. The categorical findings will be connected to the hypotheses, summarized, and linked to literature.

Procedural Practices – Hypothesis 1

Procedural Practices arose from looking specifically at classroom practices that determine how a class operates: the kinds of everyday procedures and policies utilized by the peer leaders. It was originally assumed by the researcher that the more methodical and orderly a peer leader was, the smoother the class would run, and the better the whole-class discussions would be. The literature supports this assumption and states that Procedural Practices are what separates effective instructors from ineffective instructors (Bafumo, 2005). Bafumo specifically stresses the importance of instructors being organized, planning lessons in advance of class, and wisely making use of all time. She explicitly lists how an instructor should be organized: right down to picking out clothes and laying them out before going to bed at night, packing a lunch, and making sure you know where your car keys are. From this line of thinking Hypothesis 1 was developed, which states that Procedural Practices (being organized and establishing routines) lead to productive whole-class discussions. Selena and Chantel's participant profiles reveal that while Procedural Practices are indeed their strongest suit, Procedural Practices did not create productive whole-class discussions. These profiles further support the findings revealed in the time-ordered matrices, that the implementation of one skill, in isolation of at least two other skills, does not lead to productive whole-class discussions.

Selena. Selena participated in the peer-leading program for two fall semesters. Selena was extremely procedure oriented. Selena averages about three discussions per class session and had an average discussion rating (ADR) of *Fair.* Selena tried very hard to follow all the guidelines stipulated in peer leader training. She did not permit late students to take quizzes when they arrived late to class and she used roles in the strictest sense. This peer leader only listened to questions from the manager and did not talk to anyone but the manager. Selena did not seem to understand the function of the roles and in turn used them as concrete rules that had to be followed to the letter. Selena's use of speaking to the manager only was a non-productive use of this procedure. She asked the class if they had questions and then only answered questions from the manager. This was faulty because students have not been given an opportunity to speak to each other, there is no way for the manager to know what the students' questions are. Petrie (1998) claims that by teaching students classroom procedures right from the first day of class, that many disruptive behaviors can be stopped. This was not Selena's experience. In the following excerpt, we can see how Selena's rigid use of rules only led to frustration.

Scene ID Segment from Selena-s Video:

228	O [00:30:44.11]:	PL walks to another table (Group 4):
229	Ss 1 [00:30:54.21]:	I think that is 6, isn't this 1,2,3,4,5,6. Cause we found out Mn was 7. So 7
230	Ss 2	Okay
231	Ss 1	So it goes by order
232	PL [00:31:04.04] :	Okay, I have a question. How is your group doing with the homework?
233	Ss 2 [00:31:09.05] :	Not so good. We're trying.
234	PL [00:31:11.10] :	Are you almost...almost finished?

235	Ss 1 [00:31:15.18] :	(Another Ss interrupts PL talking to the manager) we have questions but they… we have questions they just don't get answered. I mean none of us…we're all the same path but it's really... I
236	PL [00:31:22.07] :	(Peer leader interrupts students) what is your question?
237	Ss 1 [00:31:22.16] :	It's like… it's like basically with that...
238	PL [00:31:26.22] :	(PL interrupts) why don't the manager ask me the question?
239	Ss 2	uhhh
240	Ss 1 [00:31:31.24] :	I…why don't we have to go in that type of form…I mean we're all…
241	Ss 2 [00:31:33.28]:	I mean if someone has a specific question and it doesn't always like get asked directly if we're trying to…like uh translate it...
242	Ss 1 [00:31:36.00]:	That's how you learn...you ask questions and you acquire knowledge...
243	PL [00:31:43.01] :	Maybe this would… this would actually practice the rephrasing skill that way
244	Ss 2 [00:31:49.26] :	What's your question?
245	Ss 3 [00:31:51.04]:	...Okay for the five zero oh four...to charge one divided by...right? Would the Cr equal six?
246	Ss 2 [00:32:05.23]:	....for the CrO4 what's the Cr equal 6 for the oxidation order...
247	PL [00:32:17.15] :	ummm what does the rest group think about that?
248	O [00:32:18.19]:	Ss laugh and hold their heads
249	Ss 3 [00:32:25.11] :	Yes, we all think that its 6. We're not quite....
250	Ss 2	Forget it, I give up!
251	Ss 1	(Laughs)
252	PL [00:32:44.29] :	Any questions?
253	Ss 1&2	(Laugh and are clearly frustrated)
254	Ss 1 [00:32:49.15] :	It's we have questions but they don't get answered. We're just asking...
255	Ss 2 [00:32:50.03]:	Just forget it.
256	Ss 1	All right…its just I see a big in my opinion I see a big fault in this whole entire program. Its like we're not learning anything, I mean we could be doing this for sitting around at the library and we probably get more done by doing that. I mean I've gone to Dr. GenChem and I asked him but it's just not making any sense with this program is here for. I mean I'm not saying anything bad about you or anything but the system right here…I ask questions and they don't get answered...like what do we do?
257	PL [00:33:31.04] :	Well, in that case ummm I try my best to answer...
258	Ss 1 [00:33:36.09] :	(Ss interrupts PL but she does not stop talking) I'm not saying that you're doing anything wrong with it…
259	PL [00:33:37.03] :	...what specific question whatever and umm I would like to follow what I'm supposed to. You know I'm supposed to give certain tasks and certain way to do it and that's what I'm supposed to follow and that's what I'm trying to do and I believe that if you just…because my role…personal rule is that I don't give answers I ask questions in return of questions ... and I believe that …that way and that's what we believe in our class when our teacher teaches us this is way you will remember more better if you find your own answer instead of me giving you the answer.
260	Ss 1 [00:34:14.00] :	Okay
261	PL [00:34:14.02] :	So that's… that's why I'm just trying to make you think a little bit and may be you find it funny or when or suppose practice about manager asking me questions and umm if...I mean if the whole group has a question... a particular question you're really confused I try to ask questions and if you don't understand that then maybe we will...
262	Ss 1 [00:34:39.12] :	When we ask a question you answer that with another question and…
263	PL [00:34:42.00] :	I ask questions… which would guide you in a right direction

264	Ss 3 [00:34:47.05] :	How did your question guide us to the right direction? Because when we asked you, you said, "what does other group member think?" how does…
265	PL [00:34:53.06] :	And which is I want other members input on the question because…
266	Ss 4 [00:34:56.24] :	I'm sure ...like okay so she got the answer negative six...positive six...but then I think that's the right answer....
267	PL [00:35:06.07] :	Okay, then if the whole group is having difficulty with this the same thing I would like you to move on to something else and when we have a presenter report we go over that.
268	Ss 1 [00:35:20.06] :	Okay
269	PL [00:35:20.06] :	That's what I was trying to explain
270	Ss	All right
271	O	Peer leader walks over to another group and asks if they have any questions.

Selena is trying very hard to follow the guidelines taught to her during peer leader training but she has not learned how to use these rules to help students learn. In a short small group discussion, she asks do you have any questions four times (lines 236, 238, 244, and 252). Three other questions are asked: line 232 – how is homework going, line 234 – are you finished, line 247 - what does the rest of your group think. She does not ask any questions that would guide students to understanding. The data from Selena's class session does not support the findings of Petrie concerning procedural training taking care of disruptive classroom behaviors. Instead, Selena's lack of understanding and improper use of procedures added to student levels of frustration. This supports the work of Sharpe (1998) who states that student-instructor relationships can be destroyed from a lack of student understanding about classroom procedures.

Chantel. Chantel only participated in the peer-leading program for one semester. Chantel was also a very procedurally oriented peer leader. She averaged two and a half discussions per class with an average discussion rating (ADR) of *Fair*. Chantel is very nice, follows the rules and formats, but almost hides behind them. She follows the schedule to the letter and does exactly as she was directed in the peer leader training class. Coding the peer leader's behaviors revealed that while she utilized many Procedural Practices, she did not grasp the non-verbal ideas being taught during training.

Chantel's behaviors demonstrate that she "knows" what to do, however, her behaviors also reveal that she does not understand "why" she is doing something. For example, Chantel does not observe each group very carefully; she moves from group to group but does not pay attention to what each group is doing She is very nice, considerate, and polite to her students but she does not pay 'attention' to details. The many things the peer leader coordinator does during a training session such as looking at each person's answers in a group to make sure everyone is together were unseen to Chantel and she did not therefore practice these skills. She does not know what the problems are, or appear to know why they are going over them. She does not observe group answers, or notice where students are. What she does, appears to be very mechanical. She talks more than her students do during whole-class discussions. She does not really offer much help when it comes to student questions in their small groups, she puts students off by saying we will cover it in the presentations. Chantel's use of procedures in isolation of any of the other skills did not support the work of Bafumo (2005) that organizational and procedural practice separate effective instructors from ineffective instructors. Chantel's whole-class discussions were very mechanical and had an average Discussion-Rating of *Fair*.

When comparing peer leaders with the highest and lowest average discussion ratings (ADR), Procedural Practices had the lowest frequency of occurrence in the higher rated discussions and the third highest in the lowest rated whole-class discussions. The data revealed that Procedural Practices are not as important as the literature made them out to be. The pattern identified here was that peer leaders who put a strong emphasis on Procedural Practices did not have average discussion ratings (ADR) in the top five. This finding was contrary to what was expected by the researcher and contrary to the literature, as discussed in Chapter 2 (Bafumo, 2005; De Smet, 2007). The literature stated that the time it took to establish routines would pay for itself in the end (Hennick, 2007). Too much emphasis on Procedural Practices did not single-handedly lead to the development of productive whole-class discussions. The profiles of peer leaders with an emphasis on Procedural Practices support the results revealed in the time-ordered matrices, that a focus of one skill does not lead to productive whole-class discussions.

Supervisory Qualities

In order to use Procedural Practices well, a peer leader needs to have Supervisory Qualities. The behaviors listed as Supervisory Qualities describe specific behaviors attributed to leadership qualities. While Procedural Practices describe the rules that a peer leader adheres to, Supervisory Qualities describe the behaviors a peer leader demonstrates involving management issues. Kunter (2007) suggests that there is a positive correlation between classroom management skills and student levels of interest. According to the results of questionnaires administered to 1900 students at various levels of completing their academic studies, students thought that having constant supervision helped the day-to-day operations in a class setting to operate smoother (Kunter, 2007). In Kunter’s study, *constant supervision* refers to the collective branch of management skills that promote active student involvement and aid in the smooth transition from one activity to the next. While Kunter does not use the term leadership, she specifically discusses the same issues coded for in this study: i.e. classroom management, attentiveness, focused, maintaining momentum, and using time wisely. The results of this study support the findings of Kunter in revealing that classroom management skills are critical to creating an environment that fosters learning, however, classrooms that focus primarily on “discipline and rule adherence are not optimal” (Kunter, 2007). Michael’s participant profile support the findings revealed in the time-ordered matrices, that while Supervisory Qualities was Michael’s strongest suit, Supervisory Qualities in isolation of two other traits, did not create productive whole-class discussions.

Michael. Michael participated in the peer-leading program for one fall semester. Michael’s strongest behavioral trait consisted of supervisory skills. Michael averaged two whole-class discussions per class session and had an average discussion rating (ADR) of *Poor-Fair*. In Michael’s class, it was very apparent who the “boss” was. Michael was smarter; he was clearly in charge and was often seen telling his tells students what they should be doing. This passage from a memo written immediately after watching one of Michael’s video sums up all of the observations written about his class sessions:

Memo from Michael-2:

Michael is very up tight and comes across as an authoritarian. He is not mean or necessarily bossy but he is so serious and logical. You can tell from the things Michael says, that if students don’t understand something, it means that they are not reading their books or listening during lectures. As an outside observer, I thought Michael was one of our best peer leaders. Every time I walked by his room, his boards were covered and students were working. Now that I have watched his videos repeatedly, I see that he uses more of a lecture format. He reminds me of some of the chemistry professors that I have had, who claim that if one reads and studies more and it will all make sense. If you believe that knowledge is transmitted from ink to brain then that may be true, but it has not been my experience with too many things.

Michael's discussions (both small group and whole-class) were not productive. According to the literature, Michael's students would have preferred his constant supervision and adherence to the rules, if only Michael had created an environment of trust rather than authority (Kunter, 2007). The discussions occurring in this room were more about students getting the right answers while the peer leader did all the explaining. Students were missing the active levels of involvement that dealt with being open and being permitted to think aloud (Yazedjian, 2007).

When comparing the frequencies of Supervisory Qualities between classes with *Good* whole-class discussions to classes with *Poor* whole-class discussions, Poor whole-class discussions had the second highest number of positive occurrences in all five categories of behavior. Supervisory Qualities also had the second highest number of negative occurrences in all five categories of behavior. This implies that peer leaders understand the importance of using Supervisory Qualities but that they need to learn a balance between being an authority and being an authoritarian. Peer leaders need to develop managerial skills enabling them to work with students rather than becoming overt managers working over students as dictators. Michael did not develop a level of trust with his students that encouraged open lines of communication or willingness on the part of his students to share freely. According to Staples (2007), the role instructors play when engaging students in active learning environments should involve practices that build on student ideas and aid in creating a shared environment. Michael's authoritarian perspective and his sense of "if I don't tell them, how will they learn" turned his small group activities into a kind of mini lecture session. Michael and his class would have both benefited from a more open kind of dialog. Michael would have gained a greater understanding about specific ideas that students were bringing to class and students would have benefited by being able to explain their ideas to each other. These results support the findings revealed in the time-ordered matrices that Supervisory Qualities do not single-handedly lead to the development of productive whole-class discussions. No hypothesis developed from this categorical finding.

Questioning Techniques – Hypothesis 2 & 3

Questioning Techniques arose from looking specifically at questions being asked by peer leaders and students alike. The first look at questions involved categorizing them according to their perceived intent. From the categorization process, coding questions diverged into coding skills associated with questions in order to develop a more complete picture about entire Questioning Techniques. The techniques included how questions were asked, when they were or were not asked (missed opportunities), and the amount of time between the question and an answer. It was originally believed by the researcher that questions would be the number one cause of productive whole-class discussions. Hypothesis 2 and 3 developed as a result of the coding that took place while looking at the numbers and kinds of questions asked.

Derron asked 100 questions during a class session and had an average discussion rating (ADR) of *Poor* for that class. As discussed previously, just asking many questions did not mean that productive whole-class discussions would occur. Just asking a variety of different kinds of questions also did not lead to productive whole-class discussions.

The number of questions being asked by peer leaders had no effect on the average discussion rating (ADR) for any class session. The kind of questions asked, however, did play a role in average discussion rating (ADR). The observation that the more clarity and elaboration questions a peer leader asks, the higher the average discussion rating (ADR), supports the findings of Kirkton (1971) who studied discussions in English classes well over 37 years ago and stated that ineffective whole-class discussions were due to the kinds of questions being asked by instructors. The questions being asked by instructors need to stimulate student thinking by pushing students beyond algorithmic answers and towards creating conceptual understandings; in this study, that is the definition of clarity and elaboration questions. When peer leaders ask many information and procedural kinds of questions, these do little in the way of stimulating students to think.

Scene ID Segment Derron-2 Video:

(53)	Observation:	While PL can be found in the front of the room at the board. This is not a class discussion. It is more of the pl asking questions to one group and writing on the board.
(54) Information	PL [00:05:20.15]:	Equals n r t, right? What are the constants?
(55)	Ss [00:05:26.13]:	r?
(56) Information	PL [00:05:27.27]:	r is always a constant. What else is it telling you? What else, what else is constant?
(57)	Ss [00:05:32.08]:	Temperature
(58) Information	PL [00:05:33.28]:	Temperature's constant, and what else would be constant?
(58)	Ss [00:05:38.11]:	The volume?
(59) Information	PL [00:05:42.24]:	What else is constant in this equation? We got r and t, what else? hmmm?
(60)	Ss [00:05:51.01]:	Number of moles
(61) Understanding	PL [00:05:50.28]:	Right, the number of moles, do you understand why?
(62)	Ss [00:05:53.29]:	Don’t know
(63)	PL [00:05:55.04]:	…you’re not losing, there's no hole in there, you're not going to lose any amount of material, any amount of gas.

The dialog above demonstrates the frequency and level of questions asked by Derron during a class session. Derron asked frequent questions and used six of the seven kinds of questions classified in this study and still had the next to lowest rating found in any of the whole-class discussions in this study. Derron frequently asked questions at the information level of understanding. He asked questions in a question-answer, question-answer format and then asked students now do you understand?

In a meta-analysis by Wilen (1986), effective questioning practices were examined revealing that student achievement was positively correlated to questions. Wilen also reported that questions alone did not increase student understanding, but rather a combination of eleven effective questioning practices. Wilen classified questions into three different categories: procedural, low and high cognitive level questions. Wilen addresses the conflict between the use of low and high level cognitive questions, and concludes that high level questions are generally related to effective teaching. These results are similar to the findings presented by Boyd (2006), who classified questions based on the kind of answer they solicited. The conclusion of Boyd's study reiterated that it was not simply the kind of question but rather the combined effect of a teacher building on student responses to questions that led to the practice of effectively using questions. The results of Wilen and Boyd are substantiated by further analysis of peer leaders like Derron. The participant profile below demonstrates that merely asking many questions, especially low-level questions, does not encourage students to openly participate and share in discussions. Additionally, Derron's ineffective use of questions is further weakened by the quality of the Feedback/Responses being provided to students after they answer a question. The combined effect of asking numerous low-level questions and providing weak feedback results in the producing poor whole-class discussions.

Derron. Derron participated in the peer-leading program for two fall semesters. Derron's strength could be classified as a combination between Supervisory Qualities and Questioning Techniques. Derron is a no-nonsense peer leader. He averaged two whole-class discussions per class period and has an average discussion rating (ADR) Poor-*Fair*. Derron is one of four peer leaders with an average discussion rating (ADR) of *Poor*; it is the next to the lowest score on all thirty-four videos. He was good at asking questions, but they were mainly directed at one or two students. He does nothing to help the group function as a group by encouraging teamwork. In the class session where Derron had his lowest Discussion-Rating, the category that he had the highest number of marks in was Questioning Techniques, in negative responses to students. The next highest number of tallies for Derron was in positive questions, but the negatives outweighed the positives. There were not enough questions to balance out the number of times he told students answers.

Student questions are a valuable class tool that can aid in depicting the conceptions and misconceptions held by students that would otherwise go unnoticed in a large lecture setting (van Zee, 2001). The overall findings of this work, based on looking at the questions being asked by peer leaders, support the work of others, which stress the importance of questions during whole-class discussions. This study, however, takes it one step further and simultaneously demonstrates that when students are continually asked to clarify their ideas and elaborate on their thoughts, both when working in their small groups and during whole-class discussions, there is a greater tendency for students to participate during whole-class discussions.

Feedback/Responses – Hypothesis 4

The category, Feedback/Responses, arose from the many different ways that peer leaders responded to students. Sometimes a peer leader would answer a question with information that could be classified as advice, consisting of recommendations concerning the next step. Other times a peer leader would give a response that was more of an answer than feedback that could be used to produce an answer. Like each of the previous categories, this category consists of positive and negative forms of feedback and responses. This category includes positive behaviors that encourage students to build on information learned earlier and move students towards understanding.

According to Durham (1997), little information is known regarding instructor responses to students. As analysis of the different categories developed, it became obvious that instructor feedback interacts with a multiple of different categories. In the study described in this dissertation, it was easy to tell that some kind of feedback or response was being given. This category, however, had much overlap with the other categories and was often coded with multiple codes. For example, a response to a student could be a classroom management procedure (coded as Supervisory Quality) or a question of some sort (coded also as a Questioning Technique), or a playful response (coded as Interpersonal Skills).

Nina, had enough positive traits in this category to warrant saying that Feedback/Responses was one of her strengths, but because this was not Nina's strongest suit, her profile will not be given until we look at interactions. One unique behavioral trait that does deserve mentioning at this time, however, is the neutral manner in which she continuously used to respond to students. It is generally not possible to tell from Nina's responses if an answer is correct or not. For example, she repeats students answer and says "those all sound like good possibilities. Right?" or "What do you guys think about that?" "Do you think it's a good explanation that he gave?" "Everyone has the same answers?" She continuously asks questions, but does not imply that an answer is right or wrong; instead, she continues to ask questions until everyone says what the right answer is. What is unique about observing this trait in Nina is that while other peer leaders were occasionally seen asking the same sorts of questions, Nina was always observed responding with neutral responses.

The fact that this particular category had the lowest number of positive occurrences and the highest number of negatives occurrences in both the low and high rated discussions helps to explain why none of the whole-class discussions viewed for this study were rated as *Excellent* or *Superb*. As Keefer (2000) concluded, it is essential that instructors learn to provide effective feedback that aids in developing classroom discussions. The low frequencies of positive feedback and the average discussion rating (ADR) of *Fair* indicate that peer leaders also need to learn to provide effective feedback. Strategies to teach peer leaders this skill will be presented later.

Since Feedback/Responses were coded based on how a peer leader provided feedback that could be utilized by students, the idea began to develop that perhaps, ineffective feedback was linked to a lack of peer leader content knowledge. Content knowledge refers to an individual's understanding about a particular discipline. This term, used widely in educational fields, conveys a level of understanding concerning the discipline being taught. In a preliminary study by Roehrig (2004), a lack of content knowledge was found to be a limitation in establishing inquiry-based activities in classroom settings, because teachers are unable to direct students towards understanding without directly lecturing or giving answers.

Hypothesis 4 developed from the idea that a peer leader's content knowledge could be observed through the kinds of Feedback/Responses given to students. Hypothesis 4 states that content knowledge would generate productive whole-class discussions. The idea that content knowledge could be directly observed is based on the belief that an individual can gauge how much a peer leader understands the material from the kinds of Feedback/Responses given.

Many feel that content knowledge is a key component for being an effective instructor (Elliot, 1997; Evan, 2002). Several efforts have been implemented into instructor training programs to evaluate content knowledge of beginning instructors. For example, qualifying exams over the various disciplines must be passed, GPA's must be 2.5 or higher in courses taken that reflect the area of teaching focus, and three letters of reference are required from professors within the major area of concentration (Fiene, 2004). These kinds of requirements demonstrate the belief that content knowledge in a particular discipline is important to being an effective instructor. A lot of weight is put on instructor exam scores: without a passing score, no teaching license is issued. In many states, teacher exam scores are made public and ranked across different counties within a state. The assumption is made that the better the test score, the better the pre-service candidate will be as a teacher (Fiene, 2004).

Although this study is not dealing with beginning teachers, the idea that content knowledge is critical in being a good teacher is also observed at the university level. For example, it is assumed by the college that if you have a Ph.D. in a subject, then you should be able to teach it; by the department that if you are a graduate student, you should be able to teach an undergraduate level course; and by PLGI administrators, that if you have taken General Chemistry II and passed with an A or a B, you should be able to effectively lead students through selected General Chemistry I activities with content review.

The assumption that successfully taking a course or passing a test entitles you to be able to lead productive whole-class discussions, guiding others to an understanding of a particular subject, was not supported in this study. Several different class sessions (Michael, Steven, Derron) where the peer leader demonstrated an understanding of the concepts learned in General Chemistry I, resulted in poor whole-class discussions. Poor whole-class discussions occurring in classes where the peer leader has a very good understanding of the subject matter are indicative of the need for pedagogical content knowledge training in peer leader training sessions. Pedagogical content knowledge (PCK) refers to the methods and strategies involved in teaching (National Science Teachers Association, 1998). This is also one of the reasons that chemical education is so important, content knowledge alone does not automatically make someone an effective chemistry teacher.

The videos analyzed in this study support the hypothesis that content knowledge alone does not necessarily lead to productive whole-class discussions. The conclusions drawn from this part of the study support other findings in educational sources that state,

“…expertise in a discipline is not a guarantee of success at teaching…” (Ryan, 1984). Several researchers have stressed the importance of combining content knowledge with pedagogical understandings (Emerson, 1997; Evans, 2002; Shulman, 1986; Zohar, 2006). Each of these studies demonstrated that content knowledge or pedagogical knowledge were not helpful in isolation of each other. Lloyd (1998), when comparing beginning teachers in England and Singapore, concluded that teacher programs should emphasize pedagogical knowledge in addition to teachers' subject knowledge. One would be inclined to think that if content knowledge does not automatically make a teacher effective, it would not be responsible for making peer leaders effective.

Merely making peer leaders aware of different strategies utilized within a body of PCK practices is not the answer to creating productive whole-class discussions either. Roehrig (2004) used four factors to predict a teacher's ability to successfully utilize inquiry activities in class. The results from Roehrig's study indicated than none of the factors: content knowledge, nature of science viewpoints, teaching beliefs, and pedagogical knowledge in seclusion of the other factors were indicative of successful inquiry-based implementation. Other studies have similar outcomes, suggesting that it is not just a matter of content knowledge but that strong Interpersonal Skills are needed (Ertmer, 2003). The results of this study support and link together the work of Roehrig and Ertmer by demonstrating that interactions between several behaviors lead to productive whole-class discussions. One of the behaviors continuously associated with productive whole-class discussion, was Interpersonal Skills.

Interpersonal (or Social) Skills – Hypothesis 5

Interpersonal Skills include the behaviors exhibited by a peer leader that describe social interactions. This includes personality traits, sensitivity, and rapport building traits. Ertmer (2003) studied the components necessary to be a successful peer coach for beginning teachers. The results of Ertmer's study suggest that a coach's personality traits are the most important quality and vital to building relationships of trust with students. Seventy-seven percent of the participants in Ertmer's study stated that personality was the "most important" aspect to being a good coach. Hypothesis 5, that Interpersonal Skills created productive whole-class discussions, was supported by the literature. The results of this study are somewhat in agreement with Ertmer that personality is very important. However, the results of this study suggests that even Interpersonal Skills alone do not lead to productive whole-class discussions on their own.

James. James participated in the peer-leading program for one fall semester. James has great Interpersonal Skills and relates well to his students. James had one discussion per class session and an average discussion rating of *Fair*. James played, joked around, and presented himself as very approachable to his students. James's students clearly liked him; this was directly observed as well as read in the student evaluations. He was funny, energetic, and animated. However, James did not buy into many of the guidelines established for peer leaders. Each week James would write in his journal how much he disliked having students use roles and how much he really disliked the suggestion to ask questions instead of giving answers. James wrote long, sarcastic, and derogatory journal entries about the methods he was being asked to use in his class sessions. One week James wrote about leading his class session using a recitation format. This was the only week that he felt as if he did anything to help his students understand chemistry concepts. James's students reflected his attitude concerning the usefulness of these peer-leading sessions. More than two-thirds of his students said they did not feel like they benefited from these small group sessions, however, his students made positive comments about how helpful James had been in trying to help students learn new concepts.

James's attitude, in addition to his mediocre whole-class discussions was the second clue that personality alone was not enough to warrant good whole-class discussions or peer leading sessions. James was an extremely personable young man, but his condescending, sabotaging remarks about the peer leading process hurt his peer leading sessions. James seemed to be using the system to explain his own inabilities to help students understand. Most of his students reported that class would have been better if the peer leader had been allowed to give answers. Students do not need to know that peer leaders do not give answers. Peer leaders should be more helpful in helping students to arrive at getting answers. While James demonstrated that he knew his chemistry, he was not sure about how to help students arrive at the right answers. He only knew what the correct answers were and he only had a limited understanding about why something was the correct answer. Observations in James's classes showed that his students were dependent on him. James's students did not ask specific questions about concepts, instead students waited for James to ask questions, at which time students would respond with short one-word answers. There was no evidence of any kind of thinking on the part of the students. James's students were not willing to take risks and to participate in whole-class discussions. James worked hard at keeping students' interest, in addition to drawing out factual knowledge from students in an effort to "teach" the concepts. This observation supports Fassinger's (1995), conclusion that professor traits (such as giving praise, being inviting, and encouraging questions) do not help to explain student interactions and levels of participation. Fassinger concluded from his study that students create the classroom climate, rather than the instructor. Fassinger's study was not the results of actual classroom observations but instead a Likert scale summary given to students several years after completing a program, leading one to doubt the credibility of student responses, years after a course is finished.

At this point in the study, things were getting a little frustrating. There was literature stating that each of the individual components uncovered during the coding process increased teacher effectiveness and developed trust with students. However, when examining each of the participant profiles and comparing peer leader whole-class discussions with individual traits, no pattern was visible. There were no direct relationships between productive whole-class discussions and peer leaders being strong in any one of the five categories: Procedural Practices, Supervisory Qualities, Questioning Techniques, Feedback/Responses, or Interpersonal Skills.

Interacting Categories

The results of this study revealed that creating productive whole-class discussions was an integration of at least three behaviors, rather than just one specific kind behavior. Each of the hypotheses deal with observed behaviors that do not lead to productive whole-class discussions. Peer leader characteristics that hindered student development were much more obvious to the researcher than behaviors that encouraged productive whole-class discussions because it was very easy to see when students refused to participate or when they immediately shut down. On the other hand, while an observer may think they see behaviors that encourage student participation in one video, the same behaviors did not have the same results in the next video. This was eventually labeled as an interaction factor that occurred because of several categories interacting in a given classroom setting. Profiles of peer leaders strong in more than one category were examined next, in order to see where two or more variables might have jointly interacted to produce productive whole-class discussions.

Lydia

Lydia participated in peer leading for two years. She had aspirations of becoming an M.D. Lydia's greatest strength was her use of Procedural Practices. If a poster child for peer leading were needed, Lydia would be the person for that. She is organized and prepared; everything runs orderly and flows smoothly. The students really seem to like her. She is very nice on a consistent basis and really seems to care about each student in her class. Lydia's classes, however, lacked personality. They are very dry and regimented, with students talking quietly before writing answers on the board, followed by brief explanations from students concerning how these answers were derived.

Lydia does everything straight by the book with no deviation or personal interjections. Everyone in Lydia's classes appears to be working, even the peer leader. Lydia works differently from many of the other peer leaders in that she does not explain and lecture, but instead she coordinates who would write or explain what question. She keeps notes of things that were going on in class so that she can accurately report in her journals what happened in class. Her journals are long and included every detail about who reported what questions. Lydia does great on-the-spot thinking, using information given by students for pop quizzes given at the end of class. These closure activities demonstrate that Lydia understands the subject to come up with questions off the top of her head.

Lydia averages five whole-class discussions per class. She holds short but frequent *Fair* whole-class discussions. The whole-class discussions were more of an oral problem checking session than a discussion, however. Lydia established trust with her students, ensuring confidence that she would not let them present wrong answers to the class. Lydia has a unique way of taking a question asked directly to her and inviting others to work together encouraging teamwork. Lydia's responses are very useful to students, without telling students the answer.

Lydia's success as a peer leader does not seem to be directly linked to one behavior only but more of an integration between a couple of different categories. Lydia's Feedback/Responses enhanced her consistent implementation of Procedural Practices. Even with this interplay occurring between two different categories, Lydia's average discussion rating (ADR) was still only *Fair*.

Ultimately, multiple strengths were needed in order to support good whole-class discussions. The decision to look at multiple categories of behavior is supported by the work of Roehrig (2004) in her study to determine the kinds of constraints that beginning secondary science teachers experience in the implementation of inquiry-based lessons. Roehrig concluded that the presence of one strong skill was not enough to successfully implement the use of inquiry activities. In this study, the Discussion-Ratings indicate that some peer leaders do have *Good* whole-class discussions. But what number of categories must one be strong in, in order create productive whole-class discussions?

Time-Ordered Matrices

Patterns of strengths in multiple categories that lead to productive whole-class discussions did not appear until late in the study, when the researcher began to use time-ordered matrices to help see interactions between each of the various coded categories. Miles (1994) describes time-ordered matrices as tools designed to help demonstrate patterns in the data by chronologically organizing events and helping to reveal trends. This manner of organizing the data proved to be extremely helpful in this study. The time-ordered matrices demonstrated that when positive interactions were occurring between three or more of the behavioral categories for several minutes at a time, productive whole-class discussions were created. Five whole-class discussions had Discussion-Ratings that were rated *Good-Excellent*, and each revealed a triadic behavioral pattern. As described in Chapter Four, the triadic behavioral pattern does not mean that the exact same three categories of behaviors showed up for each of the five higher rated discussions, but instead means that three of the five categories of behaviors occurred simultaneously throughout a discussion. The patterns of interacting behaviors were revealed in the time-ordered matrices and further exemplified by examining additional peer leader profiles.

Nina. Nina participated in the peer-leading program for one semester. Nina held a little more than two discussions per class session and had an average discussion rating (ADR) of *Fair-Good* (2.7), which was the highest overall average discussion rating (ADR) of all the peer leaders. A single strong suit could not be identified for Nina. She went back and forth between Supervisory Qualities, Questioning Techniques, Feedback/Responses, and Interpersonal Skills. A low observance of Procedural Practices does not mean that Nina did not have routines set up for students to follow, it just means that she did not make a big deal out of them. As evident in Table 4.2 from Chapter Four, Nina had one of the highest average discussion ratings and exhibited many behaviors from the remaining four categories. Students turned in their homework in neat piles in the front of the room as they entered and she returned them as she collected their quizzes. Nina was a very good peer leader. She was cordial, friendly (Interpersonal Skills) and in control without being intimidating or bossy (Supervisory Qualities). Students were willing to do what she asked them to do, indicating that some level of trust had been established.

One of Nina's most notable differences, in terms of leading a whole-class discussion, was the manner in which she responds to her students, her tone (Feedback/Responses). As previously discussed in Feedback/Responses a student could not tell from her voice or response if an answer was correct or not. She did not, however, generally leave students without first giving them a concrete picture of what to do or where to go next. Her questions do not appear to be clustered questions geared towards a single answer but more of a way to take what students were saying and move forward from there (Questioning Techniques). Nina responds to each and every student that addresses her, but does not become engaged in activities that are not important to this class. Her responses to each student seem genuine in a way that appears to make them all feel special and important.

Reading over Nina's end of the year evaluations, every one of her students had positive things to say about her. All but three of her students said they would take Chemistry II using small sessions, if this option was available. Drop out rates are extremely high in General Chemistry I, with ending peer-leading sessions in this study having around 8-12 students. Nina had seventeen students attend on the last day of the session, only one week before the end of the semester! Students also wrote on their evaluations that they found the reporting out sessions (whole-class discussions) helpful and their peer leader was very polite. Nina was asked to take over for another peer leader late in the semester; in the final evaluations for this room, all of the students mentioned that they liked the new peer leader (Nina) better than their first peer leader.

In addition to the literature supporting each of the behavioral categories, literature also addressed the way that Nina did not give students answers, or imply if they were right or wrong, instead Nina would encourage other students to say when and if something was right or wrong by explaining it. Nina achieved this by using nonverbal techniques to help keep students on track (Petrie, 1998). As mentioned in Chapter 2, nonverbal techniques include body language (such as smiling, frowning, and crossing of arms), helping to convey friendliness and aid in building relationships with students. Nina exhibited positive nonverbal skills by not call attention to misconduct and quietly taking care of the misbehaviors unbeknownst to the rest of the class or group. She was not observed embarrassing a student by getting on to someone or calling out poor behaviors, not even in a playing kind of way.

Alice. Alice participated in the peer-leading program for two years during her sophomore and junior semesters. Alice had two discussions per class session and had an overall average discussion rating (ADR) of *Fair-Good* (2.4). Alice presented herself as a vibrant, bubbly, and exceptionally personable peer leader. She was cheerful, friendly, encouraging, and accommodating to her students. She was quick at defusing situations when students would challenge her, by taking the blame for a miscommunication. On two occasions Alice was slightly challenged by her students. Students claimed that she had not told them something and they were not clear about what to do next, she had no problem quickly admitting that she was in error. Alice would say, "I'm sorry I must not have explained myself clearly, " then she would explain something again or she would take the blame and immediately stop a situation before it escalated. In other words, she defused most awkward settings quickly and smoothly with little incidence. She would take the blame, laugh, explain it again and move on.

One of Alice's whole-class discussion-ratings was a *Good* (2.75). During the class discussions held during this class session, Alice spoke very little. Alice frequently began her discussion using a round robin method where each group would say their answer. Using this method groups with different answers would become apparent leading to whole-class discussions explaining how each answer was derived. Alice did not come across as an authoritarian, but she was in control. Alice had good classroom management skills, encouraging students to work together, staying on track and focused (Supervisory

Qualities). She had the ability to laugh at herself and gave the impression that she truly enjoyed what she was doing (Interpersonal Skills). Alice was very attentive to the small groups, held on average at least two discussions per class, and was frequently heard singing as she went from group to group asking questions (Questioning Technique).

The major difference when comparing Alice's two average discussion ratings (ADR) is the discrepancy between the different categories of behaviors coded during each class session (Table 4.2). During Alice's class session with an average discussion rating (ADR) of 2, only one positive behavior was salient, her Interpersonal Skills. During the class session with an average discussion rating (ADR) of 2.75, three behaviors: Procedural Practices, Questioning Techniques, and Interpersonal Skills were noted. The range between the positive numbers of categories support the findings revealed through the time-ordered matrices.

Summary of Study

After having the triads of behavior revealed through participant profiles such as Nina and Alice, and using the time-ordered matrices, the literature was reviewed to see if other researchers had noticed this interconnection between behaviors. The closest thing found to the conclusions that came from this study, is the results of Roehrig (2004) mentioned previously. The chances of an instructor using inquiry activities in a class increased in proportion to content knowledge, student-centered beliefs, and understanding about the nature of science (Roehrig, 2004). Roehrig's study did not reveal specific traits describing what instructors should do to bring about student understanding using inquiry, nor did she speak directly about whole-class discussions.

To create productive whole-class discussions several different kinds of behaviors must occur simultaneously. This conclusion can be linked to the work of Kirkton (1971), who discussed teachers' abilities to craft questions. The term craft implies more than just having a checklist of behaviors that must be marked off in order to be successful at leading a discussion. To "craft," implies that something is being made because of a unique set of skills. Kirkton's results stated that questions needed to be carefully crafted to bring about learning. The idea that several different kinds of behaviors must occur simultaneously in order to create productive whole-class discussions is tied to the idea of crafting a discussion. The interaction between behaviors also implies that there is more than one way to do accomplish something, as we saw with Nina, Keith, and Alice, who all had good whole-class discussions but a different pattern of positive traits.

In summary, five different types of behaviors play a role in successfully leading students in productive whole-class discussions. The interactions among categories of behaviors revealed that no behavior single-handedly determined if a discussion was productive. Instead, peer leaders tended to create productive whole-class discussions when they regularly exhibited positive behaviors in at least three of the thematic categories: Leadership Skills (Supervisory Qualities and Procedural Practices), Interpersonal Skills, and Communication Skills (Feedback/Responses and Questioning Techniques). Individuals desiring to create productive whole-class discussions need to provide opportunities for students to participate, persuade students to contribute, and facilitate discussions without dominating them. The interactions necessary to bring about productive whole-class discussions reaffirm the work of Carlsen (1991) who states that training peer leaders [teachers] to focus on one specific behavior results in "misplaced effort(s).” Carlsen recommends that interactive aspects of teaching need to be explored. The results of this study also support the idea that trainers should focus on more than one behavior.

Peer leaders need to exhibit leadership skills by maintaining a balance between Procedural Practices (Bafumo, 2005) and Supervisory Qualities (Kunter, 2007). Competent leadership skills are established through the consistent use of routines and organization; without letting any of these become the focus of the class. Additionally, peer leaders need to exhibit Interpersonal Skills by cultivating an environment where students feel comfortable, involving a little humor when possible and becoming familiar with their students (Ertmer, 2005). Familiarity with students includes traits such as knowing student names, recognizing student attributes, along with having a genuine concern for how students are doing. Peer leaders also need to exhibit communication skills, involving Questioning Techniques and Feedback/Responses. Once a relationship has been developed and the discussion has begun, questions can be used to encourage participation and to arouse student interest (Wilen, 1986). Student interest can be achieved by integrating several different practices together. Instructors should use a range of different kinds of questions and vary the levels of questions asked. Questions should be designed to help students understand the processes, as opposed to just using algorithms. Questions should be used to direct student thinking, kindle inventiveness, and to identify difficult areas for students (Chin, 2004). Finally, peer leaders need to provide effective, relevant, and timely feedback and responses that promote student understanding, and encourage students to seek further information and knowledge (Durham, 1997).

Contributions of this Study

This study makes three contributions to the research of peer-led productive whole-class discussions. First, as shown in Table 3.4, a way to rate peer-led discussions using student and peer leader levels of involvement has been developed. Second, this study supports the findings of others as categories of behaviors emerged from the grounded theory process (Chin, 2004; Gilley, 2009; Roehrig, 2007). Third, and probably the most important contribution, is the relationships revealed between the five behavioral categories which further led to three distinct areas of competencies that need to be emphasized in peer leader training sessions: Interpersonal Skills, Communication Skills, and Leadership Skills. This research suggests that a peer leader's ability to lead students in productive whole-class behaviors is dependent on being able to integrate these three competencies. First and most important, is Interpersonal Skills, a peer leaders' ability to form trusting relationships with students. Followed by a peer leaders' ability to make use of Communication Skills by appropriately providing useful Feedback/Responses and using Questioning Techniques, which require students to clarify and elaborate on their answers. The last area of competency is to demonstrate Leadership Skills using Procedural Practices and Supervisory Qualities, consistently being the authority figure without being authoritative.

The results of this study have the potential to aid in developing more effective peer leader training programs, while simultaneously emphasizing an interactive way of involving students in their own learning. Peer leading programs have been said to enhance science education across a diverse group of students (Bowen, 2000; Coe, 1999; Lewis, 2005, 2008). In an age when more and more educators are claiming to use constructivist pedagogical practices in their classrooms, increasingly more educational settings are involving students in the training of other students (PBL, PLTL, PLGI) (Eberlein, et al. 2008). New training programs can offer opportunities for students to openly express themselves while participating in these new programs. The benefits of these kinds of reforms provide advantages to both students and peer leaders.

After reviewing several studies that explored teacher-directed questions and the patterns that evolved from the different results brought about by questions, Rop (2002) suggested that teachers should rely less on whole-class interactive strategies and concentrate more on small group lessons. PLGI uses a compromise: both small group and whole-class discussions. What is being proposed here is a way to make the whole-class portion more effective. Students' number one complaint about working in these small groups is that they never know what the right answers are. Educators' major complaint about small group work is that it is too slow and takes too much staff power to coordinate and interact with these small groups. The use of whole-class discussions in small group settings will provide peer leaders (or maybe teachers) the opportunities to facilitate discussions while actively involving students in the entire process.

While many other studies discuss the issues brought up by this study, no single study discusses them all together or explains about the inter-relatedness of each category. This news should be exciting to those responsible for training programs because it suggests more than just a one-size-fits-all formula for promoting productive whole-class discussions. The integration of the five categories: Procedural Practices, Supervisory Qualities, Questioning Techniques, Feedback/Responses, and Interpersonal (or social) Skills, into three areas of concentration (Communication, Interpersonal, and Leadership

Skills) means that facilitators of peer leader training programs can build on individual strengths instead of teaching a rote set of skills that everyone needs to learn and practice.

As chemical educators one of our goals is to help develop scientifically literate citizens capable of making informed decisions about current and real issues occurring in today's fast changing world (Zeidler et al., 2004). The whole process of education should not be merely about building chemists, but instead about teaching science in ways that help to develop individuals capable of contributing to the body of knowledge in industrious and ethical ways (Danko, 2003). As a result of identifying factors associated with productive whole-class discussions, peer leader training programs can begin to hone in on activities that develop and enhance these behaviors. The three areas of competency needed to encourage student participation during small group sessions, Interpersonal, Communication, and Leadership Skills contend with much more than just learning about chemistry.

This study makes two major contributions to research in the area of chemical education. First, the data supports many of the ideas about what constitutes effective leadership skills in individuals both in and out of academia. Second, this study isolates various components of Communication and Leadership Skills so that each may be studied separately in order to develop these skills during different phases of an individual's training.

The areas of competency that arose from this grounded theory study do not exist in a vacuum outside the realm of other fields. The literature reveals several ideas about traits that one needs to acquire in order to be an effective leader. The topic of leadership is approached in a diverse group of settings, ranging from adolescent organizations such as Boy Scouts to medical residency programs, and various levels of business in between (Marco, 2002; Phelps, 2000). This study supports the findings of others involving leadership effectiveness in places outside of academia (Gilley, 2009). In order to be an effective leader or manager, an individual must have the ability to influence others by systematically integrating interpersonal skills (Church, 1999).

In the medical field, the concept leadership is discussed under the heading of professionalism. Professionalism encompasses the integration of two different areas of competency (Professionalism, and Interpersonal & Communication) according to the Accreditation Council for Graduate Medical Education (ACGME). In spite of all the new advances being made on a daily basis in medicine, technology is no substitute for professionalism and interpersonal skills. The ACGME identified five basic competencies desired by anyone working with people: sensitivity, content knowledge, professionalism, interpersonal skills, and communication skills. While ways of assessing these competencies have not been formally addressed yet, the ACGME feels that identifying residents with questionable skills is an important first step towards remediation and that these three skills are essential skills that should be developed before completing any residency program (Marco, 2002).

In yet another study, examining individual management personnel in a high-tech government agency, researchers revealed that the ability to influence others and therefore be an effective leader was based on a level of self-awareness concerning one's role (Church, 1999). Church also claims that leaders must be able to convey a purpose behind what they are doing or trying to get others to "buy-in" to doing. In the case of peer leaders, they are trying to get students to buy-in to the importance of whole-class discussions and the benefits of being actively involved.

The literature reviewed demonstrates that the three behavioral skills necessary to bring about productive whole-class discussions are not just useful in an academic setting but also useful in real-world settings and therefore worthy of being taught. A study examining the development of new employees resulted in producing five specific recommendations to create a smooth initiation into their company setting (Holton, 1996). The first recommendation involved identifying specific learning tasks, what kinds of things would a new employee need to learn in order to be successful in this setting. Next, partnerships needed to be developed to continue the process of learning even after the “training” was over. The third recommendation concerns the partners recommended in step two, each mentor needs to be trained to train others. It should not be assumed that just because you can perform a task that you can teach others to perform the task. Fourth is the suggestion of having some form of intervention available to continue the process of learning and evaluating a new employee. The last recommendation is that businesses should collaborate with educational institutions to help teach students valuable organizational traits that can be used in the work place (Holton, 1996). The results of Holton’s study are brought up because of the way that these recommendations integrate social skills into the training of workers, a direct connection to the category of Interpersonal Skills, and their implications for peer leader training.

First, individuals responsible for training peer leaders need to identify specific skills desired of peer leaders. The three foci suggested by this study are Interpersonal, Communication, and Leadership Skills, so that step has been addressed. Peer leader training programs should address these three foci.

Second, new peer leaders could be assigned more experienced peer leaders as mentors. The idea of mentors has several advantages to offer the whole peer leading process and addresses all three of the skills that emerged from this study. One advantage of using mentors is that a second year peer leader knows more about the difficulties he/she experienced during his/her first year than a facilitator does. After all, that is the whole concept behind how "peer" leading works, peer leaders are closer to the actual learning experience than instructors are. The next advantage to using mentors is that it would provide a reason for first year peer leaders to sign up for a second year. New peer leaders can continuously go to their mentor with questions that might otherwise go unanswered. This opportunity brings with it a sense of pride, and usefulness. Having experienced peer leaders can only help to build a peer leading program because with experience comes acquired skills. The implementation of peer leading could even be coordinated with the education department for individuals desiring to teach.

Glimpses of peer leadership were seen when experienced peer leaders would volunteer to share their findings orally with classmates both in and out of class. Peer leaders would share their experiences orally with classmates, in their journals with the coordinator, and visually when preparing short video segments to share during class time. The more experienced peer leaders choose to share portions of their classes that were not operating smoothly. Selena, for example, was willing to take a chance on sharing a "bad" portion of her class because she had developed a sense of trust in the system. Selena had established an understanding about how she would benefit from revealing an awkward setting occurring in her class. As a result of her taking this chance, a productive whole-class discussion occurred during training, resulting in many peer leaders benefiting from Selena's risk taking. Leadership Skills are being shared as peer leaders share Supervisory Qualities and discuss Procedural Practices, while simultaneously using Communication Skills to answer peer leader questions and provide feedback.

The third recommendation takes the whole peer leading process to another level of peer leading. Peer leaders trained to lead under graduate students in cooperative learning groups will also be training fellow peer leaders to lead undergraduate students. The process is cyclical with students learning and teaching each other. Students will really be gaining greater understanding not only at the content knowledge levels, but at pedagogical content levels as well. The best way to learn something is to try to teach it. Through the integration of peer leaders training other peer leaders, it is the belief of the researcher that peer leaders will begin to gain insight into many of the nonverbal skills being utilized by the coordinator. For instance, in the example regarding Chantel's lack of understanding about Supervisory Skills and what a peer leader actually does while he/she moves from group to group, if Chantel had played a more active role in observing other peer leaders, perhaps she would have been able to see the purpose behind some of the Procedural Practices. These traits could be identified by others and shared during training.

The fourth recommendation is that some form of evaluation and intervention be established to monitor and gauge peer leader effectiveness. A quarterly evaluation might be suggested for new peer leaders every three to four weeks, with older peer leaders being evaluated every five to six weeks. The evaluations could be designed to involve students using the SII format and even Discussion-Ratings of different whole-class discussions. The focus of these evaluations would be to discover ways to increase productivity and effectiveness of student involvement and learning. Peer leader training could implement the use of writing SII's while viewing other peer leading sessions. Viewing others provides an opportunity to absorb and take in the whole setting without the pressure of having to perform, like there is when leading a class session. This observation period would also be a great time to use the Discussion-Rating Tool. Using this tool would benefit both peer leaders, the one viewing the class session and the peer leader being viewed. As the viewer begins to become more aware of who is doing the work, and the necessary actions that need to be observed in order to be rated *Good*, *Superb*, or *Excellent*, they will begin to internalize some of the positive behaviors that lead to productive whole-class discussions. The peer leader being observed will benefit from hearing another peer's interpretation about what happened during the class period. Using evaluations as a part of peer leader training provides an opportunity to develop Leadership, Communication, and Interpersonal Skills in both the observer and observed peer leader through the process of first noticing the positive and negative traits, and second by communicating these findings in a useful and productive manner.

The fifth and final recommendation, for businesses to corroborate with colleges and universities, could involve students seeking out businesses in terms of skills that are required in specific businesses. This could be something required of peer leaders in the areas of their specific majors or career goals. This idea takes us back to the ideas stated in Church's (1999) study that individuals need to "buy in" to the ideas in order to see their value and incorporate them into their own practices.

The results from this grounded theory study support the work of other individuals involving leadership effectiveness in a variety of different organizations. Gilley (2009) for example, examined characteristics of effective leaders. In this study, Gilley composed a list of six traits necessary for leading others: coaching, communication (Communication Skills), involving others, motivating, rewarding (Interpersonal Skills), and promoting teamwork (Leadership Skills); a direct connection to all three of the areas of competencies revealed in this study. Church (1999) revealed in the business world that encouraging others to follow occurred as a result of communicating (Communication Skills), listening, debating, coordinating (Leadership Skills), and respecting others (Interpersonal Skills). Watanabe (2007) found that students took chances and applied themselves when time was spent teaching students to communicate (Communication Skills) and study, developing a sense of community within a classroom setting (Interpersonal Skills). Each of these studies, although they do not all occur in a classroom setting, demonstrate the importance of developing these competencies through building supportive relationships and establishing trust in any given setting.

Because the results of this study on peer leader behaviors support the findings of so many other researchers both in and out of academia, one could speculate that individuals responsible for training peer leaders could enhance their training programs by borrowing from the work of others regarding effective leadership, communication, and social skills. For example, peer-leading sessions could be videotaped to enhance training programs looking for effective and ineffective behaviors (Bond-Robinson, 2005; Hativa, 2001; Keefer, 2000). Videotaping offers several advantages for peer leaders: peer leaders could view others involved in the peer leading process and they could see themselves as they work with students and lead discussions. From the use of videotapes, peer leaders could be asked to rank their individual discussions using the Discussion-Rating Tool to first bring about an awareness of behaviors exhibited during a class session, and then to bring about an awareness of who is doing most of the work in terms of developing concepts, the students or the peer leaders. From the showcase videos created by peer leaders to watch during the training sessions, peer leaders greatly improved in their ability to spot individual strengths and areas for improvement. This improvement was seen in the quality of the SII's as the semester progressed.

Peer leaders could be actively involved in role-playing various types of student problems or questions, acting out both positive and negative responses (Bonwell, 1991). Role-playing provides peer leaders with an opportunity to 'freely' act out, see, and try out behaviors in a safe environment. For example, using Selena's video mentioned earlier, peer leaders were able to observe a peer leader and the peer-leading program under attack. The brainstorming session that followed was directed towards helping peer leaders find useful ways to deal with this unfortunate set of circumstances. The same kind of discussions could follow a 5-10 minute role-playing scenario. Peer leaders could be asked to come up with the topics that they felt needed to be role-played. Topics could range from things peer leaders were worried about, to things they had already experienced and wished to discuss, but specifically should be targeted at developing the five categories of peer leader behaviors that lead to productive whole-class discussions: Interpersonal Skills, Questioning Techniques, Supervisory Qualities, Feedback/Responses, and Procedural Practices.

As much as possible peer leader training sessions should be teaching peer leaders how to build a sense of community through participating in the production of a community of peer leaders, rather than being told this is what they need to do (Watanabe, 2007). First peer leaders need to experience community-building activities, learn about the importance of these activities, and then develop activities that they themselves feel comfortable enough to replicate in their own class sessions. The idea of community building, developing interpersonal skills was central to this study in classes with productive whole-class discussions. Classes where students do not feel safe, and free from ridicule, are classes were students are not going to be inclined to openly discuss new ideas with each other. Peer leaders can help develop a sense of community through many different means such as learning student names, showing their individual side by sharing about what it was like for them when they were taking this class, and genuinely expressing a concern about how students are doing. The process of community building needs to be initiated, first by the coordinator, by showing videos of past peer leader problems. In doing this peer leaders can express ideas freely without fear of hurting someone's feelings. Then after a level of trust has been developed, peer leaders can begin to talk freely about their own mistakes and difficulties with peer leading.

New peer leaders could also learn the process of leading whole-class discussions by observing and evaluating discussions using the Discussion-Rating Tool. Through the process of evaluating discussions, peer leaders would begin to identify who is doing the work (students or peer leader) and the level that students are engaged. During the different observations, peer leaders could be asked to hone in one a specific competency. For example, Communication Skills could be examined by looking specifically at the kinds of questions and feedback being supplied during a single class session. Peer leaders could be asked to identify positive Communication Skills and to note specific ideas about what could have been done to strengthen these skills in a particular setting. One way to strengthen peer leader responses could be obtained from creating alternative responses as a collective group to use in place of routine and ineffective responses viewed in video recorded sessions.

Peer leaders need to participate in various levels of whole-class discussions, in addition to just learning about and observing them. Mock discussions could be encouraged during training sessions with topics addressing necessary qualities needed to develop Leadership Skills integrating Supervisory Qualities and Procedural Practices and involving a variety of levels of authority and practices. Discussions could cover competencies needed to address Leadership Skills that tie together Feedback/Responses and Questioning Techniques. These discussions could involve a whole realm of effective and ineffective techniques. For example, an excerpt from a videotaped class session like Michael could be viewed. In a video such as this, peer leaders could see firsthand how communication shuts down student levels of participation as Michael asks some really good questions, but spends too much time answering his own questions. Communication Skills could be discussed by comparing Michael's manner of over explaining with Donna's lack of effective feedback. This process would help peer leaders to see the importance of integrating multiple skills simultaneously.

Discussions involving actual content knowledge should be experienced by peer leaders on a continual basis. Peer leaders should be expected to lead discussions during their training sessions concerning the activity for the next class. Each training session should involve many whole-class discussions where the facilitator gradually becomes less involved in the actual discussions in order for peer leaders to have opportunities to "discuss" ideas.

In addition to participating in discussions, peer leaders could write journal articles using a diary kind of format that would permit peer leader to see changes that are occurring in their individual sessions because of trying various activities. Journal prompts could be given to help peer leaders focus on each of the three areas of competencies, or even a little more specific in terms of the five behavioral practices. Looking for the specific competencies and writing about them may bring about a level of consciousness that overflows into peer leading practices. Journal prompts could consist of discussing how a peer leader plans to develop a classroom community. Just the thought of knowing that you have to write on this subject, will automatically force an individual to look at how they intend to go about trying to do such an activity. The same process would occur when asking peer leaders to journal about the kinds of questions they ask, or the kinds of feedback that could be supplied for different answers to a problem. These entries benefit the peer leader, in addition to offering insights to facilitators, by providing a glimpse into peer leader understandings concerning each of the behaviors needed to create productive whole-class discussions.

Peer leaders could also be responsible for creating professional development portfolios consisting of individual accounts of successful and unsuccessful practices in personally trying to incorporate three of the five behaviors that emerged from this study (Barnett, 2001). Through the development of identifying ones strengths, one could focus more on these competencies, thereby increasing their occurrences. Developing a portfolio would also *force* a peer leader to identify their strong suits. While there is a plethora of information about building professional leadership traits in individuals, there is no evidence that directly measures the success rate of individual practices (Gehrke, 1991). There is, however, research suggesting that change occurs as a result of identifying problem areas and identifying possible solutions (Candler, 2009).

The instrument developed during this work, Discussion-Rating Tool, offers a way for trainers to gauge the various levels of participation in discussions being conducted by individuals in their distinctive programs. Peer leaders would benefit from having an observer rate their discussions according to this scale, and further benefit by orally going over the scores. It would also be helpful if peer leaders rated other peer-led discussions using the Discussion-Rating Tool. The instrument, despite its simplicity, would enable a peer leader to catch a glimpse of who is doing most of the work and permit them to search for changes that they could implement accordingly. Awareness is essential to initiating changes, and the Discussion-Rating Tool is now available to assist in creating that awareness.

The classroom observations and literature reviewed during this study demonstrate that whole-class discussions have many benefits to offer instructors in their individual settings as well as offering benefits to students through the development of life skills needed in every day experiences. Several lists of whole-class discussion techniques and classroom practices exist; however, many of these studies fail to emphasize the human side of teaching, involving Interpersonal Skills.

Implications for Future Research

At this stage of the work, the researcher is stuck with a paradox concerning the study's completion and the reader's use of the material. This study carefully demonstrates the steps leading to the development of the hypotheses and the theory but at this time, the process stops in order to be written up. This essentially "freezes the on-going [development]" of the ideas expressed here (Glaser, 1978, p.129). This material should not be "read as a fixed conceptual description" but rather as one explanation to be explored further. Each of the contributions made to chemical education through the results of this study will present opportunities for further research. There are many patterns affecting whole-class discussions and future projects that may arise from this work. Each of the findings presented here offers opportunities to ask even more questions. Future research could incorporate methods that will: (1) measure and develop the three competencies of skills observed in peer leaders, (2) view peer leader interactions when working with small groups as a means to gauge how a peer leader will function during whole-class discussions, and (3) measure benefits of having and participating in whole-class discussions.

As a result of uncovering some of the diverse categories possessed by individual peer leaders, would it be possible to make an instrument that could be used to measure the three areas of competencies: communication, interpersonal, and leadership? If it is possible to measure these traits, would it be possible to measure these characteristics while a peer leader is in training in order to develop the natural abilities in peer leaders?

Attributes that peer leaders exhibit when working with small groups appear to have a strong relationship with how a peer leader facilitates a whole-class discussion.

After coding the individual peer leader behaviors when they were working in small groups and then comparing them to the large class behaviors, many patterns seemed to exist in both types of discussions. There were many examples of this in the videos viewed for this study.

One example of peer leader behavior in small groups that carried over to whole-class discussions is Nina. The researcher noticed that when Nina talked to the group members in a small group of four, she would not become involved in a discussion with just one person. At no time would she direct a question, answer, or explanation to a single individual. Instead, she would continuously direct the question (or comments) to each member of the group by looking at each person while she spoke a few words, then move to the next and speak a few more and so on and so on. Oftentimes, she would stand back a little so that everyone would have to look at her and she could see all of the group members at one time. When one person in the group would ask a question, she would immediately turn to another group member and ask, "*what do you think about what he/she just said?*"

When Nina directs whole-class discussions this very same behavior is seen, she looks at members of each group as she talks, moving her head and her body from group to group as she talks. After someone has shared an answer or explanation, she will ask the class "*what do you think about what he/she just said?*" In the first few weeks of class, students were inclined to think that this behavior meant that something was wrong with the answer given, but after a short time they learned that an answer could be incorrect or even correct and she would still ask the same kind of question. As a result of repeatedly utilizing the same trait, students learned to offer evidence for their answers, rather than caving in and looking for the "correct" answer from someone else.

The idea of observing peer leaders during their training sessions can be used in subsequent peer leader (teaching assistant, beginning teacher, or instructor) training or workshops. What a great way for trainers of peer leaders to be able to "see" peer leaders in action. Training sessions where peer leaders lead during training sessions will permit facilitators to observe peer leaders in action while they are working with one or more small groups. This offers many advantages, especially since observing each peer leader in their individual classrooms may be more difficult to arrange due to time constraints.

The patterns revealed in this research could have important implications for peer leader training, small group and whole-class discussions, as well as areas involving beginning teacher training. The actual benefits of finding and using ways of creating productive whole-class discussions could have far reaching effects as students increase their understanding of chemical concepts and learn to verbally express their ideas and understandings openly. This form of interactive learning has the potential to reach diverse populations of students and increase science literacy. The understandings developed because of this study could provide a significant improvement in our capacity for preparing peer leaders (and other educators) to lead productive whole-class discussions.

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Appendices

Appendix A: Description of Roles

Almost all of the class time in this course is spent working in groups of about four. Every class meeting, each member of the group is assigned a new role. Not all roles will be assigned on any given day. It is up to the Manager to assign any additional roles as needed. Here are some roles that are commonly used:

Manager	Manages the group. Ensures that members are fulfilling their roles, that assigned tasks are being accomplished on time, and that all members of the group participate in activities and understand the concepts. *Your instructor will respond to questions from the manager only* (who must raise his or her hand to be recognized).
Presenter or Spokesperson	Presents oral reports on behalf of the group to the class. These reports should be as concise as possible; the instructor will normally set a time limit.
Recorder	Records the names and roles of the group members at the beginning of each day. Records important aspects of group discussions, observations, insights, etc. The recorder's report is a log of the important concepts the group has learned.
Reflector or Strategy Analyst	Observes and comments on group dynamics and behavior with respect to the learning process. These observations should be made to the manager on a regular basis (no more than 20 minutes between reports) in an effort to constantly improve group performance. The reflector/analyst may be called upon to report to the group (or the entire class) about how well the group is operating (or what needs improvement) and why.
Technician	Performs all technical operations for the group, including the use of a calculator or computer. Unless otherwise instructed, only the technician in each group may operate equipment such as this.
Encourager	Acknowledges the good ideas and insights of group members (or the group as a whole) through expressions such as "*That was a really good point!*" at appropriate times.
Sigfig Checker	This role should be self-evident!

Appendix B: Weekly Group Record (WGR)

Date: _______ WEEKLY GROUP RECORD Peer Leader _________________

Role	*Assigned*	*Actual*
Manager:	____________________________	_____________________________
Presenter:	____________________________	_____________________________
Recorder:	____________________________	_____________________________
Reflector:	____________________________	_____________________________

What has been one strength of your group's performance as a group today?

What is one area for improvement in your group's performance as a group today?

What were the key peer-leading concepts your group learned today?

What questions do you have? Are there any peer leading concepts that are still unclear?

What does each group member do during peer leader training to make sure he or she understands that day's material?

Appendix C: Process Skills

Process-Oriented Classroom

Students work in small groups on specially designed activities that are intended to develop both mastery of course content and key process skills

Targeted Skill Areas
Information processing
Critical thinking
Problem solving
Communication
Teamwork
Management
Assessment

Targeted Process Skill

Considering the ChemActivity and how that activity was implemented, identify how each of the process skill areas was addressed.

Information Processing – taking information (correctly) and checking to see whether it has been correctly perceived; using information to think

Critical Thinking – making decisions based on information; analyzing, comparing, synthesizing, and reasoning

Problem Solving – not merely doing exercises; using information in ways new to the student, e.g. developing an algorithm (different from using a received algorithm)

Communication – both written and oral

Teamwork – collaboratively working together within a group, working together, keeping group members at same pace

Management – self-managing and group managing, keep everyone together, being conscious of time, asking questions on behalf of group

Assessment – both assessment and assessment of others' responses (part of critical thinking as well)

Appendix C (Continued)

Information Processing

Below are several verbs referring to various actions within "information processing."

Searching	Manipulating	Storing (in memory)
Gathering	Classifying	Retrieving (from memory)

As you work through today's ChemActivity, notice how often you perform these actions. At the end of the session, use your answers to the three questions below to help your group answer the questions on the Weekly Group Record sheet.

1. Which of these is your strongest (which is the easiest for you)?
2. Which of these do you think needs the most improvement?
3. How do you plan to make that improvement?

Searching: *finding one piece of information* within a large number of pieces of information
Gathering: *bringing together the pieces of information* needed for the task at hand
Manipulating: *using the gathered pieces* of information to complete the task at hand
Classifying: *organizing a large number of pieces* of information by *grouping* similar pieces
Storing: selecting information worth remembering and *deciding how to remember* it
Retrieving: *remembering* a useful piece of information *when needed*

Problem Solving

Problem solving is what you do when you do not know what to do. To focus on the skill of problem solving this week, think of a situation when you were faced with a challenging chemistry question that seemed to be unrelated to any other chemistry question you had seen previously – so challenging that you weren't even sure how to begin. What did you do? How did you manage to work through your difficulties and solve the problem? For many students, Problem 1 in CA34 is a good example of a situation that requires problem solving. Was this the case in your group? How did the different members of your group get this problem done?

Take a moment to have your Recorder write down 2 specific examples of strategies group members use when they don't know how to start a problem. Do the strategies have anything in common? Why do you think these strategies are successful?

Strong assessment skills are linked to successful problem solving. During today's session, your Reflector is still responsible for writing down 2 specific examples of a group member learning something during the session that he or she did not previously know. What was learned, by whom, and how did the learning occur?

Assessment

Assessment simply means taking stock, or checking to see how things are going. For example, as you study, you assess your current understanding of key chemistry concepts in order to decide whether you need to find help before the exam. In these Friday sessions, your Manager has been using assessment to decide whether all members of the group understand before moving on. Thorough assessment explores *what you have learned and how* you learned it as well as *what you still need to learn* so that you can set up a plan to learn it. Both are important for successful studying, but often the first (what has been learned and how?) is overlooked.

During today's session, your Reflector is responsible for writing down 2 specific examples of a group member learning something during the session that he or she did not previously know. What was learned, by whom, and how did the learning occur?

Rephrasing

Rephrasing means to say something again, typically in a different, more complete and clearer way. Rephrasing someone else's words requires careful listening. When you rephrase someone else's words and the original speaker agrees that your rephrasing is accurate, you can be confident that you truly understood the idea being expressed. Communication of complex ideas (such as those involved in chemistry) *without* rephrasing often goes astray, producing only superficial understandings at best, and misunderstandings at worst.

During the homework check for today's ChemActivity, group members should take turns reading their answers aloud to the group, providing an explanation for each answer. [Manager: 1a, Presenter: 1b, Recorder: 1c, Reflector 1d; Manager 2a, Presenter 2b, etc.]. After each answer, the Recorder and the Reflector share responsibility (take turns) for rephrasing the answer ALOUD, for the rest of the group to hear, with emphasis on the explanation. The Manager is responsible for making sure that the rephrasing is different, more complete, clearer, and understood by all group members. As the class progresses, the peer leader will ask the Presenters to rephrase answers given by other groups as well as conclusions reached by the class as a whole.

If the Reflector and the Recorder cannot rephrase an answer and explanation provided by another group member, this is an indication that the group is having difficulty with a concept. In this case, the Manager can ask a question of the Peer Leader on behalf of the group.

Appendix D: Human Participant Protection Certificate

Human Participants Protection Education for Research Teams 5/29/02 2:31 PM

Human Participant Protections Education for Research Teams

Completion Certificate

This is to certify that

Teresa Eckart

has completed the **Human Participants Protection Education for Research Teams** online course, sponsored by the National Institutes of Health (NIH), on 05/29/2002.

This course included the following:

- key historical events and current issues that impact guidelines and legislation on human participant protection in research.
- ethical principles and guidelines that should assist in resolving the ethical issues inherent in the conduct of research with human participants.
- the use of key ethical principles and federal regulations to protect human participants at various stages in the research process.
- a description of guidelines for the protection of special populations in research.
- a definition of informed consent and components necessary for a valid consent.
- a description of the role of the IRB in the research process.
- the roles, responsibilities, and interactions of federal agencies, institutions, and researchers in conducting research with human participants.

National Institutes of Health
http://www.nih.gov

http://cme.nci.nih.gov/cgi-bin/hsp/cts-cert4.pl Page 1 of 1

Appendix E: Institutional Review Board Approval

USF
UNIVERSITY OF
SOUTH FLORIDA

June 30, 2005

Teresa Eckart
Department of Chemistry
SCA 400

RE: **Approved** Application for Continuing Review
IRB#: 102819
Title: *Understanding Peer Leader Development*
Start Approval Period: 06/28/2005 to 06/27/2006

Dear Ms. Eckart:

On June 28, 2005, the Institutional Review Board (IRB) reviewed and **APPROVED** your Application for Continuing Review for the afore noted protocol. It was the determination of the IRB that your study qualified for expedited review based on the federal expedited category number six (6) and number seven (7). Approval is granted **for the period indicated above.**

Please note, if applicable, the **enclosed informed consent/assent documents are valid during the period indicated by the official, IRB-Approval stamp located on page one of the form.** Valid consent must be documented on a copy of the most recently IRB-approved consent form. Make copies from the enclosed original.

Please reference the above IRB protocol number in all correspondence regarding this protocol with the IRB or the Division of Research Compliance. In addition, we have enclosed an Institutional Review Board (IRB) Quick Reference Guide providing guidelines and resources to assist you in meeting your responsibilities in the conduction of human subjects research. Please read this brochure carefully. It is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to the Human Research Protections Program. If you have any questions regarding this matter, please call 813-974-9343.

Sincerely,

Paul G. Stiles

Paul G. Stiles, J.D., Ph.D.
USF Institutional Review Board

Enclosure(s): (If applicable) IRB-Approved, Stamped Informed Consent/Assent Documents(s)
IRB Quick Reference Guide
Cc: Christy A Stephens, USF IRB Professional Staff
Jennifer Lewis, Ph.D.

CR-AX-05-01

OFFICE OF RESEARCH • DIVISION OF RESEARCH COMPLIANCE
INSTITUTIONAL REVIEW BOARDS, FWA NO. 00001669
University of South Florida • 12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-5618

Appendix F: Informed Consent

Informed Consent
Social and Behavioral Sciences
University of South Florida
Information for People Who Take Part in Research Studies

The following information is being presented to help you decide whether or not you want to take part in a minimal risk research study. Please read this carefully. If you do not understand anything, ask the person in charge of the study.

Title of Study: Understanding Peer Leader Development
Principal Investigator: Teresa Eckart
Study Location(s): University of South Florida

You are being asked to participate because your experiences in the chemistry course you are currently taking offers a unique chance to improve the way in which chemistry is taught.

General Information about the Research Study

The purpose of this research study is to better understand how peer leaders develop effective teaching practices.

Plan of Study

I am asking for your permission to video or audio record your class so that I can help peer leaders become more effective. No additional activities are asked of you; you do not need to do anything that you would not normally do as a class participant. The recording will be limited to only the time that you are in the class.

Payment for Participation

You will not be paid for your participation in this study.

Benefits of Being a Part of this Research Study

This study is designed to help peer leaders become more effective, and therefore may benefit you directly. Your participation will also help us in our understanding of chemistry teaching, and may ultimately benefit other chemistry students in the future as well.

Risks of Being a Part of this Research Study

Because recordings will be made, there is the chance that someone hearing or seeing the recordings could identify you by voice or image. To limit this possibility, all recordings will be kept on password-protected computers or in a locked research lab, to be reviewed only by the peer leaders and the investigators in this study.

Confidentiality of Your Records

Your privacy and research records will be kept confidential to the extent of the law. Authorized research personnel, employees of the Department of Health and Human Services, and the USF Institutional Review Board, its staff, and others acting on behalf of USF, may inspect the records from this research project.

The results of this study may be published. However, the data obtained from you will be combined with data from others in the publication. The published results will not include your name or any other information that would personally identify you in any way.

As mentioned, only the investigators will have access to actual recorded media. Any published transcripts will use pseudonyms and not contain identifying language.

Volunteering to Be Part of this Research Study

Your decision to participate in this research study is completely voluntary. You are free to participate in this research study or to withdraw at any time. There will be no penalty or loss of benefits you are entitled to receive if you stop taking part in the study. Your decision to participate, or to withdraw, will not affect your grade in any way.

Questions and Contacts

- If you have any questions about this research study, contact Teresa Eckart at teckart@cas.usf.edu
- If you have questions about your rights as a person who is taking part in a research study, you may contact the Division of Research Compliance of the University of South Florida at (813) 974-5638.

Consent to Take Part in This Research Study

By signing this form I agree that:

- I have fully read or have had read and explained to me this informed consent form describing this research project.
- I have had the opportunity to question one of the persons in charge of this research and have received satisfactory answers.
- I understand that I am being asked to participate in research. I understand the risks and benefits, and I freely give my consent to participate in the research project outlined in this form, under the conditions indicated in it.
- I have been given a signed copy of this informed consent form, which is mine to keep.

____________________________	____________________________	______
Signature of Participant	Printed Name of Participant	Date

Investigator Statement

I have carefully explained to the subject the nature of the above research study. I hereby certify that to the best of my knowledge the subject signing this consent form understands the nature, demands, risks, and benefits involved in participating in this study.

___________________________	___________________________	__________
Signature of Person Obtaining Informed Consent	Printed Name of Person Obtaining Informed Consent	Date

Appendix G: Strengths, Improvements, and Insights (SII)

Individual SII

Name: ______________________ Date ____________

Strengths, Improvements and Insights

Strengths (Ideas about *Why* each is a strength and the *context* of the observed strength)

1.

2.

3.

Areas for Improvement (Include suggestions on *How* to achieve the improvement and the *context* of this observation))

1.

2.

Insights/Discoveries (and the Significance of the discovery)

1.

Appendix H: RTOP

Reformed Teaching Observation Protocol (RTOP)

Daiyo Sawada
External Evaluator

Michael Piburn
Internal Evaluator

and

Kathleen Falconer, Jeff Turley, Russell Benford and Irene Bloom
Evaluation Facilitation Group (EFG)
Technical Report No. IN00-1
Arizona Collaborative for Excellence in the Preparation of Teachers
Arizona State University

I. BACKGROUND INFORMATION

Name of teacher ______________________ Announced Observation? ______________________
(yes, no, or explain)

Location of class ____
(district, school, room)

Years of Teaching __________________ Teaching Certification______________(K-8 or 7-12)
Subject observed __________________ Grade level______________________

Observer ______________________ Date of observation______________________

Start time ______________________ End time______________________

II. CONTEXTUAL BACKGROUND AND ACTIVITIES

In the space provided below please give a brief description of the lesson observed, the classroom setting in which the lesson took place (space, seating arrangements, etc.), and any relevant details about the students (number, gender, ethnicity) and teacher that you think are important. Use diagrams if they seem appropriate.

Category	Score
Lesson Design and Implementation	
Content	
Classroom Culture	
Total	

Appendix H (Continued)

	Never Occurred				Very Descriptive
III. LESSON DESIGN AND IMPLEMENTATION					
1. The instructional strategies and activities respected students' prior knowledge and the preconceptions inherent therein.	**0**	**1**	**2**	**3**	**4**

1 = teacher refers to prior knowledge
4 = teacher solicits prior knowledge (pre-test, question, etc.) or lesson is developed to build on prior knowledge (from other lessons)

2. The lesson was designed to engage students as members of a learning community.	**0**	**1**	**2**	**3**	**4**

4 = must have student-student, teacher-student, and students present answers before teacher discusses
3 = not enough student-student development of ideas/teacher presents answers/some student-student interactions
2 = good teacher-student interactions but no student-student
0/1 all teacher centered

3. In this lesson, student exploration preceded formal presentation.	**0**	**1**	**2**	**3**	**4**

4= students explore without teacher telling them what to expect
2 = teacher gives away what will happen
0 = students watch demo and then instructor explains

4. This lesson encouraged students to seek and value alternative modes of investigation or of problem solving.	**0**	**1**	**2**	**3**	**4**

4 = students told to investigate but not told how
2 = students told to investigate but encouraged/told to do things in a certain way

5. The focus and direction of the lesson was often determined by ideas originating with students.	**0**	**1**	**2**	**3**	**4**

4 = students generate problem and how to solve it
3 = instructor defines problem but does not tell students how to solve
2 = teacher sets agenda and directs observations

IV. CONTENT

Propositional Knowledge	Never Occurred				Very Descriptive
6. The lesson involved fundamental concepts of the subject.	**0**	**1**	**2**	**3**	**4**

4 = based on the benchmarks

7. The lesson promoted strongly coherent conceptual understanding.	**0**	**1**	**2**	**3**	**4**

4 = students must connect to previous content or define patterns, must develop concept, there must be student-student, student-teacher and whole group interactions
3 = missing one of the above types of interactions
2 = focus on phenomena description and little concept building
1 = teacher makes connections to previous topics for students

8. The teacher had a solid grasp of the subject matter content inherent in the lesson.	**0**	**1**	**2**	**3**	**4**

4 = no misconceptions/able to answer most questions

	0	**1**	**2**	**3**	**4**

9. Elements of abstraction (i.e., symbolic representations, theory building) were encouraged when it was important to do so.

4 = good use of diagrams, particulate representation, diagrams; focuses attention on key elements; makes generalization or works towards theory development
3 = same as the above without theory development or generalizations
2 = some use of diagrams etc.; no theory development

10. Connections with other content disciplines and/or real world phenomena were explored and valued. **0 1 2 3 4**

4 = working with everyday materials and explicit and significant connections to other disciplines or everyday phenomena
3 = explicit and significant connections to other disciplines or everyday phenomena
2 = some connections to other disciplines or everyday phenomena
1 = passing mention of connection to other disciplines or everyday phenomena

<u>Procedural Knowledge</u>

Never Occurred — Very Descriptive

11. Students used a variety of means (models, drawings, graphs, concrete materials, manipulatives, etc.) to represent phenomena. **0 1 2 3 4**

4 = students articulate findings and/or make connections to everyday phenomena and students use multiple representations
3 = students use multiple representations but teacher summarizes findings or students use multiple representations but do not develop concepts or make connections

12. Students made predictions, estimations and/or hypotheses and devised means for testing them. **0 1 2 3 4**

4 = students state what they think will happen before they collect data
0 = students make observations without making predictions/developing hypothesis first

13. Students were actively engaged in thought-provoking activity that often involved the critical assessment of procedures. **0 1 2 3 4**

4 = students develop procedure for investigation and students make refinements to procedure based on observations/results or design further studies to clarify questions generated by observations/results
3 = students develop procedure for investigation
1 = students actively involved in activity but no thought about how to conduct investigation or why
0 = students not actively engaged

14. Students were reflective about their learning. **0 1 2 3 4**

4 = Students must develop concept/theory and provide rationale for their conclusions; most students participate. A debate/discussion of different theories would indicate this level.
3 = students involved in development of concept/theory but do not provide rationale or answer questions like: How do you know this? How can we be sure?
1 = no theory development and few students express findings/explanation.

15. Intellectual rigor, constructive criticism, and the challenging of ideas were valued. **0 1 2 3 4**

4 = Students must negotiate ideas as a whole group; majority of students involved in discussion.
3 = Students negotiate ideas in small groups but no full group discussion.
1 = Some ideas presented but no competing ideas offered.
0 = No student ideas presented

V. CLASSROOM CULTURE

Communicative Interactions

	Never Occurred				Very Descriptive
16. Students were involved in the communication of their ideas to others using a variety of means and media.	**0**	**1**	**2**	**3**	**4**

4 = Communication involves student-student, student-teacher, and whole group discussions.
3 = Communication within small groups and student-teacher but no whole group discussions; or some in group and some between group but significant teacher explanation.

17. The teacher's questions triggered divergent modes of thinking. **0 1 2 3 4**

4 = Divergent set up – allows students to explore multiple solutions/options; teacher does not guide towards answer but asks questions to make students think about options.
3 = Divergent set up; teacher poses questions to group as whole but not to individuals or small groups.
2 = Divergent set up but instructor encourages/directs towards one answer.
1 = Any questions posed to students must score a 1

18. There was a high proportion of student talk and a significant amount of it occurred between and among students. **0 1 2 3 4**

4 = most of the lesson was student talk
2 = significant amount of teacher talk in development of key ideas

19. Student questions and comments often determined the focus and direction of classroom discourse. **0 1 2 3 4**

4 = student driven design and students decide what question/problem to investigate or how to investigate a question/problem.
3 = instructor sets question/problem to investigate and materials but students decide how to use materials; teacher allows student questions to direct class discussion but instructor sets agenda

20. There was a climate of respect for what others had to say. **0 1 2 3 4**

4 = substantial exchange between individual students, group of students as a whole and between student and instructor; students display comfort in offering ideas or debating ideas; many students involved in discussion
3 = exchanges in small groups with little/no whole group discussion; teacher closes down some student investigations by explicitly pointing them in another direction
2 = teacher solicits student ideas and accepts comments but no debate about ideas

Student/Teacher Relationships

	Never Occurred				Very Descriptive
21. Active participation of students was encouraged and valued.	**0**	**1**	**2**	**3**	**4**

4 = students involved in constructing concept/theory and final construction of key ideas
3 = students involved in constructing concept/theory but teacher presents final construction of key ideas
2 = students encouraged to describe phenomena but no theory development; teacher presents key ideas first before asking for student input
1 = if students were asked to answer questions/participate you must score 1

22. Students were encouraged to generate conjectures, alternative solution strategies, and ways of interpreting evidence. **0 1 2 3 4**

4 = students directed their investigations and discussed results as a group
3 = students directed their investigations but did not discuss results as a whole group
1 = answer was student derived but teacher directed towards one correct answer

0 1 2 3 4

23. In general the teacher was patient with students.

4 = students are allowed to explore
2 = teacher explicitly redirects some of the direction students choose to explore
1 = teachers allows some wait time after questions

24. The teacher acted as a resource person, working to support and enhance student investigations. **0 1 2 3 4**

4 = teacher supports student discussions but does not direct
2 = teacher interacts with students but does a lot of directing and answers questions rather than helping students find answers on their own

25. The metaphor "teacher as listener" was very characteristic of this classroom. **0 1 2 3 4**

4 = teacher does not dominate group interactions
3 = teacher interacts with groups but provides too much direction

About the Author

Teresa Eckart received a B.S. in Chemistry and Biology from Florida Southern College in 1987 and a M.A. in Chemistry from the University of South Florida in 2005. She has twenty-one years of teaching experiences: twelve in high school chemistry and biology, three with at risk middle school students, and six at a local university in chemistry.

Teresa's experiences are in a variety of fields, both in and out of academia. In each of her areas of employment, she implemented new programs ranging from water treatment to community building issues. Her work history includes technician jobs such as working in the laboratory at a local hospital; a water treatment analysis plant; and in quality control at a large statewide Danish Bakery.

While working towards the completion of her Ph.D. she received the Provost's Commendation for Outstanding Teaching by a Graduate Teaching Assistant and the Barbara B. Martin Endowed Fellowship in Chemistry.