COGNITIVE DIALOGUE, INTERACTION PATTERNS, AND PERCEPTIONS OF GRADUATE STUDENTS IN AN ONLINE CONFERENCING ENVIRONMENT UNDER COLLABORATIVE AND COOPERATIVE STRUCTURES

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ABSTRACT

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Cognitive Dialogue, Interaction Patterns, and Perceptions of Graduate Students in an Online Conferencing Environment under Collaborative and Cooperative Structures

This study examined how the dialogue and perceptions of groups of graduate students engaged in problem-based learning (PBL) and interacting in an asynchronous computer conference (ACC) differed under two group structures. The six heterogeneous groups were assigned to one of two group structures, a cooperative structure employing role assignment and frequent monitoring by the instructor or a collaborative structure that emphasized the use of critical dialogue and employed infrequent instructor monitoring. A mixed methods approach was employed to examine the impact of group structure during the six-week PBL activity. Using Henri and Rigault’s (1996) framework, the content of the online transcript was coded according to function, cognitive skill, and level of processing. An analysis of the interconnectedness of messages was conducted according to the guidelines of Howell-Richardson & Mellard (1996). Group’s perceptions of interdependence and intersubjectivity were aggregated from the individual results of a self-reported survey developed by the researcher.

Advocates of a more structured cooperative learning approach generally assert that assigning roles to group members results in quicker, more consistent levels of interaction, while advocates of the collaborative approach generally
contend that less structure stimulates more elaborate, critical dialogue. Evidence from this study supports the first assertion. Comparisons revealed that the cooperative structure was more potent in generating higher levels of interconnected messages over the entire PBL activity. Weekly comparisons also showed that the cooperative structure promoted higher perceptions of intersubjectivity and higher percentages of deep processing during the initial weeks of the activity; however, these levels equalized across group structures over time.

An implication for facilitators and designers of peer-directed learning in ACCs is that assigning roles and providing close monitoring of group interaction creates learning advantages in the short term. However, small groups may approach similar levels of productive interaction in the long term without the added instructional expense. In addition, the patterns and relative presence of dialogue function and cognitive skill use suggest that specific scaffolds or instructional interventions should be employed to encourage learners to deeply and critically engage the learning issues.
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Establishing peer-directed small groups is a common instructional practice in formal educational settings from primary school to the research university. Influential educational entities, including state boards of education, national standards boards, and professional organizations, recommend or mandate the use of learning methods (APA, 1997, November; NCATE, 2000). A vast body of research indicates that cooperative learning strategies, compared with competitive and individualistic efforts, result in increased achievement and productivity, supportive and committed relationships, social competence, and self-esteem (Johnson & Johnson, 1989). At the same time, a growing movement, especially in regards to a social constructivist theory of learning (Bonk & Cunningham, 1998), forwards theoretical arguments to adopt and utilize collaborative learning strategies (Bruffee, 1995, 1999). This collaborative learning movement is especially relevant to more sophisticated adult learners engaged in problem-based learning. Although these learning structures share the same goal, i.e., to optimize the productive interactions among members of peer-directed groups, they offer different instructional principles and prescriptions to achieve interactions that promote higher order, complex thinking and learning.

Readily accessible digital technologies enable teachers and learners to extend their educational interactions beyond the classroom. The Internet,
especially the user-friendly World Wide Web (Web), offers a vast array of computer-based communication tools that make interaction among group members in on-campus and distributed learning environments a feasible instructional and learning option. Some early educational integrators of these networked communication tools contend that participation in online environments is more frequent and equally distributed than face-to-face interactions (Cooney, 1998; Kang, 1998). Others argue that such participation promotes increased cognitive and metacognitive activity by extending more time for analysis and reflection (Alavi, 1994). Still others claim that networked conferencing systems readily support critical thinking and inquiry (Duffy, Dueber, & Hawley, 1998).

Despite the potential benefits of integrating these technologies into pedagogical practices, minimal empirical evidence exists to support these propositions about online environments. Blumenfeld, Marx, Soloway, and Krajcki (1996), Windschitl (1998), and King (1998) agree that further substantive, critical, and systematic research is needed to inform instructional designers and educators as to how to combine these network communication tools with peer-directed learning strategies. More specifically, study is needed to investigate the complex relationships between the nature of learner dialogue, the various small group learning methods (Meloth & Deering, 1994), and the role and interventions of the teacher (Meloth & Deering, 1999).

Computer-mediated communication (CMC) technologies, especially online conferencing systems, offer unique opportunities to examine peer-
directed group interactions under varying learning methods. These digital transcripts offer a permanent record of group discourse, and may suggest the influence that these methods play on the learner’s level of cognitive activity, especially more complex, higher order thinking and learning required for solving ill-structured problems. In addition, these digital transcripts may provide insight into whether cooperative or collaborative peer-directed structures offer more influential conditions for promoting intersubjectivity, a “shared collective understanding” (Bonk & Cunningham, 1998), and interdependence, i.e., a mutual reliance upon one another (Johnson & Johnson, 1994). For it is argued that both intersubjectivity and interdependence are desirable, if not necessary, conditions to enable productive group interaction and the achievement of small group goals (Bonk & Cunningham, 1998; Slavin, 1991, respectively). Hence, the case study articulated here, explores these critical constructs by examining the digital records of group discourse and the learner perceptions that are engendered under two group structures.

**Significance of the Study**

This study takes one small step in uncovering the subtle differences that exist in two types of small group structures when groups pursue a problem-based learning task and interact in an asynchronous conferencing environment. The digital transcripts of this semi-permanent environment and the groups’ self-reported perceptions of intersubjectivity and interdependence provide a window through which to interpret how these instructional approaches influence group
learning processes during a problem-based activity. Therefore, this unique view of group learning expands the knowledge base on both teaching and learning by highlighting two psychological conditions that might parallel different small group strategies.

This study documents the patterns of interaction that occur over time during a problem-based learning activity. It not only attests to the dynamic nature of competing priorities for coordinating group effort and pursuing learning goals, but also attests to variations in students’ cognitive skill use during problem-based learning in distributed environments. The relative ebbs and flows suggest that there are critical points in the group process that may not only benefit from both organizational and pedagogical supports, but also serve as key indicators of the level of group productivity. Therefore, other practitioners of problem-based learning may find that this study provides insights into the hidden workings of the group learning process and suggests opportunities for designing, facilitating, and evaluating that process.

Most directly, however, this investigation better informs instructors of similarly designed courses, as well as instructional designers of such Web-based courses, as to what group structures might elicit more complex, critical dialogue from learners who are geographically dispersed.

**Research Questions**

This study examines how the interactions of graduate students engaged in a problem-based activity differ under cooperative and collaborative
approaches in an online conferencing environment (Figure 1). Of special interest to this study is examining how these approaches contribute to patterns of productive interactions, (i.e., dialogue that is indicative of complex, higher order thinking and learning). A secondary goal is to investigate how the approach might influence the group's perceptions of interdependence and intersubjectivity.

Specifically, four research questions guide this inquiry:

1. Are there differences in the dialogue (functions, cognitive skills, and levels of processing) and cohesion of messages between the cooperative and collaborative learning approaches?

2. What are the patterns of productive interactions over time? How do they differ under the two approaches?

**Figure 1. Model of Research Design**

**Web-based Graduate Course**

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Process</th>
<th>Variables</th>
<th>Analyses</th>
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<tbody>
<tr>
<td>Sociable</td>
<td>Timer: 6 Weeks</td>
<td>Function</td>
<td>Content Analysis</td>
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<td>Cognitive</td>
<td>• Henn (1992)</td>
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<td>Organization</td>
<td>• Henn &amp; Rigaut (1996)</td>
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<td>Inference</td>
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<td>Collaborative</td>
<td>Interaction</td>
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<td>Asynchronous Conference</td>
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<td>Cooperative</td>
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<td>Heterogenous groups controlling for group process skill, academic major, and sex</td>
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</table>

5
3. What are the group’s perceptions of interdependence and intersubjectivity? Do they differ under these two approaches?

4. Are there relationships among the groups’ perceptions of interdependence and intersubjectivity, cohesion of messages, cognitive function, and level of cognitive dialogue?

**Definition of Terms**

The following terms are employed in specific ways in this proposal:

**Cognitive Dialogue** refers to text located within the postings of an asynchronous computer conference that is indicative of learners’ cognitive skills and strategies while engaged in a learning process (Henri, 1992; Henri & Rigault, 1996), such as analyzing, inferencing, judging, and synthesizing.

**Collaborative Learning** refers to a learning and instructional approach typified by self-directed groups working together on a common learning task. The approach relies upon mutual engagement of learners to jointly clarify their reasoning process and construct common meaning primarily through dialogical discourse (for example, Bruffee, 1999; Koschmann, 1996b; Pea, 1996).

**Cooperative Learning** refers to a teacher-structured, systematic instructional approach typified by small groups of learners working together on a common learning task (for example, Johnson & Johnson, 1989; Sharan & Hertz-Lazarowitz, 1980; Slavin, 1983). The approach employs specific mechanisms to achieve positive interdependence and promotive interaction, especially division of labor activated by role assignment (Johnson & Johnson, 1996).
**Intersubjectivity** refers to a state of mutually shared conceptions, understandings, and knowledge held by members of a group as a result of interaction and cultural processes (Poole, Folger, & Hewes, 1987). In this study, intersubjectivity is operationalized as the learner's perception of shared understandings.

**Interdependence** refers to a state of mutual dependency that exists among the members of a group when individual success is influenced by the action of others (Johnson & Johnson, 1989). In this study, interdependence is operationalized as the learner's perception of mutual dependency.

**Problem-Based Learning** refers to both a curriculum organizer and an instructional strategy that is organized around an authentic, ill-structured problem. The strategy employs self-directed study, reflection, and dialectical discourse to drive learning (Duffy & Cunningham, 1996).

**Productive Interactions** refers to text that indicates complex, higher order thinking and learning as classified by Henri’s (1992) Analytical Models of Cognitive Skills and Processing Information (Appendix A).

**Assumptions**

There are two assumptions in this study:

1. Complex, higher order thinking and learning is expressed in the online interactions and dialogue of students.
2. Henri's (1992) Analytical Models, specifically Cognitive Skills and Processing Information, are valid organizational frameworks from which to examine the dimensions of complex, higher order thinking and learning.
CHAPTER 2

REVIEW OF THE LITERATURE

Since the 1980's, progressive educators have persistently applied and tested small group instructional techniques for their educational worth in face-to-face (FTF) and computer-mediated communication (CMC) environments. The increasing acceptance of socio-cultural learning theory, the adoption of the Learner-Centered Psychological Principles by the American Psychological Association (1997), and the rise of distributed, network-based educational offerings have generated a renewed interest in these techniques. Relevant to the present study are bodies of research and theory concerning cooperative learning, collaborative learning, problem-based learning, and asynchronous computer conferencing.

This chapter reviews these bodies of literature. First, peer-directed learning strategies including cooperative, collaborative, and problem-based, are described. Second, the relevant research literature in FTF environments is summarized. After detailing the relevant asynchronous computer conferencing (ACC) literature, the specific concerns and constructs of this study are highlighted.

Small Group Learning and Instruction

Peer-directed small group learning, in its simplest form, refers to learning that occurs as a result of several people interacting while attempting to learn together. Small group learning strategies have a widespread and long
established record in public school classrooms as a means for teachers to initiate and sustain student motivation to learn, to provide equitable access to limited resources, and to manage large classes (Wagner, 1982). Moore (1991) notes that within the adult community “the self-directed autonomous study circle is one of the oldest and most well-established adult education learning methods” (p. 7).

The widespread use of small group strategies is certainly understandable given its history of empirical validation within educational and work settings and given the contemporary business practices that employ cooperative work groups. A large body of theory and research in educational settings provides substantial evidence that small group strategies, especially cooperative strategies, increase student achievement, productivity, motivation, supportive and committed relationships, social competence, and self-esteem (see reviews by Cohen, 1994; Johnson & Johnson, 1989; Sharan, 1980; Slavin, 1990; Springer, Stanne, & Donovan, 1999).

Within work settings, the demands of conducting business in a global economy and the affordances of contemporary communication media (e.g., digital computer networks) have given rise to a collaborative work mode among professionals, especially within the science, mathematics, engineering, and technology fields (Springer et al., 1999). Commonly referred to as computer-supported cooperative work (CSCW), this line of research and development offers compelling evidence that computer-based communication tools can
enhance collaborative group work including such tasks as generating ideas, making decisions, and problem solving (Kies, Williges, & Rosson, 1998). Therefore, teachers have also been encouraged to employ small group learning strategies in their pedagogical practice, not only to capitalize upon the learning advantages inherent to the instructional strategy, but also to better prepare students for authentic work roles and responsibilities.

Strategies for small group learning are not easily delineated because they are extremely broad in scope ranging from the systematic and prescriptive variety commonly known as cooperative learning strategies, to the more liberal, democratic dialogue-based varieties known as collaborative learning strategies. These peer-directed learning approaches have much in common; they each require active student involvement, employ the principles of interdependence (i.e., individual success is dependent upon group success) and mutuality (in terms of activity, task, goals, interaction), and rely upon student interaction as a primary means of promoting learning. However, as Matthews, Cooper, Davidson, and Hawkes (1995) point out, these approaches (i.e., cooperative and collaborative learning strategies) also have distinct differences, such as: “the style, function and degree of involvement of the teacher; the extent to which students need to be trained to work together in groups; and a variety of additional implementation concerns including, for example, group formation, task construction, and the degree of individual and/or group accountability necessary to ensure equitable distribution of work and accurate grading” (p. 36). In
addition, their theoretical underpinnings and grounding assumptions evolved from different camps.

Practically speaking, these approaches disagree about the amount and type of structure that is appropriate for promoting complex reasoning, critical thought, and the development of problem solving skills. Those who promote a cooperative approach generally argue that higher order thinking occurs when learners are given the means (i.e., the structure, task specialization, and group tactics) with which to interactively engage in high-level discussions that lead to greater conceptual understanding (Johnson & Johnson, 1994). In contrast, the collaborative camp contends that “too much structure on a task that involves higher order thinking skills is dysfunctional because it impedes conceptually oriented interactions” (Cohen, 1994).

Hooper (1992) maintains that the distinction between cooperative and collaborative strategies is essentially based upon the task. The task specialization that is employed in cooperative strategies suggests that individuals learn a subset of the target content, then teach others. In collaborative strategies, learners are encouraged to mutually assist one another in the co-construction of knowledge. Furthermore, Henri and Rigault (1996) argue that the “collaborative approach reduces interdependence within the groups,” while emphasizing the importance of mutuality in accomplishing the task (p. 49).
Among the research literature on small group learning, minimal evidence exists that these two persuasions of small group strategies differentially affect learning. In an attempt to identify possible differences, Springer, Stanne, and Donovan (1999) conducted a meta-analysis of 28 field research studies examining small group learning with over 3,000 undergraduates in science, mathematics, engineering, and technology (SMET) courses. Among other methodological tactics, Springer et al., used high inference coding\(^1\) based upon descriptions of theoretical foundations and classroom practices to assign studies (reported since 1980) to one of three types of small groups, i.e., cooperative, collaborative, and mixed forms. No significantly different effects on achievement were found among these three forms of small group learning. However, results should be interpreted with caution since the assignment of studies to these three group types was limited by sparse descriptions of instructional practice within the studies.

In the present study, it is hypothesized that if differential effects do exist between cooperative and collaborative small group strategies, evidence would exist in the content and patterns of interaction, i.e., in the function of dialogue, level and type of cognitive skills, and cohesion of messages, as well as in the

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\(^1\) Hall, Tickle-Degnen, Rosenthal, and Mosteller (1994) associate high inference coding with research synthesis studies where the findings from primary studies are summarized and new hypotheses are tested. In synthesis studies, the researcher attempts to discover moderator “variables that are associated with effect magnitude” (p. 24). If the variable under scrutiny in the synthesis study was not the focus of the primary study, the researcher uses characteristics of the primary study to make inferences and judgments. This process is referred to as high inference coding.
perceptions of the learners. To set the background for an exploration of these variables, an overview of the theoretical foundations, instructional prescriptions, and research findings will be presented next.

**Cooperative Learning**

Cooperative learning is "a structured, systematic instructional strategy in which small groups work together toward a common goal" (Cooper & Mueck, 1990, p. 68). Cooperative learning strategies are teacher-centered and prescriptive in that the instructor specifies the procedures for organizing and structuring group tasks, interaction patterns, and processes with the goal of enhancing individual achievement and developmental growth of learners.

**Interdependence.** According to Johnson and Johnson (1992), the cooperative learning approach builds upon the Social Interdependence Theory\(^2\) that grew out the work of Lewin (1935) and Deutsch (1949). The premise is that “the type of interdependence structured in a situation determines how individuals interact with each other which, in turn, determines outcomes” (Johnson & Johnson, 1989, p. 5). A structure that supports positive interdependence would be typified by interactions that are encouraging and facilitative, i.e., promotive interactions. In contrast, a structure that supports negative interdependence

\(^2\) In social settings, dependence is cast as a social phenomenon that relates to the directionality of cause and effect relationships. Four dimensions of dependence have been identified, including: positive interdependence (individual outcomes are positively correlated); negative interdependence (outcomes are negatively correlated, such as in competition); social dependence (reliance of one upon another without reciprocity); and social independence (outcomes are not related).
would be typified by oppositional interactions such as discouragement, overt obstructions, and depriving others of information.

Cooperative learning strategies also emphasize the use and development of interpersonal and group process skills. Specific topics, such as conflict resolution and brainstorming, often form the content of a cooperative learning lesson. As such, cooperative methods have been found to increase prosocial behaviors and increase a learner's ability to take the perspective of another (Slavin, 1990).

Johnson and Johnson (1989) contend that an individual's ability to develop, maintain, and modify interdependent relationships with others is the key to their own psychological health. Furthermore, they emphasize that it is an individual's “perceptions of interdependence” that enables the individual to manage social relationships and be motivated to act in ways consonant with group norms. If these contentions have merit, then learners' perceptions may vary in reaction to instructional intervention or the changes in group development.

Among the various pedagogical recommendations to promote perceptions of positive interdependence are those that address common goals, group and individual rewards (e.g., the STAD strategy, see Slavin, 1986), division of roles and resources, heterogenous group composition, and prescriptions for the sequence of interaction (e.g., the Jigsaw strategy, see Aronson, 1978). These
instructional interventions are purported to promote mutual responsibility, obligation, and influence.

Although a teacher may employ a cooperative strategy on an informal or ad hoc basis, the present study relates to more formal, long-lived approaches such as reciprocal tutoring (Palinscar & Brown, 1984), Jigsaw (Aronson, 1978), Learning Together (Johnson & Johnson, 1987), Student Team-Achievement Division also known as STAD (Slavin, 1986), and Group Investigation (Sharan & Hertz-Lazarowitz, 1980). Although the instructional method varies across these strategies, Johnson and Johnson (1996) offer a generalized account of teacher activities in the following:

1. Specify the objectives for the lesson. In every lesson there should be an academic objective specifying the concepts and strategies to be learned and a social skills objective specifying the interpersonal or small group skill to be used and mastered during the lesson.

2. Make a number of preinstructional decisions. A teacher has to decide on the size of groups, the method of assigning students to groups, the roles students will be assigned, the materials needed to conduct the lesson, and the way the room will be arranged.

3. Explain the task and the positive interdependence. A teacher clearly defines the assignment, teaches the required concepts and strategies, specifies the positive interdependence and individual accountability, gives the criteria for success, and explains the expected social skills to be engaged in.

4. Monitor students’ learning and intervene within the groups to provide task assistance or to increase students’ interpersonal and group skills. A teacher systematically observes and collects data on each group as it works. When assistance is needed, the teacher intervenes to assist students in completing the task accurately and in working together effectively.
5. Evaluate students’ learning and help students process how well their groups functioned. Students’ learning is carefully assessed and student performances are evaluated. Members of the learning groups then process how effectively they have been working together. (p. 1019)

Collaborative Learning

Collaborative learning strategies, in contrast, are not as easily defined because they include a broad scope of strategies that are not systematic nor prescriptive (see Bruffee, 1999). Rather, proponents of collaborative learning strategies share a common appreciation that active social interaction plays an important role in learning, especially as it relates to conceptual change (Roschelle, 1996), critical thinking (Duffy, Dueber, & Hawley, 1998), reflection (Scardamalia & Bereiter, 1996), and solving problems in complex, ill-structured domains (Koschmann, Kelson, Feltovich, & Barrows, 1996). As Matthews et al. (1995) point out, collaborative strategies tend to rely upon social interaction and dialogue as the primary mechanism to support learning rather than imposed instructional frameworks. The general contention is that deeper understandings and construction of knowledge result as a byproduct of mutual engagement as participants coordinate their own learning through a dialogical process (Bruffee, 1999; Teasley & Roschelle, 1993).

As only one example of the instructor’s responsibilities in collaborative learning activities, Bruffee (1995, 1999) suggestions to instructors are paraphrased below:
• organize short-term consensus-building groups of five learners or, less optimally, six and long-term research groups of three;
• manipulate group composition to maximize a heterogenous mix to encourage the challenging of unshared biases and opinions;
• define only one social role, the recorder/reporter, and the group member who assumes that role would be determined by the group;
• place group governance in the hands of students;
• utilize negotiation, argumentation, and dialogue as the primary instructional processes;
• redirect student questions about substance, procedure, or social concerns back to the group;
• direct evaluation of group process back to the group;
• cultivate cognitive dissent among groups; and
• hold groups accountable for learning and performance in order to promote group consensus-building and peer mentoring.

**Intersubjectivity.** Collaborative learning strategies typically employ dialectic discourse, negotiation, multiple perspectives, and scaffolding to achieve a shared construction of meaning (see Koschmann, 1996a). As such, a central element is that learners coordinate their social and cognitive activity to establish intersubjectivity, a mutually shared understanding (Wertsch, 1991) or common ground (Clark & Brennan, 1991). The process through which one coordinates common understanding is also referred to as convergence
(Roschelle, 1996), an iterative cycle of displaying, confirming, and repairing meanings, or as grounding (Clark & Brennan, 1991).

Social constructivism and situated cognition offer different perspectives on intersubjectivity. From a Piagetian perspective, social interaction, especially exposure to social confrontation, prompts a state of disequilibrium or cognitive conflict. Further social discussion and negotiation generates movement toward new common conceptual understandings and cognitive restructuring.

Some social constructivist accounts of intersubjectivity link the construct to Lev Vygotsky's conceptualization of learning as occurring first on an external, social plane and second on an internal plane (for example, Bonk & Cunningham, 1998). Central to the theory is the idea that tools (both technical and psychological) and signs, i.e., abstract representations, mediate all thought (Wertsch, 1991). As such, language is used as a primary tool in social activity to negotiate common meaning and understanding. Thus, intersubjectivity is a function of cooperation, co-presence, and continuous coordination of participants' behaviors within a social environment. Implicit in this explanation is the notion that learners are mutually dependent, that is, interdependent upon each other to achieve intersubjectivity.

A prototypical example of a collaborative pedagogical process would consist of a democratic team where individuals of varying abilities provide supports (scaffolds) for each other as they jointly influence each other to achieve progress (through a zone of proximal development) and come to dynamic joint
understandings about the task (Driscoll, 1994). Case-based reasoning (Bonk, Angeli, Malikowski, & Supplee, 2001), debate (Gunawardena, Lowe, & Anderson, 1997), and consensus groups (Bruffee, 1999) are examples of collaborative learning structures.

Situated theories of cognition challenge the separateness of the internal from the external and emphasize the relational interdependencies of all that currently and historically exist (for example Resnick, 1991). In Bereiter's (2000) words, “knowledge inheres in social practices and in the tools and artifacts used in those practices.” In simpler terms, historical precedence, social conventions, and an individual's cognitive conditions establish the tools, constraints, and patterns for interaction. As cognitive operations become more complex, they in turn make more sophisticated social interactions possible. More sophisticated social interactions, in-turn generate more integrated socio-historical conditions, including common knowledge. Therefore, cognitive and socio-historical processes engender one another.

Learning, in this view, is sometimes portrayed as a process of moving from peripheral to full, legitimate participation in cultural practices (Lave, 1991). Proponents of situated cognition often employ pedagogical strategies that immerse the learner (novice) in rich, authentic environments with more experienced others (experts), such as an apprenticeship model (Rogoff, 1990) or with critical knowledge-seeking others, such as in a knowledge-building communities model (Scardamalia & Bereiter, 1994). The focus is on continuous
authentic activity, with the co-participants dependent upon each other to create and push forward a community of practice (Lave, 1991). Intersubjectivity, in this sense, is embedded in the activity and emerges out of participation.

**Problem-Based Learning**

Collaborative learning, with less teacher-imposed structure, is viewed as a complementary match for groups of mature adolescents and adults (Bruffee, 1999) as they employ complex reasoning and problem solving skills during a process of solving ill-structured, real-world problems. In complex, ill-structured domains and situations (such as those encountered in clinical medicine or the classroom), a vast array of concepts and procedures are potentially fruitful for problem analysis and problem resolution. The more complex the knowledge domain and the problem, the greater the difficulty an individual has in representing the problem, judging relevant from irrelevant information, hypothesizing solutions, reasoning, planning a strategy to solve the problem, and executing the solution (Koschmann, 1996b). For example, the research of Zook and DiVesta (1991) points out that students often develop single analogical interpretations that interfere with their future ability to interpret and represent complex problems. In addition, Coulson, Feltovich, and Spiro (1989) document that learners have a tendency to oversimplify complexity, both by reducing complex problems into a few manageable components and by recognizing only obvious, direct cause and effect relationships.
Proponents of collaborative problem-based learning (PBL) approaches contend that PBL provides learners with an authentic context and a motivational incentive to overcome single analogical interpretations, individual bias, and oversimplification by exposing learners to the multiple perspectives, multiple representations, and multiple reasoning processes of their group members (for example, Koschmann, 1996b). Because these perspectives and processes are typically varied and sometimes vague and implicit, they prompt PBL group members to:

- seek, challenge, and give explanations for various perspectives and thereby expose inconsistencies and weaknesses in the reasoning process (Lipman, 1991);
- compare differences and commonalities, and mindfully extract underlying principles (Chi, Feltovich, & Glaser, 1980) and conditional understandings that are necessary for representing and solving complex problems;
- co-construct conceptual meanings; and
- exercise reflection and reflexivity (Cunningham, 1992) as they reassess their own interpretations, thinking, and beliefs in light of these multiple perspectives.

The PBL approach is commonly used as both a curricular organizer and an instructional strategy in professional schools (Savery & Duffy, 1995), e.g., medical, law, and education schools. Duffy and Cunningham (1996) explain that during PBL, it is the "activity in relation to the content that defines learning: the
ability to think critically in their content domain, to collaborate with peers and use them to test ideas about issues, and the ability to locate information related to the issues and bring it to bear on the diagnosis” (p. 190).

Barrows (1985) describes the PBL approach as: “encountering the problem first, problem solving with clinical reasoning skills and identifying learning needs in an interactive process, self-study, applying newly gained knowledge to the problem, and summarizing what has been learned” (p. 15). In collaborative PBL learning, as Haith-Cooper (2000) points out, the role of the instructor ranges from being a co-investigator with full participation in the PBL process, to that of a facilitator who stimulates discussion by questioning and challenging learners' ideas, to a silent observer who intervenes only when the group learning process loses direction.

**Research in Face-to-Face Settings**

**Cooperative Learning**

Much of the early research on cooperative learning has been quasi-experimental with K-12 learners in FTF classrooms or laboratory settings. Historically, the research focused upon on the outcomes of cooperative learning vs. competitive or individualistic efforts, i.e. the nature of interdependence inherent in the learning situation. The results from early reviews (Sharan, 1980) and meta-analyses (Johnson & Johnson, 1989, 1993) of this type have been mostly positive on numerous outcome measures, including: improved interracial relations; higher individual achievement on verbal, mathematical, and procedural
Metacognition refers to “one’s awareness of thinking and the self-regulatory behavior that accompanies this awareness” (Driscoll, 1994, p. 103). The acts of monitoring one’s own performance, pacing oneself, and reflecting upon one’s own thinking are examples of metacognitive strategies.

However, as Cohen (1994) noted, the variability of findings from this same body of research suggests that these positive effects “can actually be obtained under certain conditions” (p. 2). More contemporary studies have sought to identify these conditionalities by focusing upon the processes and content of interaction to determine if the frequency and patterns of exchange, the content or level of dialogue, and the nature of the task-mediated learning and achievement. For example, studies examining the relationship between frequency of interaction and achievement offer conflicting conclusions. Many studies report no relationship (e.g., Webb, 1983), but Cohen and her colleagues consistently report strong positive relationships with achievement on a variety of measures, e.g., post test scores. Cohen (1994) contends that these differences relate to the type of learning task. The bulk of Webb's small group studies were set in mathematics classrooms where the tasks were well-defined computational procedures. Cohen’s research studies, on the other hand, emphasized higher order thinking and employed open-ended discovery and conceptual tasks.

\[3\] Metacognition refers to “one’s awareness of thinking and the self-regulatory behavior that accompanies this awareness” (Driscoll, 1994, p. 103). The acts of monitoring one's own performance, pacing oneself, and reflecting upon one’s own thinking are examples of metacognitive strategies.
Therefore, Cohen and others (e.g., Salomon, 1992; Slavin, 1992) argue that the learning task must require resources that no single individual possesses so that coordination of effort is required. In other words, the task generated a need for mutual dependence upon each other, and prompted increased frequency of discussion.

In a review of studies that linked peer interaction and achievement, Webb (1989) concluded that student-generated explanations have differential effects depending upon whether the learner gives or receives an explanation. More specifically, giving elaborate explanations was found to positively correlate with achievement, yet no consistent relationship was found for receiving elaborated explanation. Although Webb interpreted these findings to mean that explaining behavior influences achievement. In a later study where the goal was to investigate the conditions necessary for help received to be effective, Webb, Troper, and Fall (1995) hypothesized that an elaborated explanation followed by a constructive activity, e.g., summarizing and paraphrasing, would predict achievement. Using multiple regression analysis, the study confirmed the hypothesis when the group tasks were well-defined mathematics operations. The implication for instructional practice was that instructional interventions should be employed to promote both explaining behavior and constructive activity after an explanation. Giving question prompts (Palincsar, Anderson, & David, 1993) and assigning discussion roles (Palincsar & Herrenkohl, 1999) have each been
found to positively influence the quality of explaining behavior by prompting constructive activity.

Within the PBL literature, the quality of group discussions has also been linked to student-generated learning issues (van den Hurk, Wolfhagen, Dolmans, & van der Vleuten, 1999a) and self-directed learning (van den Hurk, Wolfhagen, Dolmans, van der Vleuten, 1999b). For example, van den Hurk et al. (1999b) examined the questionnaire responses of first year medical students enrolled in a PBL course using a structural modeling approach to test the hypothetical interrelationships between the factors in their PBL model. Among other insights, van den Hurk et al. concluded that “the more students prepare themselves in an explanation-oriented way, the deeper the discussion in the tutorial group” (p. 5) and that deeper discussions lead to higher test scores. The explanation-oriented study strategy was typified both by an intent to study the literature in order to explain and summarize the content to another student and by taking notes. The implication for PBL facilitators was that they should encourage learners to use summarizing and note-taking for the specific purpose of supporting future explaining opportunities afforded during small group discussions.

The quality of group discussion and its relationship to group composition is also a common focus of research. For example, Webb, Nemer, Chizhik and Sugrues (1998) examined the quality of group discussion and the individual achievement (hands-on and written) of 662 middle school students as they
pursued a well-structured task, i.e., the construction of electrical circuits. In a rather complex methodological design, this study employed pre-post test conditions administered in three phases with individuals and a variety of group ability compositions. In the final phase of the study, three-person groups were videotaped as they worked to complete the hands-on test. These discussions were coded at the group and individual levels so that higher scores represented more accurate substantive explanations or more constructive dialogue, respectively. The findings showed that (1) dialogue was of higher quality among groups with above-average ability students as evidenced by more correct answers and high-quality explanations; (2) below-average ability students benefitted from these high-quality discussions as evidenced by higher achievement scores than similar students in homogenous groups and high-level group participation; and (3) high-ability students generally performed better in homogenous groups. Statistical analyses indicated that heterogenous grouping was not a significant factor. As Webb et al. noted, these findings present instructional dilemmas in that (a) “the performance of high- and low-ability students cannot be optimized at the same time by manipulating group composition based on ability” (p. 643) and (b) assessments of student work using different group compositions raise issues of fairness and equity.

**Collaborative Learning**

In contrast to the positivist tendencies of research on cooperative learning strategies, research on collaborative and problem-based learning tends to be
more naturalistic, focusing upon the natural and socio-historical significance of
the setting. As such, the studies typically employ more interpretivist research
methodologies (Huynh, 1999), such as case studies, observations, document
analysis, and semantic network maps. Research questions tend to focus on the
process of learning (Roschelle, 1996), asking questions such as “how does
social interaction mediate the construction of knowledge” (Kumpulainen &
Mutanen, 2000), what interaction mechanisms enable the negotiation of
knowledge and shared meaning, and what patterns of interaction emerge during
knowledge co-construction.

For example, Roschelle (1996), working from a relational or situated
action theory of meaning, conducted a micro-analysis of a single case where a
learning dyad, two high school females, explored a computer simulation and
collaboratively constructed an understanding of velocity and acceleration. The
goal was to examine how convergent conceptual understanding may be
achieved in social interaction. In that micro-analysis, Roschelle identified two
mechanisms that enabled the dyad to incrementally co-construct concepts and
work toward mutually held understandings, or convergence. The two
mechanisms of convergence, he claims, are (a) displaying, confirming, and
repairing shared meanings, and (b) the application of progressively higher
standards for evidence of convergence.

**Intersubjectivity.** Koschmann (1999) perceptively observed that the
generation of meaning has been studied under a variety of names including
intersubjectivity, grounding, co-construction, sense making, convergent conceptual change, and managing the intermental (p. 103). Kellerman (1987) noted that studies of intersubjectivity are usually divided into two foci: either a “state of intersubjectivity” or the processes generating mutual or shared understandings. As described in the previous paragraph, Roschelle’s (1996) examination of a convergence process is an example of the latter. In contrast, Stiles (in Kline, Hennen-Floyd, & Farrell, 1990) proposed that “intersubjectivity be studied by analyzing utterances for the extent to which the speaker or the hearer is used as the focus, frame of reference or source of experience in the utterance” (p. 350). In another study, Lee (1999) operationalized intersubjectivity as the number of shared link meanings and directional links between an individual's concept map and a whole class concept map. More specifically, Lee examined the influence of reflection (either individual or collaborative) and metacognitive skill (high and low) on cognitive structure and intersubjectivity. Forty-four undergraduate educational psychology students produced two concept maps, one before reflection and one after. Cognitive structure was operationalized as the concept map. Changes in the link meanings and in the direction of the links were tallied and used to indicate changes in the individual's cognitive structure. A whole class concept map was compiled that contained all data from the individual maps with summed frequencies for each link meaning and directional links. Intersubjectivity scores were derived for each person's final concept map based upon their congruence with the whole class map. Among
other findings, Lee reports that intersubjectivity was significantly higher in the collaborative reflection group, thus substantiating the claims forwarded by proponents of collaborative learning.

**Research in Distributed Environments**

In a network-based environment, such as those afforded by the Internet and its graphic World Wide Web, peer-directed learning is sometimes envisioned as distributed learning (Ehrmann, 1988) or as computer-supported collaborative learning (CSCL, Koschmann, 1996a). Distributed learning and CSCL is thought to emerge from the “intellectual partnerships” that are forged through interaction with all the individuals, computer-based tools, resources, instructional materials, and experiences within a learner’s reach. Salomon (1993) emphasizes the opportunity for intellectual partnerships with technology that are afforded by computer-based environments where learners have almost seamless access to wordprocessors, spreadsheets, databases, modeling tools, and electronic tutors. Others emphasize that CSCL environments facilitate intellectual partnerships with peers through social interaction, i.e., negotiation, debate, and collaboration (Bonk, Appelman, & Hay, 1996; Duffy, Dueber, & Hawley, 1998).

**Computer Conferencing**

Among the widely researched network technologies to enhance social interaction for learning and instructional purposes are computer conferencing tools that permit many-to-many communication (Collis, 1995). These computer-
mediated communication tools enable the exchange and storage of information in either a synchronous (at the same time) or asynchronous (delayed) manner. Asynchronous computer conferencing (ACC) tools, such as SiteScape Forum, E-education, or Blackboard’s CourseInfo Discussion Board Forums (Appendix B), typically archive textual messages in temporal (chronological) or hierarchical threads (Duffy, Dueber, & Hawley, 1998). The hierarchical thread organizes messages offered primarily as text in an outline structure that allow responses to be interjected at strategic levels of the thread. The temporal structure of the ACC is purported to enable a free flow exchange of ideas that is more typical of realtime conversations.

Harasim, Hiltz, Teles, and Turoff (1994) report that computer conferencing has been used for educational purposes since 1982. Teachers have not only extended the intellectual engagement of students by supplementing traditional FTF instruction with ACC learning activities (for example, Vrasidas & McIsaac, 1999), but have orchestrated the delivery of entire courses using an ACC tool and other network-based supports, such as courseware or a Web site (for example, Kitchen & McDougall, 1999). In fact, growth in the offerings of distance education courses at higher education institutions (between 1994 and 1997-98, the number of courses and enrollments approximately doubled) can be attributed, in part, to the adoption and use of asynchronous Internet-based technologies that include conferencing tools (Lewis, Snow, Farris, & Levin, 1999).
Within most tools used for computer conferencing, the conference manager (usually the instructor), and often the learners, can customize the structure and content of the learning environment to support various kinds of learning, management, and social tasks. For example, subconferences or forums can be created to discuss and archive draft versions of group project. The literature documents a broad range of small group activities in ACC environments, including: debates (Gunawardena et al., 1997); case studies (Bonk, Malikowski, Angeli, & East, 1998); simulations; role playing; discussion groups; transcript-based assignments; brainstorming; Delphi technique; nominal group technique; and group projects (Paulsen, 1995). Not surprisingly, the student messages in these various activities tend to be goal-oriented (McIsaac, Blocher, Mahes, & Vrasidas, 1999).

**Research Methodologies**

The online ACC environment offers a ready tool for researchers because the digital data are not only text-based, self-transcribed, and non-intrusive (Levin, Kim, & Riel, 1990), but also readily quantified, summarized, and transformed using a wealth of data mining and analytical tools (Bonk & Wisher, 2000). Quantitative analyses evidenced in the literature include participation rates of student and moderator messages, message lengths (i.e., the number of words or characters per message), the distribution of messages across time, and the linkages between messages (e.g., Howell-Richardson & Mellar, 1996). However, Windschitl (1998) recommends that researchers draw upon a variety
of qualitative methods (see Bonk & Wisher, 2000 for a list) when investigating network-based teaching and learning because a single paradigm of methods may be insufficient to interpret and understand new learning environments.

The most common qualitative research methods examining computer-mediated communication, as reported by Hara, Bonk, and Angeli (2000), include survey research, evaluative case study, and content analysis, often called transcript analysis and envisioned as a subset of discourse analysis. Schiffrin (1994) describes the study of discourse, i.e., a form or unit of language use, as evolving from two distinct paradigms: a formal (structural) or a functional paradigm. Discourse analyses following the formal paradigm tend to find constituents (phonology, syntactic configurations, or speech events) that have particular relationships with one another and can occur in rule-governed arrangements regardless of the context in which the discourse is embedded. For example, “turn-taking” patterns inherent in conversations are a focus of conversation analysis. In contrast, those methods following the functional paradigm assume that discourse is “interdependent with social life, such that its analysis necessarily intersects with meanings, activities, and systems outside of itself” (p. 31). The content analyses employed in the present study follow the functional paradigm in that inferences are drawn from the discourse about the nature of group process and the negotiation of understandings within the group.

Kuehn (1994) and Henri (1992) concur that content analysis, the indirect, unobtrusive, yet structured observation of the information within a specified
container, is one of the most promising methods for analyzing online interactions. Content analysis is a replicable analytical technique employing an explicit set of rules used to discriminate, code, and compress text into a few relevant categories (Krippendorf, 1980). Content analysis may proceed through an emergent coding process, where categories emerge over time by repeatedly returning to the text, or an a priori process, where relevant conceptual frameworks (i.e., mutually exclusive categories, units of analysis, indicators of categories and rule sets) have been generated prior to an examination of the text.

Furthermore, Henri and Rigault (1996) argue that content analysis exposes the learning process by examining the characteristics of the message in terms of its coordinates, functions, and content. Their framework identifies four functions of dialogue including cognitive, metacognitive, organization, and social. The cognitive function includes indicators that discriminate text elements that focus on both the product and process of learning. Based upon Ennis' (1987) taxonomy of critical thinking, Henri’s (1992) cognitive skill element discriminates reasoning skills, i.e., elementary clarification, in-depth clarification, inference, judgment, and strategies. In addition, a dichotomous element, “processing information”, was included to indicate either an “in-depth-elaborative” treatment of content or a “surface-level” treatment.

Working under the assumption that learning occurs at both an individual and social level, Gunawardena, Lowe, and Anderson (1997) developed an
analytical framework that they contend “characterize[s] negotiation of meaning where participants are engaged in the social construction of knowledge in a constructivist learning environment” (p. 413). This interaction analysis model consists of five phases including: (a) sharing/comparing; (b) dissonance; (c) negotiation/co-construction; (d) testing tentative constructions; and (e) statement/application of newly-constructed knowledge. The successive phases of the model are also represented as a movement from lower to higher mental functions, e.g., sharing/comparing is indicative of lower function.

Regardless of its framework, content analysis is often faulted for its lack of discriminant capability and its lack of reliability among users (Fahy, 2001). Several researchers have noted that Henri’s (1992) analytical framework suffers from these problems (LaPointe, Eddy, & Gunawardena, 1993). For example, Gunawardena et al. (1997) noted that Henri’s guidelines for establishing a distinct “unit of meaning” were ambiguous and that the cognitive and metacognitive functions did not mutually exclude each other. However, given that 82% and 75% agreement between coders was reported by McDonald (1998) and Hara et al. (2000), respectively, and that 70% is generally acceptable for such subjective cognitive instruments (Gable, 1986), it must be conceded that Henri’s framework is reliable under certain conditions. Unfortunately, little evidence can be found to support the framework of Gunawardena et al. (1997), i.e., they fail to report a measure of reliability for their framework and also offer ambiguous guidance on determining the unit of analysis.
Research in Asynchronous Computer Conferencing Environments

Following historical precedence (see Clark, 1983, for a discussion of media comparison studies), many studies compared ACC learning environments to FTF on different measures of achievement, such as final grades or post test scores. For example, Hiltz, Coppola, Rotter, Turoff, and Benbunan-Fich (2000) reported no significant difference between modes of delivery for overall course grades in a three-year longitudinal field study of 26 undergraduate courses that were part of a series of studies examining the New Jersey Institute of Technology Virtual Classroom projects. Furthermore, a field experiment in the same series of studies indicates that it was the pedagogical strategy, i.e., the peer-directed small group strategy, that accounted for any differences between the learning environments. More specifically, Hiltz et al. conducted a field experiment within an undergraduate course that examined the separate and joint effects of medium of communication (manual off_line vs. asynchronous computer conference) and types of teamwork (collaborative vs. individual working alone). A case analysis and written report on an ethical scenario comprised the task. Learning perception, length of reports, and solution quality were higher among those who worked in groups through the ACC. In addition, “conditions with (or without) both factors, i.e. individuals/manual and groups/on_line, perceived higher learning than conditions in which only one of the factors was present.” These findings point out that individual characteristics, e.g., preferences for
group vs. individual work, also influence the measures of the efficacy of both the medium and the small group strategy to promote learning.

In an adaptation of the cooperative strategy called Student Teams-Achievement Division (STAD) developed by Slavin (1987), Alavi (1994) examined three classes of MBA students (N=127) as they analyzed business cases. The content and sequence of instruction for all four-person groups consisted of lecture, team task assignment, team case analysis, team report, and individual questioning. However, the classes met in either a traditional lecture hall (one class) or a teaching theater equipped with computer-based group decision support system (GDSS). Groups in the GDSS classes were required to use GDSS tools to support their group discussions of the business cases, however FTF communication was not prohibited. Alavi found that groups with the GDSS support had significantly higher positive affective reactions (perceived skill development, self-reported learning, interest in learning the subject, evaluation of classroom experience, and evaluation of group learning exercise) and significantly higher exam scores. These combined findings suggest that combining social interaction with technological tools enhances peer-directed learning.

Other studies have sought evidence that indicators of peer-directed learning exists in distributed learning environments. For example, Curtis and Lawson's (2001) exploratory study attempted to identify elements of collaboration in Blackboard’s online environment as distributed groups of two to
four mature undergraduate and graduate students pursued three different 
learning activities, including the generation of a composite group report. The 
content of e-mail and discussion board interactions of these groups were coded 
by major types of behaviors thought to be indicative of peer-directed learning, 
e.g., elaborating information, challenging others' contributions, and organizing 
group work. Findings were also presented as more general categories, with 
planning behaviors accounting for about 27% of the interaction, 26% for 
contributing, 28% for seeking input, 16% for reflection and monitoring, and 4% 
for social (totals do not equal 100% due to rounding). Although this study is faught with methodological concerns (e.g., no defined unit of analysis, failure to 
report the reliability of coders, undifferentiated analysis based upon varying 
instructional activities), the findings indicate that the distributed media supports 
some peer-directed learning behaviors, such as “actively seeking help and 
feedback” and “initiating activity” (planning activity). However, the absence of 
both “challenges to the input of others” and attempts to “explain and elaborate 
contributions” strongly suggests that complex, substantive discussions indicative 
of higher order thinking and learning did not occur. This suggests that the 
pedagogical strategy or the distributed medium may have created challenges for 
the groups to both jointly learn and coordinate joint activity.

Student Perspective. From the student perspective, transforming 
conferencing spaces into productive peer-directed environments have met with 
varying levels of success. Numerous studies employing exit surveys or exit
interviews gaging student satisfaction have reported favorable opinions among undergraduate and graduate learners regarding their small group conferencing experiences (such as, Yakimovicz & Murphy, 1995). For example, LaPointe et al. (1993) relate that “many students felt they performed better as participants in an asynchronous setting due to the opportunity to read and reflect before responding” (p. 272). Kitchen and McDougall (1999) report that most learners tend to rate the quality of their group experience high and tend to procrastinate less, but that older students tend to be less satisfied. However, as Gunawardena and Duphorne’s (2000) study documents, learner’s satisfaction with their conferencing experiences is strongly related to the learners’ readiness to learn in an online environment, comfort with various learning approaches, and awareness of online features.

The research literature also reports difficulties in ACC environments regarding information/communication overload (Bullen, 1998), technology limitations (Sage, 2000), and group process, such as coordinating and negotiating requirements of the task or decision-making. For example, Kitchen and McDougall (1999) surveyed graduate students who completed a six-week course on computer applications in education. Their group task was to design and facilitate a week-long class conference. Many comments from the survey indicated that “the magnitude of the task, tight timelines, and the goal oriented approach created considerable pressure for groups to make quick decisions. They felt the medium did not generally support this requirement” (p.252).
Technological issues were also a point of frustration for many students during small group learning activities. Notable among these were: (a) the dissatisfaction with asynchronicity, as evidenced by student desires to have a synchronous conversation (Curtis & Lawson, 2001; Sage, 2000) and by accounts of students meeting independently in FTF meetings (Bullen, 1998); and (b) dissatisfaction with the interpersonal and community-building characteristics of the conference (McIsaac et al., 1999). Although research and practice have documented that the ACC environment can be an effectual conveyer of socioemotional content (such as McDonald, 1998) and a useful medium for creating a “community of learners” (Eastmond, 1995; Weedman, 1999), this evidence supports Gunawardena and Zittle's (1997) findings that learner satisfaction is contingent upon the degree to which a conversant is perceived as a real person, (see discussions of social presence, such as Rourke, Anderson, Garrison, and Archer, 2001). The implication is that instructors in ACC environments should take active steps to assist learners in building and maintaining promotive interpersonal relationships, e.g., making students aware of the importance of acknowledging each other’s points of view (Gunawardena & Duphorne, 2000).

In an ACC environment, decision-making by arriving at group consensus appears to be a difficult small group task. In a 1978 experimental study with college students, Hiltz, Johnson, and Turoff (1986) used a 2 X 2 factorial design with repeated measures to examine small group problem solving discussions for
two modes of communication (FTF groups and computer conferencing groups) and two problem types (human relations versus a ranking problem). Among other findings, the level of agreement among the FTF groups was found to be much higher on both tasks. In fact, for the human relations task, in which the issue was related to differences in personal values, only one of the eight conferencing groups reached agreement compared to all of the eight FTF groups.

Furthermore, imposed or voluntary division of labor in regards to small group tasks have met with various levels of success. For instance, Kitchen and McDougall (1999) reported conflicting evidence from a study of graduate students (N=18) enrolled in a six-week course examining computer applications in education. In this study, four-person groups were charged with designing and moderating the class conference for one week. Although the results of an exit survey offered favorable opinions regarding efficiency gains achieved through shared workload, the analyses of the transcripts revealed that one group which divided the responsibility of moderating the class conference into individual daily responsibilities struggled with the task. Because Kitchen and McDougall failed to elaborate upon the nature of these struggles, one is left with the impression that: (a) task specialization limits the full learning potential afforded by the entire breadth of the conversation and (b) the lack of consistent moderation resulted in a lack of coherence in the online conversation.
**Instructor Perspective.** From an instructor’s perspective, studies have documented that transforming conferencing spaces into productive, peer-directed environments is both a challenging and rewarding task. Research reporting instructors' perspectives suggest: (a) that teachers spend more time teaching an online class than a traditional class (Harasim, 1993; McIsaac et al., 1999; SchWeber, 2000); (b) there is general satisfaction with the frequency of student participation (Bullen, 1998); and (c) there is disappointment that the discussions are not more interactive (Hiltz et al., 2000), more critical (Bonk et al., 1998), and more indicative of “negotiation of meaning and co-construction of knowledge” (McLoughlin & Luca, 2000).

Another issue of concern is how to best facilitate online discussions. In a counterbalanced research design, Bonk et al. (1998) explored the effect of heavy scaffolding (mentoring offered by instructors and other moderators) versus weak scaffolding (peer feedback only) in a case-based online conference of undergraduate educational psychology students. Although they found that heavy scaffolding fostered more contributions, they also discovered that the quality of the cases was significantly higher in the weak scaffolding condition. Content analyses of about a quarter of the discussion threads also revealed that in both conditions “students’ unjustified opinions outnumbered student [justified] claims and questions by more than a six to one ratio” (p. 287). This study indicates that it may be better to present a relaxed conversational tone and minimal instructor intervention in learning situations that demand deep
engagement with the learning issues. However, it also highlights a failure of learners to evaluate unsubstantiated opinions and critically engage the line of reasoning within the online conversation.

**Critical Thinking and Cognitive Dialogue**

Some empirical evidence suggests that effectively designed small group learning activities within ACC environments can promote critical thinking, higher-level cognitive goals, and metacognitive activity. Proponents justify their position by noting that delayed computer conferencing: (a) minimizes irrelevant interpersonal issues that are often present in FTF interaction and focuses the group’s attention on the process and content of the learning task (Phillips & Santora, 1989); (b) extends more time for analysis, the formulation of ideas, and reflection (Harasim, 1993); and (c) offers more equitable opportunities for participation (Bullen, 1998). In this section, those studies related directly to measuring critical thinking will be presented.

Researchers conceptualize critical thinking and other types of complex thinking in different ways. Therefore, cross study generalizations should be viewed with skepticism. However, examining the details of how researchers operationalize and measure the construct will assist in making appropriate comparisons.

Several researchers adopted Ennis’ (1987) or Norris and Ennis’ (1989) definition of critical thinking, i.e., thinking that is reasonable, reflective, and focused upon what to believe or do, as well as their taxonomy of critical thinking
to generate a coding framework to guide content analysis. Notable among these efforts is Henri's (1992) cognitive dimension earlier discussed.

Newman, Johnson, Webb, and Cochrane (1997) employed both Henri's (1992) cognitive dimension and Garrison's (1992) theory of critical thinking to devise paired opposites as indicators of critical thinking for each of Garrison's stages. Garrison viewed “critical thinking as a sequential problem solving process with five stages: problem identification, problem definition, problem exploration, problem applicability and problem integration” (p. 488). Using a controlled experiment of 49 undergraduate students with approximately half in a computer conferencing seminar and the rest in a FTF seminar, factor analysis of the content analyses and questionnaire results (based on Garrison's stages) revealed similar amounts of critical thinking in the two conditions. However, overall depth of critical thinking was higher in the conferencing condition.

In a case study of an online undergraduate course in computer information systems (N=13 completers), Bullen (1998) employed Norris and Ennis' (1989) taxonomy of critical thinking skills (i.e., clarification, assessing evidence, making and judging inferences, using appropriate strategies and tactics) as a framework to identify positive and negative indicators of critical thinking within the computer conferencing transcripts. These transcripts generally consisted of group discussions of weekly readings. After content analysis was complete, students were distributed to three groups that corresponded to high, medium, or low use of critical thinking skills. Bullen
reported higher levels of critical thinking at the beginning and end of the course. He also found overall critical thinking to be at a low-moderate level, with no consistent trends related to task. In addition, semi-structured interviews with students revealed that the majority of students thought the time-independence of ACC facilitated critical thinking; however, students’ understanding of the construct did not conform to the instructors’ definition. For example, Bullen reported that students had difficulty defining the concept and none cited skills in all four categories noted above.

The preceding studies highlight that both the increased gestation time to allow ideas to formulate and the exposure to multiple perspectives do not necessarily result in complex, elaborate postings. Therefore, a perplexing problem in online conferences is how to promote higher quality interactions, especially reasoned justifications of student claims and propositions. The following study reports encouraging results from role assignment to promote productive interactions.

Hara, Bonk, and Angeli (2000) used the starter-wraper technique in a graduate level course in applied cognitive psychology. This technique required students to serve as a starter or wrapper during weekly conference discussions. Starters initiated the weekly conversations with a set of questions from the assigned readings and wrappers summarized the week’s discussion. Their content analysis, also based upon Henri’s (1992) framework, revealed that 70%
of the cognitive dialogue in the conference was at a cognitively elaborate level.

In addition, Hara et al. concluded that:

• the starter’s level of questions provided shape and direction to the types
  and levels of cognitive skills exhibited in online discussion;

• over time, interaction patterns became more continuous and engaging
  with increased peer referencing;

• inferencing skills were more frequently found in the beginning of the
  discussion and judgment appeared more frequently at the conclusion; and

• message length was a consistent indicator of in-depth information
  processing.

These reports are encouraging. However, given that the average number
of messages posted per student per week equaled 1.01, the high levels of
dialogue are heavily skewed by the contributions of the starter and wrapper.
Rather than attributing the high levels of dialogue to the shaping influences of
the starter, one could also suggest that the individual accountability imposed by
the class requirement to perform a specific role may have provided an extrinsic
incentive to the weekly starter and wrapper to engage the concepts under study
at a deeper level. Controlling for role assignment would certainly provide a more
accurate picture of the impacts of role assignment upon other participant’s levels
of processing in this case.
Problem-Based Learning

A search of major educational databases and indexing services indicates that there are few published research studies that examine PBL in ACC environments (Corrent-Agostinho, Hedberg, & Lefoe, 1998) beyond those that investigate the compatibility of various CMC tools to support PBL (Cameron, Barrows, & Crooks, 1999). One example, however, is offered by Sage (2000). She examined eight learners and two teachers in a six-week graduate course where a PBL pedagogy was employed. The researcher interpreted the data (i.e., online dialogue, student journal responses, e-mail questions, and telephone interviews) through a constructivist framework as she attempted to discover how “doing PBL online affects the teaching and learning process” (p. 5). Findings indicated that learners struggled with the dual novelty of communicating in an asynchronous environment and the PBL pedagogy. Those who were novices to playing the role of an active learner and problem solver “found wading their way through multiple resources, online group work, defining and conceptualizing the problem, and using past experience to be overwhelming at times” (p.6). One group, in particular, had difficulties coming to a shared understanding about their task and noted a loss of control over the direction of their studies.

Other closely related projects examined PBL using a mix of CMC tools, such as e-mail lists and chat tools, in on-campus courses. One such project, conducted by Naidu and Oliver (1996), examined the instructional design architecture used by groups of final year nurses charged with a three clinical
decision-making problems. A combination of FTF lectures was used to describe the problem and the required learning process: (a) expressing first perceptions of the problem; (b) exploring the problem and first perceptions; (c) revising first perceptions; (d) preparing posting a critical reflection record. Then, student nurses posted their responses to each of the steps of the learning process to a mailing list whose membership consisted of about a one-fourth of the class. Although this project appeared to lack analytical rigor and methodological soundness, the analyses of critical reflection records and an online attitude questionnaire do offer clear and redundant results. Students not only exhibited collaborative learning practices, such as their willingness to explain and seek validation for their conclusions, but also valued collaboration for its contribution to their learning and problem solving ability.

**Group Development and Interaction Functions**

Following Lundgren's (1977) premise that phases of group development are apparent in the verbal behavior of discussants within a group, McDonald (1998) looked for patterns in group development within a graduate-level distance education course (N=19 students in 3 groups) using the asynchronous capabilities of FirstClass, a course management software system. The weekly task was twofold: (a) students were to read and comment on a reading assignment; and (b) the three groups were to post a summary of their discussion to the larger group. McDonald examined the transcripts of the three groups
across three time periods (weeks 3, 8 and 13) after Henri and Rigault's (1996) content analysis model and Lundgren's (1977) typology of interpersonal needs.

Analyses of the general function of the speech segment (i.e., cognitive, metacognitive, social, and organizational) found that cognitive dialogue dominated the group conferences at all three time intervals with a significant upward trend for the combined groups (i.e., 47%, 81%, and 82% in weeks 3, 8, and 13, respectively). In contrast, organizational speech segments, i.e., those that deal with how to organize oneself and the group, initially accounted for 28% of the discourse and then consistently diminished over time. McDonald discounted the low levels of metacognitive dialogue (i.e., 2%, 1% and 4%) because a separate organizational folder was offered within FirstClass for reflections. As expected, social segments, i.e., those not related to the subject matter, were more prevalent in the initial weeks of the conferences as participants began to get to know each other. The frequency of social dialogue in later weeks is hypothesized by Henri (1992) to be a function of social cohesion within the individual groups or an indicator of task focus.

McDonald's study begins to unravel the group learning process as it relates to group development. Most interestingly, the upward trend in cognitive dialogue may be explained by Walther's (1997) finding that when anticipated future interaction and group unity (as opposed to individual diversity) are stressed, discussants expend more academic effort. Anticipated interaction and group cohesion may also provide the impetus for learning groups to negotiate
and mutually adopt interpretive and interactional schemes (Delia, O'Keefe, & O'Keefe, 1982) that may foster collaborative knowledge creation and intersubjectivity.

**Cohesion and Intersubjectivity**

Cohesion is a construct employed in group dynamics literature to refer to “group connectedness” (Budman in Cota, Evans, Dion, Kilik, & Longman, 1995) or the unity of the group. In communication literature, coherence refers to the connectedness of utterances in a conversation (Pavitt & Johnson, 1999) and is considered an essential component of the communicative act. The two constructs, cohesion and coherence, have much in common including mutual engagement, collective action, commitment to a goal, and similar processes of attaining and maintaining connectedness. For example, in a conversation, the attainment of coherence is believed to occur as discussants make their utterances relevant to the function or topic of what had previously been said (Pavitt & Johnson, 1999). The attainment of group cohesion is also believed to occur as participants contribute to progress toward the group goal and make their contributions relevant to previous ones. Clark and Brennan (1991) call this coordination process “grounding” and maintain that it occurs in a cumulative fashion on both a content and a process level, i.e., “discussants cannot even begin to coordinate on content without assuming a vast amount of shared information or common ground ... And to coordinate on process, they need to update their common ground moment by moment” (p. 127). To paraphrase
Schegloff (1991), the coherence and coordination of interaction depends on the shared understanding, i.e., intersubjectivity, of what has gone before both proximately and distally, and what alternative courses of action lie ahead.

The asynchronous nature of ACC environments presents a challenge to achieving and maintaining coherence, cohesion, and intersubjectivity because the structure of interaction is functionally and temporally disjointed. Therefore, it is not surprising that many researchers measure the interconnectedness of messages to gage the “interactiveness” or “collaborativeness” of the conferences (Henri, 1995) or that they identify the “multiple threads” (i.e., topics) moving through the conference. For example, Levin et al. (1990) describe an analytical method called “Intermessage Reference Analysis” that uses the message as the unit of analysis. This method proceeds by determining if a message is connected to a previous message and coding it accordingly. The resulting data, i.e., the connections between individual messages and the sum of all messages referencing a message, identifies the concentrations of messages that can be used to pursue specific research questions, e.g., is there a tendency for people in a given role to reference messages of those in the same role (Levin et al., 1990).

Howell-Richardson and Mellar (1996) employed interaction analysis and patterns of lexical cohesion to document whether differences in moderator behavior (student moderator versus guest speaker) and tasks (discussion of readings versus plenary session) influence the patterns of interaction within the

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same student body. They examined the first 44 messages of two subconferences within a training course for educational trainers. One conference was student-moderated group with 12 members and the other was moderated by a guest speaker with 48 members. Three criteria were employed to designate the interconnectedness of messages: (a) use of the comment command; (b) explicit reference to a previous message; and (c) reference to a previous topic. Findings were reported as percentage of total messages referenced during the conference and as graphic message maps that employed various types of lines to depict types of references. Howell-Richardson and Mellar found marked differences between the groups in the extent to which messages were referenced. The student-moderated group exhibited higher levels of interconnected messages compared to group moderated by the guest speaker.

Also relevant to the present study is McDonald's (1998) exploration of the intent of the speaker. Taking a variation of Henri's (1992) interactive dimension, McDonald distinguished between independence, explicit response, implicit response, and engaging. She found that independent (i.e., unconnected) and engaging (i.e., trying to engage participants) messages significantly decreased over time, while explicit and implicit responses to previous messages significantly increased over time. McDonald interprets these results as a pattern of interactivity that could indicate collaboration and construction of knowledge by the group.
Summary

The way learners interact is directly influenced by the structure of the learning task (Cohen, 1994) and the context in which they pursue the task. Even small manipulations of task directions and statements of objectives have had an observable impact on the productivity of group discourse (Cohen, 1994).

Peer-directed small group strategies take advantage of group discourse to support learning. However, they differ on theoretical and practical grounds. Cooperative strategies emphasize prescription and teacher-centered interventions, especially by specifying the means of achieving interdependence through task, resource, goal, and reward structures. Collaborative strategies also value interdependence, however that interdependence is also believed to be inherent in communicative processes and mutual activity that enable the co-construction of shared meaning and mutual understanding, i.e., intersubjectivity. Therefore, collaborative strategies tend to be student-directed and employ dialogue (explication, discussion, debate, argument, compromise, and negotiation) as a fundamental method of learning.

Problem-based learning activities are viewed as appropriate learning activities for adult learners because they present authentic problem situations that enable learners to enhance their critical thinking skills through a dialectical inquiry process. Despite the fact that PBL has not been used extensively in distance education settings, the research literature attests to the ability of asynchronous computer conference environments to support peer-directed small
group learning. This predominately text-based environment provides a window through which to examine the subtle differences that may exist in the productive interactions of the cooperative and a collaborative groups.

Productivity in this sense refers to conference dialogue that is indicative of critical and complex thinking. Content analysis methods can be applied to discriminate dialogue based on its function, cognitive skill, depth of processing, and level of cohesion. Furthermore, the theoretical literature suggests that two mechanisms may influence productive interaction, i.e., interdependence and intersubjectivity, and that different group structures may engender these mechanisms. This research study combines an examination of these constructs to uniquely inform our common understanding about peer-directed learning during a problem-based activity in an asynchronous computer conference.
CHAPTER 3

METHODS OF THE STUDY

This study examined a single problem-based learning activity occurring within a single online graduate course. The primary goal was to build a chain of evidence about how six groups interacting in an asynchronous computer conference differed under two group structures, i.e., collaborative or cooperative structure. As indicated in Table 1, this “mixed methods” approach employed both quasi-experimental and qualitative methods by analyzing the cognitive dialogue and interaction patterns of six group conferences, and examining the groups' self-reported perceptions of interdependence, intersubjectivity, and dependence on instructor.

Table 1. Model of Research Design

<table>
<thead>
<tr>
<th>Structure</th>
<th>Dialogue of ACC</th>
<th>Interaction Patterns of ACC</th>
<th>Perception Survey (Mid-project and Final)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Function</td>
<td>Cognitive Skills Level</td>
<td>Cohesion Distribution of Function, Skill, and Level</td>
</tr>
<tr>
<td>Collaborative</td>
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<td></td>
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</tr>
<tr>
<td>Grp 1</td>
<td>A</td>
<td>B</td>
<td>C</td>
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<td>Grp 2</td>
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<td>Grp 3</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grp 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grp 3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Naturalistic Setting

This investigation targeted a six-week problem-based learning activity that occurred during the initial offering of a graduate Web-based course, Technology: Use & Assessment, offered by a midwestern state university in the fall of 2000. According to the course description, this course analyzes the use and assessment of technology. This three-credit, 16-week course was an elective for majors pursuing a masters in Technology Education and was used as a program requirement for a wellness and gerontology program. Of the 27 students initially enrolled in the course, 26 completed the course. The one incompleter dropped during the first week of class.

The course was delivered to two combined sections using Blackboard’s CourseInfo 4.0 which integrates a variety of communication tools, including an asynchronous conferencing tool called Discussion Board, a chat tool called Virtual Chat, and internal e-mail. The Discussion Board maintains an archive of its hierarchical thread including the author, date sent, and the number of times the message was read.

The course was taught by an associate professor from the same department that offered the course. The instructor had 13 years of full-time teaching experience, 9 of which were at the college level. Although this was the first distance course that the instructor had taught via the Web, the instructor had integrated Web-based tools and materials into his face-to-face classes for three years, including the use of Blackboard and the creation of original Web-
based instructional materials. He facilitated his first online class discussion during the spring of 2000. In preparation to teach the course, the instructor completed two online courses, both addressing skill development with online tools for teaching, and developed course materials for two semesters prior to the course. As evidenced by his published monograph on cooperative learning⁴, the instructor was knowledgeable of small group instructional strategies.

**Participants**

Per the approval of the research protocol by the institutional review boards of both the hosting and home universities, the student enrollment was recruited to participate in the study on two occasions, i.e., at the beginning and conclusion of the course. Twenty students agreed to participate in the study by returning signed informed consent forms. During the initial week of class, the instructor administered a student profile survey. This survey (described in more detail in a later section) generated data about participant demographics, as well as participants' skills and experiences related to group processing and asynchronous computer conferencing. These data are used in the following sections to describe the participants of this study.

The 20 participants were all postgraduates and included 3 doctoral, 15 masters, and 2 non-degree students pursuing studies in audiology (N=3), technology education (N=3), and health and wellness (N=14). Sixty percent of the students reported that they accessed the online course from a local site, i.e.,

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⁴ No citation given to assure confidentiality of participants.
from the same city as the host university. Given these data, it can be assumed that some of these individuals attended other classes together and possibly had known each other before entering this course.

Their overall level of prior experience in an online learning environment was low. For instance, only one of the participants (5%) had previously taken an online course. In addition, three (15%) reported that they had collaborated with groups using the Internet, while 16 (80%) had little to no experience using Blackboard's courseware.

While online learning experience was low, 67% of the participants reported that they had previous educational training concerning group process or group dynamics. Therefore, it was not surprising that their self-reported group processing skills were relatively high. More specifically, 100% of the students reported moderate to high levels of proficiency in leading a group, using group process skills, facilitating group discussions, providing substantive feedback, negotiating difference, and building group consensus. However, only 85% report the same level of proficiency regarding the conflict resolution skills.

**Instruments**

The researcher developed one instrument and a separate set of questions for standardizing the collection of data.

**Perceptions Instrument**

Participants’ perceptions of interdependence and intersubjectivity were measured using a self-report survey, the *Perceptions of Interdependence and*
Instrument Development. The researcher initiated the development of the perception instrument by devising a pool of statements that addressed a range of issues relevant to the target constructs, i.e., interdependence, intersubjectivity, and dependence on instructor. These statements were logically derived by synthesizing the discussions of constructs proposed by theoreticians and practitioners, especially those who addressed intersubjectivity, i.e., Roschelle and Teasley (1995), Schegloff (1991), and Delia, O’Keefe, and O’Keefe (1982), and those who addressed interdependence, i.e., Johnson and Johnson (1987), Cohen (1994), and Salomon (1992).

For the intersubjectivity construct, items were devised to address perceptions of mutual or shared understandings about group goal, group process, roles within the group, and target learning concepts. For the interdependence construct, items were devised to ascertain each participant’s perceptions of dependence upon other group members and the structure of the inquiry task. For dependence on instructor, the items related to reliance upon the instructor for learning and group progress. This original item pool resulted in 29 statements.

Readability Focus Group. Three master’s students, who were enrolled in the same statistics course at the host institution of the present study, analyzed the readability of the survey to ensure an accurate interpretation of the
instructions and the perception statements. Among other comments, this focus group noted: (a) redundancies; (b) an imbalance in the wording of questions, e.g., “I rely” rather than “I do not rely”; and (3) interpretation issues related to key terms, e.g., “facilitator” can be interpreted to mean “group leader” rather than the intended instructor. The items and directions were revised and resulted in the survey described below.

**Content Validity.** To assure the content validity of these statements, thirty-five experts (i.e., authors who had either published articles addressing the constructs or graduate students who had read extensively on the constructs) were e-mailed an introductory letter that asked them to examine the list of survey statements and judge whether each question was appropriate to represent the construct, i.e., interdependence, intersubjectivity, and dependence on instructor. Thirteen Web-based surveys were returned. Two respondents were eliminated: one because of self-reported “lack of expertise” and another because of failure to respond to the questions. Statements receiving less that 70% approval were eliminated from the study with the exception of items #10 and 14. These items appeared on the mid-project and final surveys administered during this study, but were eliminated from the computations of composite scores for each scale since they did not reach the 70% criterion for validation.

**Perceptions of Interdependence and Intersubjectivity Survey.** The perceptions survey had three sections (Appendix C). The first section consisted of one item to identify the respondent with their specific group and one open-
ended question that elicited the participant’s conception of their team’s goal. The second section consisted of 23 statements. The responses were made by marking levels of agreement with each statement according to a seven-point Likert-like scale: (1) strongly disagree, (2) moderately disagree, (3) somewhat disagree, (4) no opinion, (5) somewhat agree, (6) moderately agree, and (7) strongly agree. Six of these items (#1, 8, 11, 13, 16, and 23) were included to indicate the respondents' perception of intersubjectivity in regards to perspective taking, group goal, group process, group role, and target learning concepts. Twelve items assessed the participants' perceptions of interdependence with ten focusing upon group members (#4, 5, 6, 9, 12, 13, 15, 17, 18, 21, and 22) and two items focusing upon the structure of the task (#2, and 7). Three items addressed dependence upon the instructor (#3, 19, and 20). The third and final section asked for open-ended comments about the group experience.

**Pilot Test and Reliability Analysis.** Pilot tests of the *Perceptions of Interdependence and Intersubjectivity* instrument were conducted to ascertain the internal consistency of the items. Data from two trials, 15 responses from an on-campus class from the same department as the target population and 6 responses from an online graduate course offered at a nearby university, were combined and resulted in a Cronbach Alpha of .77 for the entire instrument. Internal consistency of items for the three scales were .73 for interdependence, .60 for intersubjectivity, and .50 for dependence upon instructor.
Participant Question Set

The instructor administered a student profile survey to students during the first week of class to establish baseline information about student demographics. Among the questions included in the survey were ones relevant to this study, including: educational attainment level, self-assessments of computer and group processing skills, online experiences, and formal education in these areas. Specifically, the survey included 8 Likert-like questions, 2 closed questions, and 2 open-ended questions to assess the learner’s experience and perceptions of their own group processing skill (see Appendix D for details). A typical Likert-like question asked students to rank their proficiency in “facilitating equitable group decision making.” The questions were reviewed by the instructor of record and a professional educational researcher to assure validity and readability.

Procedure

During the introduction to the course, the instructor distributed a description of the research study and a student profile survey to the course participants following university guidelines. In addition, “Informed Consent” forms were mailed to all students. Student profiles and returned consent forms were collected and stored for future reference and data analysis.

During the middle third of the course, after the class participants had acclimated to the Web-based communication tools and before any self-directed group work had been employed, the facilitator purposefully assigned students to groups of 4 to 5 learners in order to achieve heterogenous group composition
based upon the following criteria: (1) learners’ previous experiences and skills in group process techniques (as evidenced by an average on question 18 of the Student Profile); (2) educational major; (3) gender; and (4) local or distant access. Groups were randomly assigned to either a cooperative or a collaborative treatment. The instructor initiated the PBL activity by posting the learning task to the Assignments section of Blackboard and posting the initiating message to each of the six group conferences.

**Learning Task.** As described in Appendix E, the problem-based task for all groups consisted of the same learning goal, context, inquiry expectations, time requirements, and deliverables. However, the instructor purposefully structured and interacted with the groups in two different ways, as a cooperative learning approach and a collaborative learning approach, according to the principles and guidelines outlined below. When introducing the learning task, the instructor did not inform groups/individuals which type of approach they had been assigned in order to minimize the placebo or Hawthorne effect.

In the three **cooperative learning groups**, interdependence was enhanced through role assignment. Specifically, the instructor assigned specialist roles (i.e., economics, Web, schools, health and wellness, lead editor, and in a five-member group a lead editor) to each participant. During the six-week task, the facilitator closely (every 2 or 3 days) monitored discussions in the conferencing environment and interjected praise, offered advice, answered questions, and posed critical questions.
In the three **collaborative learning groups**, the facilitator encouraged each group to employ a critical dialogue to achieve their goal by explicitly explaining the nature of a critical dialogue (i.e., when each participant advocates and defends a point of view with evidentiary support then challenges the propositions of others). He informed them that governance, organization, and management was a group responsibility. During the six-week task, the facilitator sporadically (every 4 or 6 days) monitored discussions in the conferencing environment, reminded the team of deadlines, interjected praise, answered questions, and posed critical questions. But when asked a question regarding governance, organization, or management of the group, the facilitator redirected it back to the group.

Data files of all group conferences within the *Discussion Board* were backed-up on a weekly basis. Of special note, three national holidays occurred during the PBL activity; Election Day and Veteran’s Day occurred during Week 4 and Thanksgiving occurred during Week 6. Upon completion of the course activity, the complete conference files were archived in a secure location.

Participants’ perceptions of interdependence, intersubjectivity, and dependence on instructor were tracked with a self-report perceptions survey administered on two occasions during the research project. The first online administration occurred during the mid point of the activity, the second occurred upon delivery of the group artifact (i.e, the end of the activity).
Data Analysis

In this study, four different methods were used to analyze the data:

• Content analysis was used to examine both the instructor's and students' interactions within the six group transcripts. The base unit of analysis was a single categorical unit, e.g., a single function or cognitive skill unit.

• Interaction analysis was used to judge the cohesion of messages. The unit of analysis was a single message.

• Survey analysis was used to measure student's self-reported perceptions of interdependence and intersubjectivity. The unit of analysis was the aggregated responses of students within the same group for each perception scale.

• Correlation analysis was employed to assess the relationships among key variables.

Content Analysis

Initially, the analyses of each group transcript began by deleting the content of all messages from nonparticipants from the digital file. Then, all of the messages originating from the instructor were examined to determine a level of compliance with the cooperative and collaborative guidelines. Specifically, each paragraph originating from the instructor was segmented and categorized into a single unit that represented a single function, i.e., pedagogical, managerial, social, and technological (Bonk, Kirkley, Hara, & Dennen, 2001). Managerial units were further categorized as directives-suggestions, redirects, praise,
question, or reminders. If the instructor conformed to the aforementioned guidelines for interaction, there would be a higher frequency of managerial units in the cooperative structure with evidence of more directives and suggestions posed to the cooperative groups, and a greater number of redirects to the collaborative groups.

Content analysis of the meaning of participants’ messages was conducted using a modified version of Henri and Rigault’s (1996) framework of Function (Appendix F), and Henri’s (1992) framework of Cognitive Skills (Appendix G) and Levels of Information Processing (Appendix H). These frameworks were deemed appropriate for this study because they emphasized two sets of skills often associated with problem-based learning, i.e., critical thinking and inquiry skills (Duffy & Cunningham, 1996; Albanese & Mitchell, 1993). Per Hara et al.’s (2000) suggestion, however, modifications in the models were made by adding indicators that were more specific to the learning task of this study, e.g., challenges the value of a policy option based on empirical data.

The analyses of each group conference proceeded in a chronological order of the base threads in the following manner:

1. The originator, date of message, and subject line was retained with each message.

2. Each message was segmented according to individual units of meaning that were first differentiated by paragraph structure (Hara et al., 2000). Standard salutations and closures that were often structurally separated
as paragraphs, e.g., “Hello Again” or “See Ya”, were incorporated into subsequent or previous segments.

3. Each paragraph was segmented into units that represented a single function that was no smaller than a single sentence. In sentences that contained more than one function, an algorithm (Appendix I) was employed that essentially ranked the functions, i.e., first to cognitive, organization, metacognitive, and social.

4. Each cognitive function was further segmented into units that either represented a single cognitive skill or a single sentence. In sentences that included dual skills, an algorithm was employed to determine assignment of category (Appendix J).

5. Lastly, the cognitive skill units were categorized according to level of processing, i.e., surface-level or in-depth processing.

**Statistical Analyses.** These content analyses resulted in frequencies for each category. Given that some groups of students tended to be more verbose than other groups and the focus of this study was on the relative differences between the subsets of the categories, frequency counts were converted to percentages of each preestablished category. The corresponding percentages were reported along with group structure means and standard deviations. As modeled by Hiltz et al. (2000), significance levels were set at a liberal .10 to search for results worthy of note on dependent variables. Nonparametric statistical tests were deemed most suitable for these analyses because these
tests: (1) were appropriate for the nominal and ordinal data gathered for this study; and (2) do not assume homogeneity of variance or normal distributions. Specifically, the Mann Whitney U test was used to test for between group differences and the Wilcoxon Signed Ranks were used to compare changes over time.

**Inter-rater reliability.** Rater bias was minimized by employing multiple coders (N=2) on all data sets and employing a third coder to judge disagreements. Training was provided to all coders and included: (a) full explanations of the conceptual framework and coding process; (b) copies of coding rules and guidelines; (c) examples and nonexamples; (d) practice with *unitizing* and *categorizing* a data set; and (e) discussing disagreement in rating until agreement was reached. Inter-rater reliability was established prior to the onset of coding by requiring all coders to analyze the same data subset for a specific dimension variable. Then, a Cronbach Alpha reliability analysis was conducted on the data. The training, coding, and analytical cycle continued for all coders until reliability correlations exceeded the .70 acceptable limit for affective instruments as identified by Gable (1986). As shown in Table 2, achieving acceptable reliability correlations across coders for the cognitive skill dimension required three training sessions. This methodological concern was also reported by LaPointe et al. (1993).
Table 2. Inter-rater Reliability Correlations for Analyses of Conferences

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Unit of Analysis</th>
<th># of Training Sessions</th>
<th># of Units</th>
<th>Cronbach Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor Dialogue</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Function</td>
<td>Single Function</td>
<td>2</td>
<td>75</td>
<td>.85</td>
</tr>
<tr>
<td>Managerial</td>
<td>Single Intervention</td>
<td>2</td>
<td>49</td>
<td>.76</td>
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<td>Student Dialogue</td>
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<td></td>
</tr>
<tr>
<td>Function</td>
<td>Single Function</td>
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<td>.89</td>
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<tr>
<td>Cognitive Skill</td>
<td>Single Skill</td>
<td>3</td>
<td>50</td>
<td>.78</td>
</tr>
<tr>
<td>Level of Processing</td>
<td>Single Skill</td>
<td>1</td>
<td>50</td>
<td>.74</td>
</tr>
<tr>
<td>Messages</td>
<td>Cohesion Message</td>
<td>1</td>
<td>75</td>
<td>.82</td>
</tr>
</tbody>
</table>

Interaction Analysis

The interaction patterns of the groups were analyzed by two methods to address the distribution and cohesion of the conference.

**Distribution.** An analysis of the distribution of messages resulted in simple descriptive summaries including the frequency counts and percentages of function and cognitive skill originating within each group by week, group structure means, and standard deviations. The Mann-Whitney U was employed to test for possible differences between group structures.

**Cohesion.** In this study, cohesion was defined as the interrelatedness of messages within a single group conference. It was hypothesized that higher cohesion was more indicative of complex, higher-order thinking. The level of cohesion of each group’s conference was determined by using a message
referencing technique adapted from Howell-Richardson and Mellar (1996). This process employed a set of three criteria to establish linkages among messages, including:

1. Use of the software comment command which automatically marks a message as linked to another;

2. Explicit lexical reference to a previous message either by the name of the previous contributor or by the message number;

3. Explicit lexical reference to a topic through exact repetition of key lexical items occurring in previous messages or use of a synonym (Howell-Richardson & Mellar, 1996, p. 56).

The analysis resulted in descriptive statistics (frequency counts and percentages of linkages for each message, group totals, group structure means, and standard deviations) and allowed for between group comparisons using the Mann Whitney U.

**Perceptions Survey Analysis**

The data from each administration of the *Perceptions of Interdependence and Intersubjectivity* survey were separately averaged to create individual composite scores for interdependence and intersubjectivity scales. Individual composite scores were aggregated for each of the six groups. Differences between the two group structures were compared using the Mann-Whitney U
test. Changes in perceptions over time were examined using the Wilcoxon Signed Ranks, a repeated measures test.

**Relationships of Key Measures**

The frequency values for key variables i.e., cognitive function, deep processing, and cohesion, were combined for Weeks 1-3 and Week 4-6. The Spearman's Rho Rank Order Correlation was conducted in order to determine if there were any relationships among these composite measures and the perception scales. As suggested by Best (1981), the low number of observations and the limited range of possible scores examined in this study demanded more conservative criteria for evaluating the correlation coefficient than those commonly employed in the literature. Therefore, notable relationships were indicated as "substantial to strong" for a coefficient of .80 to 1.00 or as "moderate to substantial" for .60 to .80.
CHAPTER 4

FINDINGS

This chapter reports both quantitative and qualitative findings from analyses of the computer conferences and perception surveys. To begin, the scope of participation within the study is established by characterizing the frequency of messages generated during the problem-based activity. Second, the results of the analyses of the instructor’s messages are presented in order to establish a level of compliance with the cooperative and collaborative guidelines. Third, the original research questions are addressed with narrative descriptions, descriptive statistics, and statistical analyses. Lastly, general qualitative observations made during the content analyses are offered.

Computer Conferences

During the problem-based six-week activity, the graduate class generated a total of 837 conference postings or messages during the problem-based activity with 91% of those messages originating from students and 9% from the instructor. Twenty of 26 students (77%) participated in the study, leaving at least three students in each of the six groups. After eliminating the messages from nonparticipants, 704 messages were included in the study. As indicated in Table 3, this study examined nearly 80% (N=366) of the student messages generated in the three cooperative groups and slightly over 80% (N=259) in the three collaborative groups. Students in the cooperative groups generated more
Table 3. Summaries and Test Statistics of Messages in Conferences

<table>
<thead>
<tr>
<th>Structure</th>
<th>Population</th>
<th>Messages (M)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Group N</td>
<td>Study N</td>
</tr>
<tr>
<td>Cooperative</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>4.33</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>.58</td>
</tr>
<tr>
<td>Collaborative</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>4.33</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>.58</td>
</tr>
<tr>
<td>Total</td>
<td>Sum</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>4.33</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>.52</td>
</tr>
</tbody>
</table>

Test Statistics

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>2.000</th>
<th>4.000</th>
<th>3.000</th>
<th>3.000</th>
<th>.000*</th>
<th>2.500</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mann-Whitney U</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exact Sig. [2*(1-tailed Sig.)]</td>
<td>.400</td>
<td>1.000</td>
<td>.700</td>
<td>.700</td>
<td>.100*</td>
<td>.400</td>
</tr>
</tbody>
</table>

Note: M = Message

messages with an average of 35.72, in contrast to the collaborative groups that had an average of 25.06 messages per student.

Significance testing was conducted using SPSS 10.0.7. The Mann-Whitney U, a statistical test that uses the ranks of the six cases to test whether two independent samples were from the same population, was consistently employed throughout these analyses to make between group comparisons. As
indicated in the test statistics of Table 3, there was no evidence to suggest that participation levels, e.g., number of messages in the study, were statistically different with the exception of the instructor messages which will be discussed in the following section.

**Instructor Messages**

Analyses of instructor messages were conducted in order to characterize the treatment differences between the cooperative and collaborative groups. As shown in Table 3, the instructor posted a total of 79 messages to the group conferences during the problem-based activity. On average, the instructor sent 16.67 messages to each cooperative group and 9.67 messages to each collaborative (U=.000, p=.100). A substantive review of the initial messages posted by the instructor documented that the instructor consistently assigned roles to the cooperative groups while explicitly stressing that it was the responsibility of these individuals to raise critical issues related to their role, thus promoting individual responsibility. These roles were termed as “specialist positions” and included economics, health and wellness, school, and Web specialists; a lead editor role was assigned in a five-person group. In the collaborative groups, there was no evidence to suggest that roles were assigned. The initial message from the instructor consisted of directives to mutually support each other and actively contribute to a critical, substantive discussion of the problem.
**Function.** To continue the analyses of instructor messages, each message was segmented into units that represented a single function, i.e., pedagogical, managerial, social, or technological (Bonk et al. 2001). The descriptive statistics of the instructor messages for these functions are shown in Table 4. A Mann-Whitney U Test revealed statistical evidence that the pedagogical (U=.000, p=.100) and managerial (U=.000, p=.100) units tend to be more numerous in the cooperative than collaborative groups with a mean difference of 41.66 and 29.67, respectively.

**Table 4. Summaries and Test Statistics of Instructor Units by Function**

<table>
<thead>
<tr>
<th>Structure</th>
<th>Pedagogical</th>
<th>Managerial</th>
<th>Social</th>
<th>Technological</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Function (Frequency)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>Mean</td>
<td>Std. Dev.</td>
<td>Sum</td>
</tr>
<tr>
<td>Cooperative</td>
<td>1</td>
<td>84</td>
<td>45.33</td>
<td>161</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>24</td>
<td>53.67</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>28</td>
<td>2.00</td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>136</td>
<td>7.00</td>
<td>21</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>45.33</td>
<td>3.33</td>
<td>2.67</td>
</tr>
<tr>
<td>Collaborative</td>
<td>1</td>
<td>4</td>
<td>3.67</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>3</td>
<td>24.00</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>4</td>
<td>2.67</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>11</td>
<td>2.00</td>
<td>72</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>3.67</td>
<td>2.67</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>N</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Sum</td>
<td>147</td>
<td>14</td>
<td>233</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>24.50</td>
<td>2.33</td>
<td>38.83</td>
</tr>
<tr>
<td></td>
<td>Std. Dev.</td>
<td>31.16</td>
<td>16.69</td>
<td>.52</td>
</tr>
<tr>
<td>Test Statistics</td>
<td>Mann-Whitney U</td>
<td>.000*</td>
<td>.000*</td>
<td>1.50</td>
</tr>
<tr>
<td></td>
<td>Exact Sig. [2*(1-tailed Sig.)]</td>
<td>.100*</td>
<td>.100*</td>
<td>.200</td>
</tr>
</tbody>
</table>
Due to the unexpected significant differences in pedagogical function based on treatment, a post hoc analysis was conducted of those units. This revealed two consistent patterns in the cooperative conferences that did not occur in the collaborative. First, the instructor posted a series of three to four messages that were phrased as "hints for specialists" at Week 3 in each cooperative group. While the instructor indicated that the intent of these messages were managerial, an interpretation of these units indicated both a managerial and a pedagogical function. For example, the following text shows how a single paragraph was segmented and coded:

### Text of B38.147

Elaine is the Health and Wellness Specialist for Team Blue. Although some of these points may have already been addressed in the discussion board forum, here are some tips for Elaine.

1. There are many issues related to health and wellness.

   Part of your job is to determine (with the help of your team) which issues are the most critical ones.

Is socialization critical? What about physical fitness, eyesight, posture, or carpal tunnel syndrome? And are there "positive health results?"

The call is yours.

<table>
<thead>
<tr>
<th>Text of B38.147</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elaine is the Health and Wellness Specialist for Team Blue. Although some of</td>
<td>M</td>
</tr>
<tr>
<td>these points may have already been addressed in the discussion board forum,</td>
<td>P</td>
</tr>
<tr>
<td>here are some tips for Elaine.</td>
<td></td>
</tr>
<tr>
<td>M 1. There are many issues related to health and wellness.</td>
<td></td>
</tr>
<tr>
<td>P Part of your job is to determine (with the help of your team) which issues</td>
<td></td>
</tr>
<tr>
<td>are the most critical ones.</td>
<td></td>
</tr>
<tr>
<td>M Is socialization critical? What about physical fitness, eyesight, posture,</td>
<td></td>
</tr>
<tr>
<td>or carpal tunnel syndrome? And are there &quot;positive health results?&quot;</td>
<td></td>
</tr>
<tr>
<td>M The call is yours.</td>
<td></td>
</tr>
</tbody>
</table>

Legend:
M = Managerial
P = Pedagogical
This single instructor intervention contributed greatly to units coded as pedagogical and managerial function. For example, in one cooperative group, this intervention contributed 20 of the 28 pedagogical units and 27 of the 56 managerial units. With only a few exceptions, such pedagogical text messages were not represented in the conferences of the collaborative groups.

Second, one of the cooperative groups yielded almost three times the number of pedagogical units as each of the other two (see Cooperative Group 1 shown in Table 4). A substantive review of the text indicated that this group requested feedback from the instructor on two drafts of their project. This single group action prompted the instructor to generate two messages that were subsequently coded as 44 pedagogical units. None of the other groups employed this learning strategy.

**Managerial.** As shown in Table 5, the managerial units of instructor messages were further coded into type, i.e., directives, redirects, praise, questions, reminders, and explanations. Differences (U=.000, p=.10) were found between the two treatments for directives, reminders, and questions with more directives (difference between means= 26.33) and questions (difference between means=2.33) offered to the cooperative groups and more reminders (difference between means=1.67) offered to the collaborative. However, the incidence of these variables is so low, ranging from 1 to 3 per group conference, that any interpretation would be suspect.
Table 5. Summaries and Test Statistics of Instructor's Managerial Units by Type

<table>
<thead>
<tr>
<th>Structure</th>
<th>Directive</th>
<th>Redirect</th>
<th>Praise</th>
<th>Question</th>
<th>Reminder</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coop.</td>
<td>40</td>
<td>1</td>
<td>9</td>
<td>2</td>
<td>1</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>38</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>45</td>
<td>0</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Sum</td>
<td>123</td>
<td>2</td>
<td>23</td>
<td>7</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>Mean</td>
<td>41.00</td>
<td>.67</td>
<td>7.67</td>
<td>2.33</td>
<td>1.00</td>
<td>6.33</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>3.61</td>
<td>.58</td>
<td>4.16</td>
<td>.58</td>
<td>.00</td>
<td>1.53</td>
</tr>
<tr>
<td>Collab.</td>
<td>16</td>
<td>1</td>
<td>7</td>
<td>0</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td>1</td>
<td>6</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Sum</td>
<td>44</td>
<td>2</td>
<td>16</td>
<td>0</td>
<td>8</td>
<td>13</td>
</tr>
<tr>
<td>Mean</td>
<td>14.67</td>
<td>.67</td>
<td>5.33</td>
<td>.00</td>
<td>2.67</td>
<td>4.33</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>1.53</td>
<td>.58</td>
<td>2.08</td>
<td>.00</td>
<td>.58</td>
<td>3.21</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Sum</td>
<td>167</td>
<td>4</td>
<td>39</td>
<td>7</td>
<td>11</td>
<td>32</td>
</tr>
<tr>
<td>Mean</td>
<td>27.83</td>
<td>.67</td>
<td>6.50</td>
<td>1.17</td>
<td>1.83</td>
<td>5.33</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>14.63</td>
<td>.52</td>
<td>3.21</td>
<td>1.33</td>
<td>.98</td>
<td>2.50</td>
</tr>
</tbody>
</table>

Test Statistic
- Mann-Whitney U: .000* 4.500 2.500 .000* .000* 2.500
- Exact Sig. [2*(1-tailed Sig.)]: .100* 1.000 .400 .100* .100* .400

Conclusion. The analysis of the instructor messages leaves no doubt that the cooperative and collaborative groups were structured in different ways. In the cooperative groups, the group structure and process was more instructor directed than in the collaborative groups. The instructor assigned specialist roles to each cooperative group member and offered notably more managerial guidance in the form of directives. In the collaborative groups, the instructor informed the group members that group organization and management was a group responsibility. As evidenced by the frequency of instructor messages, the
instructor monitored and interacted more frequently with the cooperative groups than the collaborative groups. Quite unexpectedly, however, these instructor messages also provided more pedagogical guidance for the cooperative groups than for the collaborative groups. Therefore, more pedagogical support must be considered part of the cooperative treatment.

**Analyses of Research Questions**

**Are there differences in the dialogue (functions, cognitive skills, and levels of processing) and cohesion of messages under the cooperative and collaborative learning approaches?**

Given that the range of frequency of messages for the six groups was broad, i.e., ranging from 66 to 221, and that the focus of this study was upon the relative function and cognitive differences of group dialogue, between group comparisons were based upon percentage of each preestablished category. It should be noted that making comparisons based upon percentages tends to "standardize" results and can hide the power of difference. For example, if the relative percentages for cognitive, organization, metacognitive, and social were 40, 40, 10, 10, one would not know if these were derived from the frequencies of data set A (A frequencies = 4, 4, 1, 1) which has a lower incidence rate and less power than data set B (B frequencies = 16, 16, 4, 4).

**Function.** To begin these analyses, student messages were segmented into single units that represented a single function, i.e., cognitive, organization, metacognitive, and social (Henri & Rigault, 1996). Segmenting by function
resulted in a total of 2,138 function units for the study including 1,265 for the cooperative groups and 873 for the collaborative. Frequency counts for each category were converted into percentages as shown in the descriptive summaries in Table 6. Overall, the cognitive (41.44%) and organization (35.71%) functions dominated all group conferences. Figure 2 details the slightly higher percentages of cognitive function units occurring in the collaborative groups (45.25%) and a higher percentage of organizational and social units occurring in the cooperative (38.34% and 12.62%, respectively). However, the differences between group structures were not statistically significant.

**Cognitive Skill.** After all participants' messages were segmented by function, the cognitive units were further segmented to represent a single cognitive skill, i.e., elementary clarification, in-depth clarification, inference, judgment, or strategy. This process yielded 1,341 cognitive skill units, of which the largest percentage was elementary clarification (27.5%) and the least was in-depth clarification (9.14%). A similar distribution of cognitive skills for both group structures can be seen in Figure 3 with the exception of a negligible deviation in the percentage of units indicating elementary clarification skills. As the test statistics in Table 7 show, a rank order comparison provides no evidence that consistent differences exist between the group structures.
Table 6. Summaries and Test Statistics of the Percentages of Function Units by Group Structure

<table>
<thead>
<tr>
<th>Structure</th>
<th>Cognitive</th>
<th>Organization</th>
<th>Metacognitive</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent</td>
<td>Std. Dev.</td>
<td>Percent</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Cooperative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>30.71 (121)</td>
<td>6.373</td>
<td>44.16 (174)</td>
<td>5.626</td>
</tr>
<tr>
<td>2</td>
<td>38.92 (79)</td>
<td>6.373</td>
<td>10.84 (22)</td>
<td>5.626</td>
</tr>
<tr>
<td>3</td>
<td>43.26 (289)</td>
<td>6.373</td>
<td>11.98 (80)</td>
<td>5.626</td>
</tr>
<tr>
<td>Mean</td>
<td>37.63</td>
<td>.570</td>
<td>11.413</td>
<td>.975</td>
</tr>
<tr>
<td>Collaborative</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>40.22 (74)</td>
<td>4.388</td>
<td>39.67 (73)</td>
<td>5.733</td>
</tr>
<tr>
<td>2</td>
<td>47.27 (121)</td>
<td>4.388</td>
<td>10.87 (20)</td>
<td>5.733</td>
</tr>
<tr>
<td>3</td>
<td>48.27 (209)</td>
<td>4.388</td>
<td>14.06 (36)</td>
<td>5.733</td>
</tr>
<tr>
<td>Mean</td>
<td>45.253</td>
<td>.570</td>
<td>11.467</td>
<td>.975</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>6.373</td>
<td>5.626</td>
<td>2.353</td>
<td>1.560</td>
</tr>
<tr>
<td>Total</td>
<td>N</td>
<td>6</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Mean</td>
<td>41.4417</td>
<td>5.8419</td>
<td>11.4400</td>
<td>1.5312</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>6.4331</td>
<td>5.8419</td>
<td>1.5312</td>
<td>1.7598</td>
</tr>
</tbody>
</table>

Test Statistic

Mann-Whitney U 1.000 2.000 4.000 1.000
Exact Sig. [2*(1-tailed Sig.)] .200 .400 1.000 .200

Figure 2. Percentages of Function Units by Group Structure
### Table 7. Summaries and Test Statistics for Percentages of Cognitive Skill

<table>
<thead>
<tr>
<th>Structure</th>
<th>Elementary Clarification</th>
<th>In-depth Clarification</th>
<th>Inference</th>
<th>Judgment</th>
<th>Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooperative</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>28.89 (52)</td>
<td>16.67 (30)</td>
<td>19.44 (35)</td>
<td>13.89 (25)</td>
<td>21.11 (38)</td>
</tr>
<tr>
<td>2</td>
<td>20.69 (24)</td>
<td>5.17 (6)</td>
<td>29.31 (34)</td>
<td>18.10 (21)</td>
<td>26.72 (31)</td>
</tr>
<tr>
<td>3</td>
<td>23.58 (104)</td>
<td>10.88 (48)</td>
<td>20.86 (92)</td>
<td>20.18 (89)</td>
<td>24.49 (108)</td>
</tr>
<tr>
<td>Mean</td>
<td>24.387</td>
<td>10.907</td>
<td>23.203</td>
<td>17.390</td>
<td>24.107</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>4.159</td>
<td>5.750</td>
<td>5.336</td>
<td>3.205</td>
<td>2.825</td>
</tr>
<tr>
<td><strong>Collaborative</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>34.65 (44)</td>
<td>3.94 (5)</td>
<td>11.81 (15)</td>
<td>20.47 (26)</td>
<td>29.13 (37)</td>
</tr>
<tr>
<td>2</td>
<td>28.90 (50)</td>
<td>6.36 (11)</td>
<td>23.70 (41)</td>
<td>18.50 (32)</td>
<td>22.54 (39)</td>
</tr>
<tr>
<td>3</td>
<td>28.29 (86)</td>
<td>11.84 (36)</td>
<td>24.01 (73)</td>
<td>14.80 (45)</td>
<td>21.05 (64)</td>
</tr>
<tr>
<td>Mean</td>
<td>30.613</td>
<td>7.380</td>
<td>19.840</td>
<td>17.923</td>
<td>24.240</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>3.509</td>
<td>4.048</td>
<td>6.956</td>
<td>2.879</td>
<td>4.299</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>27.500</td>
<td>9.143</td>
<td>21.522</td>
<td>17.657</td>
<td>24.173</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>4.845</td>
<td>4.849</td>
<td>5.843</td>
<td>2.740</td>
<td>3.255</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test Statistics</th>
<th>Mann-Whitney U</th>
<th>Exact Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1.000</td>
<td>.200</td>
</tr>
<tr>
<td></td>
<td>3.000</td>
<td>.700</td>
</tr>
<tr>
<td></td>
<td>4.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

| Mean            | 3.000          | 1.000      |
| Std. Dev.       | 4.000          | 1.000      |

### Figure 3. Percentage of Cognitive Skill Units by Group Structure
Level. As summarized in Table 8, cognitive skills were also coded for their level of cognitive processing, i.e., surface-level processing or deep processing. Surface-level processing (64.62%) dominated all conferences with in-depth processing higher among the cooperative structure (39.95%) as compared to the collaborative (30.82%). Significance testing, however, failed to reveal significant differences between the two group structures.

Table 8. Summaries and Test Statistics for Percentage of Cognitive Level by Group Structure

<table>
<thead>
<tr>
<th>Structure</th>
<th>Surface</th>
<th>Deep</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev.</td>
</tr>
<tr>
<td>Cooperative</td>
<td>60.053</td>
<td>5.272</td>
</tr>
<tr>
<td>1</td>
<td>55.00</td>
<td>(99)</td>
</tr>
<tr>
<td>2</td>
<td>65.52</td>
<td>(76)</td>
</tr>
<tr>
<td>3</td>
<td>59.64</td>
<td>(263)</td>
</tr>
<tr>
<td>Mean</td>
<td>60.053</td>
<td>5.272</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>5.272</td>
<td>5.272</td>
</tr>
<tr>
<td>Collaborative</td>
<td>69.177</td>
<td>14.262</td>
</tr>
<tr>
<td>1</td>
<td>74.80</td>
<td>(95)</td>
</tr>
<tr>
<td>2</td>
<td>79.77</td>
<td>(138)</td>
</tr>
<tr>
<td>3</td>
<td>52.96</td>
<td>(161)</td>
</tr>
<tr>
<td>Mean</td>
<td>69.177</td>
<td>30.823</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>14.262</td>
<td>14.262</td>
</tr>
<tr>
<td>Total</td>
<td>6 (832)</td>
<td>6 (509)</td>
</tr>
<tr>
<td>Mean</td>
<td>64.615</td>
<td>35.385</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>10.838</td>
<td>10.838</td>
</tr>
<tr>
<td>Test Statistic</td>
<td>Mann-Whitney U</td>
<td>3.000</td>
</tr>
<tr>
<td></td>
<td>Exact Sig. [2*(1-tailed Sig.)]</td>
<td>.700</td>
</tr>
</tbody>
</table>
Cohesion. Within each conference, messages were coded as interrelated when a subject line, a keyword or topic, or a name was employed to refer to another message. The summaries, presented in Table 9, indicate that all conferences were highly interconnected with an average of 90.69% for the cooperative structure and 81.34% for the collaborative. Significance testing revealed a statistically significant difference between the group structures with the cooperative group structure showing 9.35% more interconnected messages on average than the collaborative group structure.

Table 9. Summaries and Test Statistics for Cohesion of Messages

<table>
<thead>
<tr>
<th>Connected</th>
<th>Yes</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>110</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>69</td>
<td>9</td>
<td>88.46</td>
</tr>
<tr>
<td>3</td>
<td>198</td>
<td>23</td>
<td>89.59</td>
</tr>
<tr>
<td>Mean</td>
<td>125.67</td>
<td>13.00</td>
<td>90.69</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>65.91</td>
<td>8.72</td>
<td>2.936</td>
</tr>
<tr>
<td>Collaborative</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>47</td>
<td>19</td>
<td>71.21</td>
</tr>
<tr>
<td>2</td>
<td>66</td>
<td>12</td>
<td>84.62</td>
</tr>
<tr>
<td>3</td>
<td>127</td>
<td>17</td>
<td>88.19</td>
</tr>
<tr>
<td>Mean</td>
<td>80.00</td>
<td>16.00</td>
<td>81.34</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>41.79</td>
<td>3.61</td>
<td>8.952</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>102.83</td>
<td>14.50</td>
<td>86.01</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>55.33</td>
<td>6.19</td>
<td>7.857</td>
</tr>
</tbody>
</table>

Test Statistics

<table>
<thead>
<tr>
<th></th>
<th>Mann Whitney U</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>.000*</td>
<td></td>
</tr>
<tr>
<td>Exact Sig.</td>
<td>2*(1-tailed Sig.)</td>
<td>.100*</td>
</tr>
</tbody>
</table>
What are the patterns of productive interactions over time?

How do they differ under the two approaches?

In this section, the analyses of the weekly patterns of function, cognitive skill, level of processing, and cohesion are discussed. Then, the results of between group comparisons are presented. It should be noted that the between group differences must be interpreted with caution because the use of multiple statistical tests increase the probability of the occurrence of a Type I error. In addition, these weekly patterns of interaction may be influenced by the occurrence of three national days of significance, i.e., Election Day and Veteran's Day (Week 4) and Thanksgiving (Week 6).

**Distribution of Function by Week.** In Figure 4, the weekly patterns of student units are displayed by percentage of function. The pattern of distribution for the cognitive function appears as a normal curve with peaks occurring during Week 3 for the cooperative groups (45.59%) and Week 4 for the collaborative (52.58%), then falling to all time lows during Week 6. Qualitative analyses of the cognitive units for Weeks 1 and 2 indicated that groups were discussing the purpose and process of conducting a technology assessment, e.g., bounding the study, as well as clarifying their perspectives of the problem task, i.e., implications of increased computer use by children. During Weeks 3-5, however, discussants tended to focus on issues related to the context and resolution of the problem by sharing and comparing information. For example, discussants identified a variety of impact sectors (e.g., physical, social, and psychological)
and identified and assessed the viability of various strategies to control or overcome the negative impacts within each sector. During Week 6, the majority of cognitive units focused upon policy recommendations, i.e., proposing, affirming, refining, or adapting solutions to the problem.

For the organization units, there is a rather flat pattern until Week 5 and 6 when the percentage of organization dialogue surges upward to Week 6 highs of 50.52% and 41.41% for the cooperative and collaborative groups, respectively.

* p = .10
A substantive review of the organization units for Week 6 revealed that groups were coordinating the exchange of files and discussing the mechanics of producing the technology assessment report by the imposed deadline.

Although the metacognitive and social functions were not the focus of this study, these data are also presented by week in Figure 4. The metacognitive units showed a slight downward movement over time. The percentages of social units showed a slight upward movement, although they varied considerably between group structures for Week 1 and 5.

Statistical comparisons of group structure for each week yielded evidence that differences may exist at four data points. Each of these is identified with datum values and with an asterisk by the week number in Figure 4. For the cognitive function at Week 5, the collaborative structure showed higher percentages of cognitive dialogue (U=.000, p=.10) with a mean difference of 19.13%. At Week 6, the cooperative groups engaged in proportionally more dialogue about organization issues (U=.000, p=.10) with a mean difference of 9.11%. For the social function at Week 1, the cooperative groups engaged in an average of 15.03% more social dialogue than the collaborative (U=.000, p=.10), but at Week 5 the collaborative groups became more social (U=.000, p=.10) with a mean difference of 8.97%.

**Distribution of Cognitive Skill.** In Figure 5, the weekly patterns of cognitive dialogue are displayed by the percentage of cognitive skill units. Visual movements in the data are characterized by a bell-shaped curve for elementary
Figure 5. Comparisons of Group Structure for Percentage of Cognitive Skills by Week

**Elementary Clarification**

**In-depth Clarification**

**Inference**

**Judgment**

**Strategy**

Cooperative

Collaborative

Week
clarification, a strong upward movement for inference, a moderate upward movement for judgment, and a downward movement for strategy. The in-depth clarification category portrays no consistent pattern over time. Across all cognitive skills, percentages merged to approximately the same level for both group structures at Week 5. Significance testing for each data point revealed moderate evidence that differences may exist between the group structures at three points. At Week 3, the collaborative structure showed higher percentages of elementary clarification (U=.000, p=.10) with a mean difference of 26.27%. At Week 2 and 3, the cooperative groups evidenced higher percentages of inferencing (U=.000, p=.10) with a mean difference of 8.33% and 22.61%, respectively.

**Distribution of Level of Processing.** The weekly patterns of deep processing are shown in Figure 6. Between group comparisons at each time interval indicate moderate differences between the groups at Week 1 and 3 (U=.000, p=.10) with the cooperative groups generating 21.45% and 17.02% more in-depth dialogue than the collaborative groups.

**Cohesion.** As shown in Figure 7, the percentage of interconnected messages changed over time with both groups demonstrating an upward trend. The upward trend was more strongly evident in the collaborative group moving from 38.89% in Week 1 to 90.03% in Week 6. Between group comparisons revealed moderate evidence that differences may exist between group structures
Figure 6. Comparisons of Group Structure for Percentage of Deep Processing by Week

* p = .10

Figure 7. Comparisons of Group Structure for Percentage of Cohesion (Interconnected Messages) by Week

* p = .10
at two data points. At Weeks 1 and 2, the cooperative structure showed higher percentages (U=.000, p=.10) of cohesion with mean differences of 43.47% and 22.93%, respectively.

**What are the group's perceptions of interdependence and intersubjectivity? Do they differ under these two approaches?**

Perception data were derived from student responses on a 7-point Likert Scale where higher numbers represented higher perceptions on one of three scales, i.e., interdependence, intersubjectivity, and dependence on instructor. The descriptive and test statistics for the two administrations of the perceptions survey, i.e., at Week 3 (mid-activity) and Week 6 (end-of-activity), are presented in Table 10 and discussed below.

**Between Groups.** As indicated in Figure 8, the mean composite scores for the cooperative structure at mid-project (Week 3) were higher than the collaborative structure on all three scales. When conducting comparisons by group structure, testing suggests a statistical difference (p=.10) on both the intersubjectivity and dependence on instructor scales at mid-project with a mean difference of 1.34 and 1.29, respectively. At the completion of the activity (Week 6), statistical testing indicates no difference between the mean composite scores by group structure.
Table 10. Summaries and Test Statistics for Perceptions of Interdependence, Intersubjectivity, and Dependence on Instructor by Group Structure

<table>
<thead>
<tr>
<th>Week 3</th>
<th>Interdependence</th>
<th>Intersubjectivity</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>4.773</td>
<td>4.625</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>4.682</td>
<td>4.167</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>6.333</td>
<td>5.667</td>
</tr>
<tr>
<td>Total</td>
<td>Mean</td>
<td>5.262</td>
<td>4.819</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>.9281</td>
<td>.7686</td>
<td>.1695</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Week 6</th>
<th>Interdependence</th>
<th>Intersubjectivity</th>
<th>Instructor</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
<td>5.023</td>
<td>4.708</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>5.512</td>
<td>5.167</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>5.773</td>
<td>6.056</td>
</tr>
<tr>
<td>Total</td>
<td>Mean</td>
<td>5.435</td>
<td>5.310</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>.3807</td>
<td>.6850</td>
<td>.4339</td>
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</table>

Test Statistics

<table>
<thead>
<tr>
<th></th>
<th>Mann-Whitney U</th>
<th>Exact Sig. [2*(1-tailed)]</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>4.000</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>4.000</td>
<td>.000*</td>
</tr>
<tr>
<td></td>
<td>1.000</td>
<td>.100*</td>
</tr>
<tr>
<td></td>
<td>1.000</td>
<td>.400</td>
</tr>
</tbody>
</table>

Figure 8. Mean Composite Scores of Perceptions by Group Structure

* p = .10
**Within the Entire Group.** The Wilcoxon Signed Ranks test, a nonparametric repeated measures test, was employed to identify any changes that may have occurred within the entire class over time. The results, as shown in Table 11 and Figure 9, indicate that significant changes (p=.028) occurred from Week 3 to 6 on both the intersubjectivity (mean increase of .866) and dependence on instructor (mean decrease of .704) scales.

**Table 11. Wilcoxon Signed Ranks Test for Changes in Perceptions over Time**

<table>
<thead>
<tr>
<th></th>
<th>Interdependence_Fin - Interdependence_Mid</th>
<th>Intersubjectivity_Fin - Intersubjectivity_Mid</th>
<th>Instructor_Fin - Instructor_Mid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z</td>
<td>-1.153&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-2.201&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-2.201&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.249</td>
<td>.028</td>
<td>.028</td>
</tr>
</tbody>
</table>

<sup>a</sup> Based on negative ranks.

<sup>b</sup> Based on positive ranks.

**Figure 9. Changes of Perceptions Over Time for All Groups**

* p = .10
Are there relationships among the groups' perceptions of interdependence and intersubjectivity, cohesion of messages, cognitive function, and level of cognitive dialogue?

The frequency values for key variables, i.e., cognitive function, deep processing, and cohesion, were combined for Weeks 1-3 and Weeks 4-6. The degree of relationship among these variables and the three perception scales were tested employing the Spearman's Rho Rank Order Correlation. As previously stated, conservative criteria were employed to interpret the strength of these relationships, i.e., a coefficient of .80 to 1.00 suggests a “substantial to strong” relation and a .60 to .80 suggests a “moderate to substantial”. As presented in Table 12 and 13, notable and statistically significant relationships were found among several of these variables. For Weeks 1-3, substantial to strong positive correlations were found for cohesion and deep processing ($r_s=.829$, $p=.042$), as well as for deep processing and intersubjectivity ($r_s=.829$, $p=.042$). For Weeks 4-6, substantial to strong positive relationships were found for cohesion and deep processing ($r_s=.886$, $p=.019$), while a moderate to substantial positive relation was indicated for interdependence and intersubjectivity ($r_s=.771$, $p=.072$).

**General Observations**

During the initial analysis of a computer conference, student comments concerning communication venues suggested that individuals and the entire group were actively communicating elsewhere. For example:
Table 12. Correlation Matrix of Key Variables for Week 1-3

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cognitive Function</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td>.580</td>
<td>.290</td>
<td>-.116</td>
<td>-.232</td>
</tr>
<tr>
<td></td>
<td>Sig.(2-tailed)</td>
<td>.</td>
<td>.228</td>
<td>.577</td>
<td>.827</td>
<td>.658</td>
</tr>
<tr>
<td>2 Cohesion</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td>.829</td>
<td>.314</td>
<td>.543</td>
<td>.714</td>
</tr>
<tr>
<td></td>
<td>Sig.(2-tailed)</td>
<td>.042</td>
<td>.544</td>
<td>.266</td>
<td>.111</td>
<td></td>
</tr>
<tr>
<td>3 Deep Processing</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td>.600</td>
<td>.829</td>
<td>.657</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.(2-tailed)</td>
<td>.208</td>
<td>.042</td>
<td>.156</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Interdependence</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td>.543</td>
<td>-.086</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.(2-tailed)</td>
<td>.266</td>
<td>.872</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 Intersubjectivity</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td>.714</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.(2-tailed)</td>
<td></td>
<td>.111</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 Dependence on Instructor</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.(2-tailed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

"Well, it was great to meet everyone face to face finally. Here's a review of what we went over: Thanks to [Howard], we began putting our information into the format that he proposed (Title, Statement of Problem, Statement of Purpose, Statement of Need, Statement of Hypothesis, Assumptions, Limitations, Procedures, Conclusions, and Recommendations)." [G29]

To track the frequency of this phenomenon, a coding scheme was established consisting of subcategories for common venues. Across all six groups, 328 references were made to communication venues with 36.58% to Internet Relay Chat, 28.35% to FTF meetings, 19.51% to the asynchronous computer conference, 11.59% to e-mail, and 3.96% other. Between group comparisons
Table 13. Correlation Matrix of Key Variables for Week 4-6

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Cognitive</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td>-.029</td>
<td>.371</td>
<td>.086</td>
<td>-.486</td>
</tr>
<tr>
<td>Function</td>
<td>Sig.(2-tailed)</td>
<td>.</td>
<td>.957</td>
<td>.468</td>
<td>.872</td>
<td>.329</td>
</tr>
<tr>
<td>2 Cohesion</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td>.886</td>
<td>.257</td>
<td>.200</td>
<td>-.143</td>
</tr>
<tr>
<td></td>
<td>Sig.(2-tailed)</td>
<td>.019</td>
<td>.623</td>
<td>.704</td>
<td>.787</td>
<td></td>
</tr>
<tr>
<td>3 Deep Processing</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td>.257</td>
<td>-.029</td>
<td>-.371</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.(2-tailed)</td>
<td>.623</td>
<td>.957</td>
<td>.468</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 Interdependence</td>
<td>Spearman's Rho</td>
<td>1.000</td>
<td>.771</td>
<td>.257</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sig.(2-tailed)</td>
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yielded no statistical evidence to suggest that the groups were different in regards to the frequency of references to communication venues. A substantive review of the transcripts documented that select members of each of the six groups met in a FTF meeting at least once during the six-week activity and 5 of 6 groups conducted chat sessions. This finding supports that of Sage's (2000) qualitative study of problem-based learning in which the instructor notes:

"They need to have a synchronous way to do quick talking. When they want to have a team meeting, they need to be able to do it without having to constantly reload this page" (p. 21).
CHAPTER FIVE
DISCUSSION OF RESULTS AND SUMMARY

This in-depth analysis of peer-directed learning in a distributed asynchronous computer conference revealed information about the nature of dialogue in problem-based learning and the relative influence of group structure upon productive interaction. This final chapter provides an interpretation of the findings, their potential to inform instructional practice, a discussion of the limitations of the study, and a summary.

Interpretation and Implications

Participation in the Conferences

This study showed that during this distributed problem-based activity, students dominated the conferences, contributing 90.56% of the 837 messages. This active peer-to-peer exchange is consistent with participation levels reported for online graduate courses (i.e., 85-90%, Harasim, 1993) and other types of student-centered learning activities, such as the 90.77% participation level found by Hara et al. (2000) for the starter-wrapper technique.

As compared to other types of online learning activities, this study found individual participation rates to be considerably higher with an average of 5.26 messages per student per week. For example, when the learning activity was a teacher-initiated discussion of readings, Bullen (1998) reported 1.14 average number of messages per student per week in an online undergraduate computer information course. When the discussion was student-initiated, Hara et al.
(2000) found an average of 1.01 messages per student per week in online discussions that were supplemental to a face-to-face educational psychology course. Given that the goal of the learning task (Harasim, Teles, & Turoff, 1995) and anticipated future interaction (Walther, 1997) have been identified as motivators for student participation in online discussions, the higher student participation rates in this study are quite understandable. It can be argued that from participation levels alone, the problem-based activity essentially created a compelling student-centered learning experience.

**Instructor Interventions**

The analysis of instructor messages documents significant differences in the way the two group structures were organized and in the level of instructor monitoring. As described in Chapter 3, the research protocol called for the instructor to structure the cooperative groups through the use of role assignment and provide close monitoring; for the collaborative groups, the instructor was to inform groups that group organization and management was a group responsibility and provide sporadic monitoring. The analyses certify that the instructor conformed to this protocol, however, it also shows that the cooperative groups were given substantially more pedagogical support than was given to the collaborative groups. Among the cooperative groups, a higher incidence of pedagogical dialogue coincided with two events: (a) student-initiated requests for feedback on draft proposals, and (b) mid-activity “hints for specialists.”
The first of these events can be attributed to the “squeaky wheel gets more grease” phenomenon that is also common in FTF contexts. In a distributed group context where interactions occur in a separate, protected space, however this raises issues of concern related to instructional practice. In a private group conference, the other groups are not aware of request/response cycles that are occurring elsewhere, nor are they privy to the often relevant concerns that are addressed in these interactions. For example, the opportunity for other groups of learners to focus on the instructor's feedback to another group and relate that feedback to their own group experience is eliminated. Therefore, there are instructional efficiency losses, not the least of which are motivational losses, due to the inability to capitalize upon vicarious learning opportunities when giving feedback to requests in private conferences.

The second phenomenon, the additional pedagogical support offered to the cooperative groups, is certainly more complex and may relate to: (a) the instructor's underlying philosophical beliefs about the fundamental differences between cooperative and collaborative learning strategies; (b) the instructor’s beliefs about the role of the instructor during peer-directed PBL; (c) the instructor's failure to consciously discriminate managerial from pedagogical guidance; or (d) the intense cognitive demands required of any novice facilitator in an Web-based learning environment (Atavia, Yoo, & Vogel, 1997). As Haith-Cooper (2000) points out, “facilitation in PBL groups is no easy task” and the
guidelines for the optimal degree of intervention required for productive PBL is quite variable ranging from a more direct, active involvement to silent observer.

In this study, the instructor was essentially asked to implement both instructional strategies while facilitating a problem-based activity regardless of his personal beliefs. Later discussion with the instructor hinted that the resulting differences may be an operationalization of a belief that collaborative PBL strategies require a hands-off approach regarding pedagogical guidance. Therefore, the relationship between teacher belief and pedagogical practice, in terms of the relative incidence of pedagogical and managerial support offered in online PBL, appears to be a fruitful area for future research that would inform the 'consistency' vs. 'inconsistency' debates identified in the literature by Fang (1996). In addition, this finding also indicates that novice instructors to online PBL may also need specialized training or pedagogical scaffolding specifically related to facilitating online PBL activities, especially in developing dialogic skills and timing the use of questions, repetition, and summarizing, as Wilkie (2000) notes.

**Global Analyses of the Conferences**

**Function.** From a global perspective, this study found that student dialogue was both learning- and task-driven, with cognitive (41.44%) and organization (35.71%) functions dominating the conferences. Metacognitive (11.44%) and social (11.42%) functions were less prominent. (To recall definitions and indicators, see Appendix F).
As compared to other types of learning activities, the level of cognitive
dialogue appears to be low, and the level of organization appears to be high. For
instance, in a weekly discussion of research findings occurring over a listserv
where the participants varied each week, LaPointe et al. (1993) report that 72%
of the dialogue units for one month of dialogue exhibited a cognitive function. It
should be noted, however, that the analytical framework of the LaPointe et al.
study did not include an organizational category. Using Henri and Rigault’s
(1996) framework, McDonald (1998) found comparable results to LaPointe et al.
when she examined the ACC transcripts of weekly discussions of three groups
whose membership remained consistent during a single graduate course.
McDonald (1998) reports the relative percentages of dialogue units to be 70%
cognitive, 15% organization, 2% metacognitive, and 13% social.

The large differences in the levels of cognitive and organization functions
in the current study may be explained by the competing demands of learning and
performing. Performing, in this sense, refers to meeting or exceeding the
requirements of the instructional task which included a substantial group
deliverable, i.e., technology assessment report posted to the Internet, completed
in a short time frame (6 weeks). As was found in a business (Ancona & Chong,
1999) and a higher education setting (Druskat & Kayes, 2000), the short-term
nature of the group and task may have generated the external pressure on
groups to focus their energy, and thus their dialogue, upon work efficiencies,
e.g., coordinating responsibilities. It is also recognized that these differences
may have also been influenced by other factors such as the motivational inclinations (e.g., values or goal orientation) of this small sample or the incentive structure of the task (Slavin, 1983). Therefore, a valuable endeavor for future study is to verify the relative distribution of functions found in online PBL activities under different time constraints and incentive structures, while assessing participants’ motivational inclinations.

The overall level (11.44%) of metacognitive function (i.e., those units related to the awareness and control of one’s cognitive activity) reported here, appears reasonable given that PBL theorists extol the interconnected nature of problem solving and the use and development of metacognitive skills and knowledge (Duffy & Cunningham, 1996; Henri, 1992). As indicated by other studies, merely discriminating metacognitive from cognitive functions (e.g., Zola, Shaik, & Hitchings, 2000) presents reliability challenges when coding text. Therefore, fertile ground exists for the development of an analytical framework or process for more reliable identification of metacognitive skills and knowledge in group dialogue. This, then, could aid researchers in verifying the metacognitive skills that enhance the online problem solving process and other learning strategies (Hara et al. 2000).

**Cognitive Skill.** Elementary clarification (27.5%), cognitive strategy use (24.17%), inferencing (21.62%), and judgment (17.66%) were closely distributed among the cognitive units in the conference. In-depth clarification, i.e., deferring judgment, identifying assumptions, and interrelating information, which some
consider essential characteristics of critical thinking (Paul, 1993), represented only 9% of the cognitive units. Given that problem-based activities are purported to aid the development of critical thinking (Ennis, 1987; Norris & Ennis, 1989) and problem solving skills (Albanese & Mitchell, 1993), the relatively small percentage of in-depth clarification is surprising. However, it should be noted that this level appears to be consistent with other types of online activities. For example, in weekly student-initiated discussions of class readings, Hara et al. (2000) reported an average of slightly over 10% in-depth clarification during four separate weekly discussions.

Several explanations for low levels of in-depth clarification can be offered, three will be discussed. First, as previously noted, the requirement to coordinate group effort to produce a substantial deliverable may have interfered with the individuals’ normal practice of activating in-depth clarification skills, e.g., questioning assumptions, justifying conclusions, and generating possibilities. Second, relatively low percentages of in-depth clarification may be a simple instantiation of the widespread levels of critical thinking competence among college students. For example, Norris (1985) points out that the median scores for undergraduates on the Cornell Test, a general critical thinking test, indicates that critical thinking competence is not very high.

Third, another plausible explanation is that Henri's (1992) cognitive skill framework may suffer from validity and reliability concerns. A comparison of Henri's definition and indicators for in-depth clarification with Lipman's (1988)
description of critical reasoning show considerable overlap especially in regards to “establishing referential criteria” and “noting relationships among relationships,” which supports the content validity of Henri’s framework. However, the question of coding validity, i.e., the extent to which the coded unit indicates the use of a cognitive skill, are not so easily dismissed. As paraphrased from Hirokawa (1988), there is always a risk that “the classification of a unit will not reflect its actual nature, purpose, or function” because the coder has to make subjective judgments (p. 242). In the current study, issues also arose among the coders that indicated the cognitive skill categories were not mutually exclusive. For example, “deferring judgment” and “defining terms in multiple ways” were indicators for the in-depth clarification category. Coders often disagreed whether texts indicative of abductive reasoning (see Cunningham, 1992, for a discussion) that resulted in the generation of multiple assertions (such as those generated by brainstorming) would be coded as “inference” or “in-depth clarification”. Where these units did not offer a judgment, a decision was made to code these as in-depth clarification. This one problem certainly impacted inter-coder reliability, but also may have inflated the relative percentage of in-depth clarification.

In regards to the other cognitive skills, it is informative to note that the rank order of the skills, excluding in-depth clarification, are reversed when comparing the current study to the Hara et al. (2000) study. More specifically, the averaged percentages over four weeks of the starter-wrapper technique
were 34.12% for judgment, 22.97% for inference, 19.35% for strategy, and 13.9% for elementary clarification. An instructional intent of the starter-wrapper strategy was to promote individual's summarizing and generalizing skills, thus higher levels of judgment and inference were evident. In the present study, the intent was to promote the development of critical thinking and problem solving skills by engaging learners in a collaborative, dialectical journey where a common problem and potential solutions were critically examined, debated, and negotiated. This dialectical process required that individuals explain and clarify their observations and interpretations of the problem, reserve judgment, and coordinate actions for learning. Thus, the PBL strategy examined here yielded higher levels of elementary clarification and cognitive strategies. These differences support the contention that different types of instructional strategies, goals, and learning activities activate and exercise different types of cognitive skills.

Furthermore, with the exception of in-depth clarification, this study suggests that this peer-directed PBL activity activated a rather balanced set of cognitive skills regardless of the choice of a cooperative or a collaborative group structure. In a sense, this balanced set of cognitive skills reifies the stages in general problem solving models, such as Bransford and Stein's (1984). Typically, the students in this study not only clarified the problem space by stating what is known and what needs to be known about the problem, but they also formulated and followed through with strategies for learning about the
problem, generalized their findings to other situations by proposing potential solutions, and then judged the validity and viability of those solutions.

**Level of Processing.** Overall, this analysis revealed that 33.38% of the cognitive skill units exhibited evidence of deep processing, i.e., elaborative, integrated, and complex level of thinking. Comparing this level to the Hara et al. (2000) study which reported that 70% of dialogue was cognitively elaborate, the level found in this study is low. However, given that these studies differ in terms of the type of learning activity (PBL vs. weekly discussion), the units of analysis (cognitive skill unit vs. message), and the size of the group (4 to 5 vs. 20), these differences may not be so striking. However, a lower incidence of deep processing may be indicative of what Salomon and Globerson (1987) called "ganging up on the task," i.e., a dysfunctional group learning phenomenon whereby the group executes the most efficient way to complete the activity requirements with little or no regard to learning goals. The following excerpt from the conference of a cooperative group further suggests that this phenomenon may have occurred:

> “I sense that the group is still feeling that we don't have any direction. I think [Olivia's] idea of coming up with some objectives for a timeline may be valuable but we've spent a couple of weeks trying to get organized and I'm feeling like we're not yet organized. Maybe we can just do the work and be disorganized.” [B56]

**Cohesion.** Overall, the conferences were highly cohesive with 86% of the messages interconnected to one another, primarily through explicit structural connections (61%), i.e., threaded to a previous message by subject line. This
finding differed from those reported in the literature. Employing the same cohesion criteria as were used in this study, Howell-Richardson and Mellar (1996) reported levels of 42% and 33% for a consensus-generating activity and a “round table discussion” of readings, respectively. For a decision-making activity where students were encouraged to present a well-reasoned argument for their decision, Bullen (1998) found 23% of the messages to be connected. In a comparable study of 11 distributed adult learners, Henri (1995) found that about 66% of the messages were interactive\(^5\) when discussion revolved around information content. Yet, in conferences where shared problem solving was the task, Henri reported much lower levels of interactivity with percentages ranging from 30% to 38%. Unfortunately, Henri did not describe the problem solving task; these problems could have been well-structured tasks, such as an algebra problem with one correct solution. Therefore, it is not advisable to assume that these levels would be normal for ill-structured PBL activities.

It could be argued that the higher incidence of message cohesion in the present study indicates that the messages were more coherent, i.e., relevant to one another, and that common ground was more evident. Furthermore, it could be concluded that the PBL activity and the instructional interventions examined in this study provided the affordances and conditions conducive to initiating and sustaining a coherent, meaningful dialogical process. However, as Pavitt and

\(^5\) Henri (1995) uses the term “interactive” in almost an identical sense to the use of “cohesion” in this study, i.e., to refer to any statement containing an explicit or implicit reference to another message, idea, or interactant.
Johnson (1999) observe, messages may be functionally connected while lacking any topical relevance. For example, if Message B is sequentially positioned after Message A and acknowledgments are made to the author of Message A, it gives the appearance of functional coherence. However, topical relevance, i.e., pertinence of message content, may never be established or intended by the author of Message B. Therefore, researchers should be advised to seek additional indicators and analytical methodologies to measure levels of group coherence, such as the probability models that groups stay on topic offered by Pavitt and Johnson (1999).

**Comparisons by Group Structure**

The rank order test comparisons presented little evidence to suggest that organizing students as cooperative or collaborative groups had any differential effect upon the overall level of participation, nor upon the function, cognitive skill, or deep processing exhibited in group dialogue. One implication, therefore, is that if both approaches result in comparable student dialogue, in terms of both quantity and quality, or other measures of student achievement, then the one requiring less work from an online instructor should be chosen. However, there is more data to consider.

Significant differences were found in the cohesion measure indicating that a higher percentage of interconnected messages occurred in the cooperative structure. This suggests that the cooperative structure, its role assignment and increased level of scaffolding, provided an advantage over the collaborative
structure, quite possibly by establishing common knowledge in the first instructor posting\(^6\) that subsequent messages could build upon. Analyses of postings by week and groups’ perceptions of intersubjectivity presented later in this chapter also support this conclusion.

It should further be noted that marginal differences were also seen in the overall percentage of cognitive function, social function, and elementary clarification skills. Confirming the relative distribution of these functions and skills would be a worthwhile endeavor for future investigations.

**Patterns of Distribution**

Disregarding group structure, one would expect that over the course of a small group activity, the patterns of interaction would change in response to a variety of influences, not the least of which are learning gains, individual perceptions, changing demands of the learning task, interpersonal changes, and maturing group dynamics. Indeed an examination of the data over time indicated such changes especially in the percentages of function, skill, and cohesion.

**Function.** For the cognitive function, the patterns of changes are typified by a normal distribution representing a gradual growth and gradual decline in cognitive dialogue. For the organization function, the pattern is constant until the last third of the activity when the relative proportions of dialogue about organizational topics surge upward. The metacognitive function showed a slight

\(^6\) To clarify, only student dialogue was included in the cohesion measure. However, if a student referenced a message from the instructor it would have been coded as connected, i.e., exhibiting cohesion.
downward trend and the social function remained relatively stable with no significant changes over time.

The pattern found in the social function is contrary to those reported in the literature (Hara et al. 2000; McDonald, 1998; Zola et al., 2000). For instance, McDonald (1998) examined three group transcripts at three times during a semester, i.e., Week 3, 8, and 13. That study found significant and consistent upward trends for the cognitive function and downward trends for social and organization. Once again, it is wise to conclude that the differences in these studies can be attributed, in part, to the nature of the learning task. In the current study, groups had a prolonged PBL task requiring the delivery of a finished product, i.e., an online technology assessment report. Therefore, it is reasonable that the cognitive work—related to understanding the problem and generating proposals to alleviate the problem—proceeds at a higher level before the intense organization work required to coordinate, compile, edit, and publish the product.

This evidence raises concerns about the competing demands of learning and performing in distributed PBL groups especially during the final stage of producing a group artifact. The implications for PBL theorists and facilitators in ACC are many, only three will be noted. First, PBL in distributed environments appears to be costly in terms of the demands upon learner resources for coordinating group activity. If there are not specific and substantial learning goals related to group process, then the cost may be too high. Designers and practitioners should carefully consider their target learning goals in light of these
demands before adopting a PBL strategy in a distributed environment. Second, PBL requires time for independent study, dialogic discourse, and coordination of group activity. The distributed and asynchronous nature of the activity may accentuate the need for time. Therefore, PBL designers and facilitators should consider increasing the amount of time dedicated to distributed PBL activities. Third, during the final week of the PBL activity, organizational issues about coordinating a group product dominated group discussions to the detriment of discussions about learning issues. Therefore, designers and PBL practitioners should take active steps to ensure that learning issues remain the focus of discussions throughout the PBL activity. For example, the form and standards for the group product could be adapted to the ACC environment by requiring synthesized conclusions to be posted in distinct threads of the conference rather than in external documents. This delivery method eliminates organizational steps, e.g., the exchange of files and the external compilation of files in an HTML editor or word processor, thereby freeing up learner resources to concentrate upon the rational line of logic supporting their group’s conclusions.

**Cognitive Skill.** A variety of cognitive skills was evident at different times in the problem-based activity. There was evidence to suggest that the relative percentages of elementary clarification, in-depth clarification, and inference changed over time. These patterns revealed that dialogue exhibiting elementary clarification and in-depth clarification skills was more evident during the middle
of the PBL activity. However, as previously noted, the levels of in-depth clarification remained relatively low.

Although one might expect to find the heaviest concentration of clarification during the initial stage of problem solving because learners need to explicate what is known and what needs to be known about the problem, group development theory tells us that an incubation period, or a “forming” stage as Tuckman (1965) theorized, initially accompanies group formation. Attention at this time is often focused on social and organization issues because group members are apprehensive about working together and are uncertain about the task requirements (Cohen & Cohen, 1991). Also, Roschelle and Teasley (1995) remind us that periods of silence are common in collaborative problem solving because individual's ideas are still forming or too complicated to introduce into the common space. Therefore, it appears reasonable that a larger percentage of clarification, both elementary and in-depth, occurred in the middle of the activity.

For inferencing skill (i.e., generalizing, inducing, and deducing), a sharp, consistent upward trend was evident beginning at an overall average of 6.6% of the cognitive dialogue in Week 1 to 37.17% in Week 6. This finding appears to confirm the PBL process articulated by several theorists and researchers, such as Koschmann et al. (1996a) or Naidu and Oliver (1996). In these models, problem solving is thought to progress through stages, from problem analysis and information gathering to stages of synthesis, abstraction, and finally, reflection. In the synthesis and abstraction stages, it is proposed that learners
begin to integrate the numerous ideas and multiple perspectives that have been encountered during the previous stages. Tentative explanations begin to form, predictions are offered, and conclusions are drawn. This finding also appears to confirm the small group benefit of PBL, that interpersonal reasoning and negotiation of meaning unveils erroneous or simplistic explanations while enabling the refinement of more complex and well-grounded generalizations and understandings.

An important next step, then, is to validate the pattern of cognitive skills engendered during PBL. This line of research could assist designers of PBL, not only in establishing performance expectations and evaluative standards, but also in identifying the critical points at which to support specific cognitive skill use. In this study, for example, the dominant skill exhibited during Week 1 and 2 was strategy, i.e., proposing coordinated actions for learning. Therefore, PBL facilitators should communicate evaluative standards and expectations concerning collaborative learning strategies during the initial weeks of the activity. In addition, the consistently low levels of in-depth clarification skill across the entire gamut of this PBL activity strongly suggests an instructional opportunity to mediate a social or individual learning need. The implication is that PBL designers and facilitators should, not only model in-depth clarification skills, but also carefully compose messages and other instructional supports that prompt groups to question their assumptions, justify conclusions, and defer judgment.
Group Comparisons by Week

When a finer grained perspective is employed to examine the differences in group structure by looking at patterns of distribution over time, there was minor evidence that group structure differentially affected the relative percentage of function (cognitive, organization, and social), skill (elementary clarification and inference), deep processing, and cohesion.

**Function.** These findings highlight the differences between the groups' patterns of dialogue whereby the cooperative group mean reached its highest percentage of cognitive dialogue at Week 3 and the collaborative group mean continued a consistent upward trend through Week 5. Levels within both groups equalized in Week 6. For the organization function, the groups had a similar pattern of interaction, however, higher percentages of organization dialogue occurred in the cooperative structure during Weeks 5 of 6 with significantly higher percentages at Week 6. The higher percentage of social dialogue at Week 1 and organization at Week 6 suggests that the cooperative structure tends to focus learners on the formation and maintenance of interpersonal relationships during the initial stage of the activity, and upon the logistics of working together and creating deliverables during the final stage.

**Cognitive Skills.** Significance testing suggests that the group structures differ in the percentage of dialogue for elementary clarification at Week 3 and inference at Weeks 2 and 3 (Figure 4). Regarding the former, this finding highlights the higher percentage of elementary clarification in the collaborative
groups that occurred across the initial three weeks of the activity and suggests that the collaborative groups needed to discuss the exigencies of the learning task and its relationship to previously acquired knowledge more than the cooperative groups. It could also be hypothesized that the increased elementary clarification compensated for the instructor’s comparatively minimal pedagogical support offered to the collaborative groups.

For the inferencing skill, the pattern of interaction showed an upward trend over time with significant differences between the group structures at Weeks 2 and 3. However, because inferencing in the cooperative group’s mean reached a peak one week before the collaborative group’s mean, these differences may indicate that the cooperative structure provides that added cognitive boost that fosters the generation of propositions and conclusions earlier in the group process. However, promoting earlier inferencing skill use may also suppress the benefits to be gained from the dialectical discourse employed in small group PBL and result in erroneous or deficient generalizations. An important next step, then, is to validate whether the cooperative structure consistently promotes earlier inferencing, and examine the quality of inferencing skill as it evolves over the course of a PBL activity.

**Cognitive Level.** Comparisons between group structures by cognitive level indicated that deep processing was significantly more prevalent in the cooperative structure than the collaborative structure during the Week 1 and Week 3 of the activity. This finding suggests that the cooperative treatment may
have alleviated student concerns about coordinating their joint learning activity and established common understandings among the group members concerning individual responsibility and the scope of the problem. The higher perceptions of intersubjectivity found in the cooperative structure during the first half of the activity also support this conclusion. It could be said that reduction of cognitive load and establishment of common ground essentially fostered more complex modes of thinking and dialogue.

**Cohesion.** Although the global analysis revealed that there was a higher percentage of interconnected messages in the cooperative groups, the weekly analyses indicated that those differences were concentrated in the first half of the activity. This finding suggests that the assignment of group roles and higher levels of instructor intervention quickly created an atmosphere that was conducive for making one's messages relevant to the function or topic of the previous message, especially regarding strategies for learning and organizational issues. In contrast, the collaborative groups began their discussions with independent, tentative overtures that consisted primarily of elementary clarifications and organizational issues. Over time, however, the messages of the collaborative groups became more interconnected. Clark and Brennan (1991) would argue that these groups mutually generated and negotiated common ground as a consequence of their collective interaction. The implication of this finding is that the role assignment of the cooperative structure provides an efficiency advantage, but given time, the dialogue of learners in a
collaborative structure compensate and interconnect their messages at similar levels.

**Perceptions**

Several important points may be drawn from the results of the perceptions survey, three will be elaborated upon here: (1) interdependence; (2) intersubjectivity; and (3) dependence on instructor.

**Interdependence.** First of all, groups exhibited high and consistent perceptions of interdependence regardless of group structure and time. This indicates that the instructional interventions, exigencies of the problem-based task, and affordances of the communication media established the contextual conditions that created ongoing “genuine opportunity for interdependence,” as Salomon (1992) noted, in terms of “the information that needs to be shared, the task that needs to be divided up, and the joint thinking that is required.” In other words, there was little evidence that the two group approaches differentially influenced learners’ perceptions of interdependence, other factors must account for this. Identifying the factors that mediate learner’s perceptions of interdependence could assist designers and facilitators of PBL activities in selecting problem tasks and crafting interventions.

**Intersubjectivity.** Secondly, the rank order comparisons provide evidence that learners' perceptions of intersubjectivity were mediated by group structure and time. More specifically, the cooperative group structure was more potent in generating higher perceptions of intersubjectivity during the first half of
the activity. It appears that the instructor's initial assignment and elaboration of student roles generated a perception among the cooperative group members that they understood the task in a common way.

Over time, perceptions of intersubjectivity increased for both group structures to similar levels. Therefore, it can be hypothesized that perceptions of intersubjectivity generated during small group activities are a consequence of both the accumulation of common knowledge about each other and their common task, as well as the quantity of interaction they share.

Theoretically, this evidence adds credence to Clark and Brennan's (1991) theory that “all collective actions are built on common ground and its accumulation” (p.127). In short, the theory of “common ground” contends that successful group work depends on the coordination of content and process. However, before coordination of content can proceed, interactants must share common understandings, such as a common purpose, task, or belief. Furthermore, to coordinate process, interactants must update their common understandings in a timely fashion.

As already noted, the instructor essentially promoted a common understanding about process by posting assigned roles as the initial message in the conferences of the cooperative groups. In contrast, the directions offered to the collaborative groups, in essence, stated that the responsibility for group process was in the control of the group. This could explain the initial higher perceptions of intersubjectivity among the cooperative groups and the slightly
higher, yet not significantly different, levels of participation also seen in cooperative groups. Over time, however, all groups interacted and accumulated knowledge about group process, learning issues, and each other, thus increasing their perceptions of commonly shared understandings.

An implication is that facilitators of PBL should offer managerial guidance to distributed adult learners at the outset of group activity for the primary purpose of promoting shared understandings about coordinating group process. However, it may be that under certain conditions, pedagogical guidance which elaborates upon the relevant learning issues may be as powerful a strategy for promoting common understandings as the role assignment examined here. van den Hurk et al. (1999a) contends that there are other reasons for offering well-elaborated descriptions of the learning issues during PBL. For example, descriptions of learning issues serve to initiate independent study by assisting the learner in identifying relevant resources and personal learning goals. Therefore, future research should: (1) examine the relationship between instructional guidance and groups’ perceptions of intersubjectivity; (2) strive to identify the situations or conditions in which these various forms of guidance offer learning or instructional advantages during PBL; and (3) scrutinize the impact of these interventions at both the group and individual level.

**Dependence on Instructor.** Third, perceptions of being dependent upon the instructor for learning and performing was influenced by group structure and time. Initially, the cooperative groups perceived a higher dependence upon the
instructor. This is understandable because the instructor exercised higher levels of control over the group process. Yet, over time, these perceptions of dependency upon the instructor decreased across both group structures. Given that the majority of learning supports or scaffolds throughout this PBL activity originated in learner-to-learner interactions, this is a reasonable outcome. Therefore, it indicates that both the cooperative and collaborative interventions succeeded in creating a student-directed, student-centered learning experience. Moreover, instructors who use small group PBL in online environments may well expect this instructional strategy to wean learners from their dependence upon the instructor for guiding their learning.

**Relationships of Variables**

It was helpful to examine the relationships among the key variables of this study, i.e., cognitive function, deep processing, cohesion, perceptions of intersubjectivity and interdependence. The results for Weeks 1-3 and 4-6 show both consistent and inconsistent results that provide insight into small group PBL. For instance, cohesion and deep processing exhibited a consistently strong positive relationship across both time periods. This finding supports the contentions of several researchers (Henri, 1995; Howell-Richardson & Mellar, 1996) that the degree of interconnectedness of conference messages is an indicator that discussants are actively learning, engaged in a dialogical process, and creating common understandings by following each other's lines of reason and critically responding to each other's ideas. A practical implication of this
finding is that an instructor may be able to gage the level of cognitive processing by examining the level of cohesion within a conference. However, it would not be advisable to use cohesion as the only indicator because, as Hewes (1986) points out, some comments may only appear to be responses to previous comments and are instead independent “thought out loud” or “vacuous acknowledgments.” In this study, several comments supported Hewes observation, such as in the following case where a series of nested responses appear to be irrelevant replies to the first discussant's elaborate message concerning the seven dimensions of wellness and computer technology use in schools:

Response 1: Helen, you also sound like a smart lady and I'm glad your’ on my team, I will review more of our actual assignment, but I like your approach to this project. As I gain more knowledge, I can provide more technical aspects of this assessment. We should all be ot [not] afraid to share our strengths/interests in the project.” [G28]

Response 2: Oops, I guess I addressed some of the things you mention in my previous note. Thanks for keeping on track w/r/t the topic. I am wondering if we should think about computer use as more than sitting at a terminal typing away. ....[G29]

Response 3: Harold--thanks for going on these areas. They will be a big help. It sounds like the rest of us are good for Thursdays. WOuld that work for you? [G30]

Another practical implication of this finding is that the instructor may be able to promote higher levels of cognitive processing by encouraging students to make connections across messages. For example, the starter-wrapper strategy where student volunteers summarized the key points and issues of their weekly
class discussions was employed in the Hara et al. (2000) study. Reported findings from that study indicate that 70% of the student dialogue was at a cognitively elaborate level and the average number of peer references per post ranged from 0.88 to 1.04.

Inconsistent results that emerged from the correlation of variables in the present study included a moderate positive relationship that was found between intersubjectivity and deep processing at Week 1-3, and between intersubjectivity and interdependence at Week 4-6. It should also be noted that perceptions of intersubjectivity significantly increased over time, in contrast to interdependence and levels of processing which remained relatively stable over time. Therefore, the inconsistent findings across the two correlation tests would be a function of the degree of stability of these variables. The remaining strong correlations will be interpreted for their respective time periods.

During Week 1-3, a strong positive relationship was found between perceptions of intersubjectivity and deep processing. This finding supports the socio-cultural and socio-cognitive theories that cognitive and social activity are interdependent (for example Resnick, 1991). In other words, intersubjectivity emerges from shared social and cognitive interaction that is intertwined during a dialectical process where elaborate explanations are offered, critically examined, and negotiated. Because this relationship is exceptionally strong in the initial stages of PBL and these variables are higher in the cooperative structure at that
time, it also suggests that the cooperative structure offers both social and cognitive instructional advantages.

Since perceptions of interdependence was a stable trait and the relative position of the moderate positive relationship for intersubjectivity and interdependence was found in the final weeks of the PBL activity when intersubjectivity was highest, it suggests the nature of the relationship between the two variables. That is, interdependence may be the antecedent and the motivational force that initiates and sustains the collective action, that in time results in shared knowledge, common understandings, and mutuality, i.e., intersubjectivity.

**Limitations of the Study**

When interpreting this study, the reader should be advised of several limiting factors:

1. Although instructional variables were manipulated, this is a case study of an activity within an intact online class. The participants were aware that they were participating in a research study and may have modified their behavior. Therefore, external validity is limited and generalizable claims can only be made to contexts that are similar to the one described within.

2. This study does not represent a complete picture of group interactions during a problem-based activity for two reasons. First, the data may be biased by the self-selected nature of the population, i.e., only 20 of the 26 students enrolled in the class agreed to participate in the study. Second,
the conference transcript indicates that all groups employed other modes of communication, e.g., face-to-face meetings, chat, and e-mail.

3. The study may be confounded because the dependent variable, i.e., critical dialogue, is a prominent feature of the instructions for the collaborative groups. Specifically, the instructor encouraged the collaborative groups to employ a critical dialogue and explicitly characterized the nature of critical dialogue. However, it is argued that both groups were encouraged to use critical dialogue. Two pieces of evidence support this. First, the instructions to the cooperative groups emphasized that individuals should raise “critical issues” related to their role assignment. Second, the evaluation guidelines that were posted to all groups when the task was assigned emphasized criteria descriptive of critical dialogue, including: “The individual grade will be determined only by the quality or depth of thought involved in postings (and to some extent, the frequency of posts) in the group discussion board forum. For example, does an individual raise substantive challenges to propositions forwarded in the discussion board forum (These may include questions regarding validity, value, assumptions, implications, etc.)?”

4. Significance finding rather than hypothesis testing was employed to assist in seeking out differences worthy of note between the two group structures. This use of multiple, exploratory statistical tests increase the
probability of committing a Type I error, i.e., concluding that a difference exists between groups when this difference exists only by chance.

5. Although it was the intention that the treatment differences would be purely managerial in nature, i.e., role assignment and close monitoring of group dynamics, the analysis of instructor messages revealed that more pedagogical supports were offered to the cooperative group. Therefore, those supports must be considered part of the treatment and conclusions related to the efficacy of one small group structure over the other must be interpreted in this light.

6. During the content analyses, the occurrence of a single function or cognitive skill was used to segment the text into units, with the sentence as the smallest unit of analysis. The former criterion disregards the changes in topic that may occur within a single unit. Therefore, the incidence of functions reported here may be under represented. The later criterion, i.e., sentence as the smallest unit, resulted in units with multiple functions and cognitive skills. A rule set was generated to guide the coders and may have resulted in lower frequencies of social function, elementary clarification, and judgment.

7. The reliability coefficient for the dependence on instructor was very low, .50. Therefore, interpretation of findings for this measure should be tentative.
Summary

The present study examined the productive interactions of six groups of students in an online graduate class from a mid-western university as they pursued the same six-week, problem-based activity in the fall of 2000. These groups were purposefully populated as to achieve heterogenous group composition. Then, the groups were randomly assigned to one of two group structures, a cooperative structure employing role assignment and frequent monitoring by the instructor or a collaborative structure with no role assignment and infrequent monitoring. Substantive analyses of the conference also revealed that the instructor made more frequent pedagogical and managerial comments to the cooperative groups than to the collaborative groups.

Productive interaction in this study refers to text that indicates complex, higher order thinking and learning as defined by a framework of function (Henri and Rigault, 1996), cognitive skills (Henri, 1992), and level of processing (Henri, 1992), and cohesion (linkages) of messages (Howell-Richardson & Mellar, 1996). The constructs of this framework served as the dependent variables for the study. Content analysis was employed as the primary analytical method to observe, code, and compile the frequency of occurrence for each variable within the groups' private folders of Blackboard's asynchronous computer conferencing tool. In addition, the study also examined students' perceptions of interdependence, intersubjectivity, and dependence upon instructor from two administrations of a self-reported survey.
Significance testing was employed to identify differences between groups, changes over time, and relationships between variables. Three nonparametric analytical procedures were used including Mann Whitney U, the Wilcoxon Signed Ranks, and the Spearman's rho. These quantitative and qualitative data analyses resulted in main conclusions about the nature of interaction in this online problem-based activity and the relative influence of group structure upon those interactions. Nine primary findings are detailed below.

**Primary Findings**

1. Globally, the online dialogue was student-centered and student-driven with students contributing 90.56% of the messages with an average of 5.245 messages per participant per week.

2. Over the entire six weeks, cognitive and organization functions dominated the conference dialogue. Cognitive skills were fairly equally represented in the conference, with the exception of in-depth clarification which comprised only 9.14% of the cognitive skills. Surface level processing (64.17%) was more prevalent than in-depth processing.

3. Overall comparisons of group structure revealed that the cooperative structure (90.69%) was more potent in generating higher levels of cohesion than the collaborative structure (81.34%). Minimal evidence was found that the overall differences in function, cognitive skill, or level of processing could be attributed to the differences in group structure.
4. Patterns of interaction based upon analyses by weeks revealed changes
in function and skill over time. For example, the highest percentages of
dialogue exhibiting a cognitive function were found during the middle
weeks of the activity and the highest percentages of dialogue exhibiting
an organization function occurred during the final weeks. The percentage
of inferencing skills consistently increased over time.

5. Patterns of interaction across time also revealed differences between
group structures. Percentages of dialogue exhibiting deep processing and
cohesion were higher among the cooperative groups during the first half
of the activity. However, the collaborative groups approached similar
levels during the last half.

6. Perceptions of interdependence were consistently high across groups and
time, thus providing evidence that the PBL activity and teacher
interventions generated conditions of interdependence in both types of
peer-directed groups.

7. During the first three weeks of the activity, the cooperative structure was
more potent in promoting perceptions of intersubjectivity and dependence
on the instructor. However, by the end of the activity, levels had equalized
across group structures.

8. Perceptions of intersubjectivity significantly increased with time and
dependence on instructor significantly decreased.
9. Cohesion and in-depth processing exhibited a consistently strong positive relationship (.829 for Weeks 1-3 and .886 for Week 4-6).

**Conclusion**

Advocates of a more structured cooperative learning approach generally assert that assigning roles to group members results in quicker, more consistent levels of interaction, while those that advocate the collaborative approach generally imply that less structure stimulates more elaborate and in-depth levels of dialogue (Bruffee, 1999; Cohen, 1994). Evidence from this study tends to support the first assertion. Overall, the cooperative groups interacted more frequently and weekly analyses indicate that the cooperative structure offers efficiency gains during the initial weeks of the PBL activity. More specifically, the cooperative groups generated a more interconnected or cohesive dialogue and employed higher percentages of deep processing than the collaborative groups.

A possible explanation for this conclusion is that the role assignment used in the cooperative intervention provided the source of information which the participants could use to initiate the creation of a shared communicative environment (Krauss & Fussell, 1991) in the asynchronous computer conference. Using Clark and Brennan’s (1991) terminology, the role assignment appeared to enhance the common ground on which the cooperative groups could infer mutual knowledge and coordinate their collective action. The significantly higher perceptions of intersubjectivity among the cooperative groups at midproject substantiate this explanation. Over time, however, possibly...
as a consequence of collective interaction, the collaborative groups appear to have mutually generated and negotiated common ground. This is evident in three measures: (a) by the significant increase in their perceptions of intersubjectivity scores from midproject to final project; (b) by the significantly higher percentage of cognitive dialogue in Week 5; and (c) by the significant increase in level of cohesion over time.

**Implications and Recommendations**

Therefore, the primary implications of this study for instructors, designers, and researchers employing peer-directed PBL strategies in similar ACC contexts are fivefold. First, if a small group PBL activity is implemented with heterogenous short-term groups, there may be learning efficiencies to be gained, in terms of the quantity and quality of interaction, by assigning roles, elaborating learning issues, and providing close monitoring of group interaction. However, if small groups are longer-term or have a group history where common ground has been established, similar levels of both the quality and quantity of interaction may eventually be attained without the added instructional expense required for role assignment and close monitoring.

Future research should examine the influences that different types of learner roles (e.g., cognitive roles vs. performing roles) and other types of instructional interventions, such as the elaboration of learning issues, might have upon learners’ perceptions of intersubjectivity and group dialogue in terms of function, quality, and cohesion. Given the higher demands of teaching in an
online environment, future investigations into the influence of group longevity and PBL task length on the quality and quantity of group dialogue would better inform online instructors as to how to prioritize their limited instructional time.

Second, low levels of in-depth clarification and of deep processing indicate that employing a PBL strategy does not necessarily engender higher order thinking and learning among learners. Therefore, facilitators should employ specific scaffolds and instructional interventions to encourage learners to deeply, critically engage the problem for its learning potential. More specifically, these scaffolds and interventions should prompt learners to:

• identify and question assumptions;
• hypothesize and entertain possibilities;
• make connections across messages;
• justify assertions and conclusions; and
• detect and classify relationships.

Third, the strong positive relationship found between cohesion and deep processing suggests that an online facilitator may quickly gage a group’s level of thinking and learning by examining the interconnectedness of messages within their conference. Given that assessing the quality of online collaborative discussion can be very time consuming for the online instructor, the potential instructional efficiencies of this assessment strategy make this an especially valuable line of future research. First, such research should confirm the existence of a positive relationship between deep processing and cohesion.
across various instructional strategies, instructors, and content areas. Then, guidelines and conditionalities for use of this assessment strategy should be established and evaluated under various teaching and learning contexts.

Fourth, this analysis indicates that distributed PBL activities not only create competing demands upon learners for learning and performing in small groups, but also promote different cognitive skills over time. In this study, relatively low levels of dialogue serving a cognitive function (i.e., knowledge and skill related to the learning process) were found as compared to other instructional strategies reported in the literature. (e.g., MacDonald, 1998). Given that learners have a limited pool of resources for educational endeavors, what relative levels of dialogue function indicate a meaningful and productive learning experience? In a distributed learning environment, under what conditions is PBL a preferred instructional strategy? Are there learning advantages, such as the activation of inferencing skills, to be gained from the PBL experience? Is there a relationship between cognitive dialogue and group performance? A worthy first step in answering these questions, then, is for researchers to analyze the dialogue of small groups with the intent of identifying and verifying the relative distribution of functions and cognitive skills typically engendered by different teaching and learning strategies. Once verified, these patterns can be employed by instructors and designers to not only establish performance expectations and evaluative standards criteria, but also make more informed instructional decisions.
Fifth, this study documents that designing and facilitating small group PBL in distributed environments is a complex and demanding task. In particular, the instructor interactions in this study suggest that novice instructors may not differentiate, nor fully substantiate the various roles they could assume in a distributed learning environment. An implication is that specialized training and pedagogical scaffolding should be offered to new and preservice online instructors to both enhance their awareness of these intersecting roles and to build managerial, pedagogical, social, and technological skills that are especially effective in distributed PBL environments. One such scaffolding strategy may be for sponsoring institutions to customize their course management programs, such as Blackboard, with specific features (e.g., icons, folders, and explanations) that prompt or inform online instructors of best practices. Clearly, the development and evaluation of innovative strategies to support the performance and ongoing professional development of online facilitators is a worthy endeavor for further exploration.

Requiring learners to solve ill-structured problems together in small groups, no doubt, influences the nature of the learning process in terms of the skills and effort required for both learning and working together. With distributed learners, the communication medium enables and constrains these intellectual and organizational interactions. In particular, asynchronous computer conferencing tools temporally constrain group interactions to primarily a text or graphic symbol system while enabling a virtual meeting space for groups to
mutually articulate, explore, test, refine, and solve problems. From a researcher’s perspective, these persistent archives of group interactions offer unique opportunities to observe the complexities of individual and group problem solving. Analyses of these archives are crucial to identifying and understanding the pedagogical conditions which afford and inhibit both the individual and group learning processes. A variety of research methods, such as content analysis, interaction analysis, and survey analysis, should be employed to provide diverse perspectives upon which to interpret the complexities of learning and working together.
REFERENCES


the use of computers in collaborative learning. In T. Koschmann (Ed.),


Mahwah, NJ: Lawrence Erlbaum Associates.


## APPENDIX A

### Henri’s (1992) Analytical Model: Cognitive Skills

<table>
<thead>
<tr>
<th>Reasoning Skills</th>
<th>Definitions</th>
<th>Indicators</th>
<th></th>
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<tbody>
<tr>
<td><strong>Elementary</strong>&lt;br&gt;Clari&lt;sub&gt;fi&lt;/sub&gt;cation</td>
<td>Observing or studying a problem, identifying its elements, and observing their linkages in order to come to a basic understanding</td>
<td>Identifying relevant elements&lt;br&gt;Reformulating the problem&lt;br&gt;Asking a relevant question&lt;br&gt;Identifying previously stated hypotheses</td>
<td></td>
</tr>
<tr>
<td><strong>In-depth Clarification</strong></td>
<td>Analyzing and understanding a problem to come to an understanding which sheds light on the values, beliefs, and assumptions which underlie the statement of the problem</td>
<td>Defining the terms&lt;br&gt;Identifying assumptions&lt;br&gt;Establishing referential criteria&lt;br&gt;Seeking out specialized information</td>
<td></td>
</tr>
<tr>
<td><strong>Inference</strong></td>
<td>Induction and deduction, admitting or proposing an idea on the basis of its link with propositions already admitted as true</td>
<td>Drawing conclusions&lt;br&gt;Making generalizations&lt;br&gt;Formulating a proposition which proceeds from previous statements</td>
<td></td>
</tr>
<tr>
<td><strong>Judgment</strong></td>
<td>Making decisions, statements, appreciations, evaluations and criticisms, sizing up</td>
<td>Judging the relevance of solutions&lt;br&gt;Making value judgements&lt;br&gt;Judging inferences</td>
<td></td>
</tr>
<tr>
<td><strong>Strategies</strong></td>
<td>Proposing co-ordinated actions for the application of a solution or for allowing through on a choice or a decision</td>
<td>Deciding on the action to be taken&lt;br&gt;Proposing one or more solutions&lt;br&gt;Interacting with those concerned</td>
<td></td>
</tr>
</tbody>
</table>

### Henri’s (1992) Analytical Model: Processing Information

<table>
<thead>
<tr>
<th>Surface Processing</th>
<th>In-Depth Processing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Repeating the information contained in the statement of the problem without making inferences or offering an interpretation</td>
<td>Linking facts, ideas and notions in order to interpret, infer, propose and judge</td>
<td></td>
</tr>
<tr>
<td>Repeating what has been said without adding any new elements</td>
<td>Offering new elements of information</td>
<td></td>
</tr>
<tr>
<td>Stating that one shares the ideas or opinions stated, without taking these further or adding any personal comments</td>
<td>Generating new data from information collected by the use of hypotheses and inferences</td>
<td></td>
</tr>
<tr>
<td>Proposing solutions without offering explanations</td>
<td>Setting out the advantages and disadvantages of a situation or solution</td>
<td></td>
</tr>
<tr>
<td>Proposing judgements without offering justification</td>
<td>Setting out the advantages and disadvantages of a situation or solution</td>
<td></td>
</tr>
<tr>
<td>Asking questions which invite information not relevant to the problem or not adding to the understanding of it</td>
<td>Providing proof or providing examples</td>
<td></td>
</tr>
<tr>
<td>Offering several solutions without suggesting which is most appropriate</td>
<td>Perceiving the problem within a larger perspective</td>
<td></td>
</tr>
<tr>
<td>Perceiving the situation in a fragmentary or short-term manner</td>
<td>Developing intervention strategies within a wider framework</td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B
Threaded Discussion in Blackboard
an Asynchronous Conference Tool
APPENDIX C
Perceptions of Interdependence & Intersubjectivity

Directions: In [name of course], you have been learning and working as part of a team. This survey documents how you perceive the team experience. Please respond to each question and then select the “Continue” button to submit your responses.

Section I.

1. Please enter your team's name.

2. Briefly describe your team's goal(s) for your current team project.

Section II.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Moderately Disagree</th>
<th>Somewhat Disagree</th>
<th>No Opinion</th>
<th>Somewhat Agree</th>
<th>Moderately Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
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</tbody>
</table>

Directions: Read each of the following statements carefully and select the response which best describes how you feel about the statement. The responses range from strongly disagree to strongly agree.

1. My teammates and I share a common understanding about individual roles within the team.
2. The structure of the task makes me and my teammates dependent upon each other for success.
3. I rely on the instructor to confirm the accuracy of my conclusions.
4. Leadership responsibilities are shared within my team.
5. The comments of teammates encourage me to contribute to the team.
6. My teammates and I do not share responsibility for making decisions.
7. I can accomplish the class assignment by myself.
8. My teammates and I disagree on the meaning of key terms.
9. My contributions are useful to my teammates.
10. The comments of my teammates do not challenge me to learn.
11. My teammates and I reach a common understanding about important issues.
12. My teammates limit my progress.
13. My teammates and I interpret the team's goal in a different way.

14. The different perspectives of my teammates challenged my own thinking.

15. I do not rely upon my teammates to guide the team's progress.

16. My teammates understand the target learning concepts (e.g., technology assessment) the same way I do.

17. The contributions of my team members helped me learn.

18. I can not depend on my teammates to provide feedback on my contributions.

19. I do not rely upon the instructor to guide the team's progress.

20. The instructor's feedback is essential to help me learn.

21. The knowledge and skill of my teammates is an asset to the team.

22. My teammates and I do not depend upon each other for success.

23. I have a different vision of how to work together than my teammates.

Section III

If you have any comments about how your team experience helped or hindered your personal growth, please make them below.
APPENDIX D  
Participant Question Set  

Please rank your skill or knowledge in the following issues:

<table>
<thead>
<tr>
<th>Issues</th>
<th>Level of Proficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
</tr>
<tr>
<td>1. Providing leadership that involves all group members in the creation of shared vision, mission, and process.</td>
<td></td>
</tr>
<tr>
<td>2. Effectively using group process skills.</td>
<td></td>
</tr>
<tr>
<td>3. Using team building skills appropriate to the group and task.</td>
<td></td>
</tr>
<tr>
<td>4. Facilitating equitable group decision making.</td>
<td></td>
</tr>
<tr>
<td>5. Using conflict resolution techniques.</td>
<td></td>
</tr>
<tr>
<td>6. Providing constructive, substantive feedback to group members.</td>
<td></td>
</tr>
<tr>
<td>7. Negotiating differences and compromising one’s views.</td>
<td></td>
</tr>
<tr>
<td>8. Working to build consensus among group members.</td>
<td></td>
</tr>
</tbody>
</table>

9. Have you ever participated in a formal educational session on facilitating group process or understanding group dynamics?  
   ☐ Yes - If yes, please describe the topic and nature of the training.  
   ☐ No

10. Have you ever collaborated with a group using the Internet?  
    ☐ Yes - If yes, please describe the nature of the collaboration.  
    ☐ No
APPENDIX E
Inquiry Task Overview

Major Assignment: Technology Assessment Report
Technology: Use & Assessment, Fall 2000

Assignment:

1. Working in your assigned group, prepare a formal technology assessment report as directed by the fictitious Technology Assessment Report Contract Award below. Please format your report for the World Wide Web, making good use of its features (e.g., hyperlinks).
2. When the final report has been published, send the instructor an Email identifying the report's web address and authorship.
3. In preparing the report, be sure to use the Blackboard Discussion Board Forum for your particular group to document the learning process.

Technology Assessment Report Contract Award

Dear Madam or Sir:

This letter formalizes the award of a (fictitious) contract between the US Department of Education and your company for the production of a technology assessment report to be made available online no later than 11 pm EST on Monday, November 27, 2000. We have requested your group to provide us with an objective and well-researched technology assessment titled: "Health and Wellness Implications Of Computer Use by Children: Recommendations for School Districts to Promote Lifelong Wellness". Please include four policy options for school districts. For each option, provide a prediction to the year 2050 that forecasts the economics costs and benefits and the implications for human health and wellness. Cite relevant research as appropriate. Our office is accustomed to technology assessment reports from the US Office of Technology Assessment, so you may wish to model your report after theirs.

Our nation has invested billions of dollars to place computer technology in our nation's schools and to provide Internet access, yet we are concerned with benefits and risks of this technology on students' health and wellness. ("In the first two years, the E-Rate has committed nearly $4 billion (and 3rd year requests alone have exceeded this total), with 84 percent going to the nation's public schools." Source: http://www.ed.gov/offices/OUS/eval/erate_draft11.doc ). There have been a number of discussions among legislators and federal administrators regarding the effect of increased computer use by our nation's youth on their lifelong health and wellness. We have inquired about the effect of this sedentary practice on physical fitness, vision, psychological development, social problems, and long-term health problems. We are hoping your report can create the basis for new federal legislation, revision of Department of Education programs, and school district practices that lead to a healthier nation.

When your final report is posted on the Internet, please send an Email to my representative, [Name of Instructor], indicating the location and authorship of this report.

Sincerely,

Richard W. Riley (not really), Secretary
US Department of Education
Evaluation:

The Technology Assessment activity counts for 1500 points. Approximately half of that will be taken from a group grade, and half from an individual grade.

The group grade will be determined by an evaluation of the final product. It will be compared with other student technology assessment reports (both within our class and from other sources) and with professional technology assessment reports. In addition, the grader will consider evidence relating to the process of preparing this report. For example, if a certain economic assessment was made, but a later decision kept it out of the final document, the group will receive the recognition it deserves for having performed that assessment and then deciding not to include it, as evidenced in the group forum.

The individual grade will be determined only by the quality or depth of thought involved in postings (and to some extent, the frequency of posts) in the group discussion board forum. For example, does an individual raise substantive challenges to propositions forwarded in the discussion board forum (These may include questions regarding validity, value, assumptions, implications, etc.)? If one of your contributions is not posted to the group discussion board, it will not be included as evidence supporting an individual grade. This is the evidence by which the instructor will judge whether individual learners have cognitively engaged the target concepts, procedures, and their appropriate conditions of use.

Due Date:
Your final report is to be posted on the Internet and the url shared with the instructor by 11 pm, Monday, November 27, 2000.

All information is subject to change without notification.
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# APPENDIX F
## Framework for Analysis of Function

<table>
<thead>
<tr>
<th>Unit Focus</th>
<th>Definitions</th>
<th>Indicators</th>
<th>Examples</th>
</tr>
</thead>
</table>
| Cognitive  | Unit exhibits knowledge and skill related to the learning process, including the issue, content, process, or strategies of Technology Assessment (TA) and the context of the TA problem | • Clarifying relevant elements  
• Reasoning about the TA problem  
• Making decisions, judgments, and evaluations  
• Proposing actions  
• Seeking corroboration, guidance, clarification | • Take also in consideration, that the have wellness programs over the computer now. For example every 10 min. a screen pops up saying that is time to get up and do some stretching, or light exercise, or it can talk something about nutrition.  
• How about finding as many epidemiology reports as possible? Stuff that shows computers actually do negatively affect wellness.  
• I think we need to include wellness impacts vs. health impacts in our problem statement “and extend out our age range from adolescents to school age children.” |
| Metacognitive | Unit relates to general knowledge and skills especially those that are indicative of self-regulation | • Reflection on one’s thinking process  
• Self-disclosures about general knowledge or skill  
• Self-evaluation  
• Self-monitoring | • This did not seem to clarify any issues for me.  
• I realize that my citations are not complete, this is just in the prelim. stage, I didn’t worry about correct “APA”.  
• If anyone else is unsure or if anyone can help clarify, that would be great! |
| Organization | Unit does not relate to the formal content of subject matter, rather it relates to the management, mechanics, logistics of working together as a group or as a contributing group member  
Unit exhibits knowledge and skill related to the working process | • How to use Web-based tools and procedures  
• How to work together  
• Procedures for exchanging information, decision making, roles  
• Scheduling meetings times and venues  
• Reporting individual progress  
• Coordination of activities | • I just wanted to post my schedule so we can set up some virtual chat time.”  
• I will be a bit late with the proposal section.  
• How shall we get things started? What will our timeline be?…..And how do we do this with maximum efficiency for our busy schedules?”  
• About the attachments… a piece of cake. You’ll have no problem. When you write a message and are ready to include an attachment, just click “browse” at the bottom of the screen, next to the attachment area (a blank space after the word “Attachment.”)  
• Let me know if you need help putting the report into HTML format. |
| Social     | Unit does not relate to the formal content of subject matter, rather it serves to support interpersonal relations by referencing the self or group | • Supportive or harassing statements  
• Thanks and appreciation  
• Personal status, including statements about experiences and affect  
• Off-task statements | • By the way, thanks Joyce, for getting us off to such a GREAT start  
• Sorry for the delay. This is midterm week, and today is my first breather. But break is coming up…yah! |

Adapted and modified from Henri (1992) and Henri and Rigault (1996)
<table>
<thead>
<tr>
<th>Reasoning Skills</th>
<th>Definitions</th>
<th>Indicators</th>
<th>Examples (Surface)</th>
<th>Examples (Indepth)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Elementary Clarification</strong></td>
<td>Observing or studying a problem, identifying its elements, and observing their linkages in order to come to a basic understanding</td>
<td>• Identifying relevant elements&lt;br&gt; • Reformulating the problem&lt;br&gt; • Asking a relevant question&lt;br&gt; • Identifying previously stated hypotheses&lt;br&gt; • Relevant quotes or summaries of other's work</td>
<td>• For those not in Wellness, they are: physical, social, emotional, intellectual, <em>environmental, spiritual, vocational.</em>&lt;br&gt; • How does this problem affect society?&lt;br&gt; • Why? What is your point? What would be an example?&lt;br&gt; • Define target population ...(this has been done for us in the assignment letter)</td>
<td>• ...one of the National Health Objectives of Healthy People 2010 for physical fitness is : Increase the proportion of children and adolescents who view television 2 or fewer hours per day. The Target is 75%. The Baseline is 60% of persons aged 8 to 16 years viewed television 2 or fewer hours per day in 1998-1994.</td>
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<td><strong>In-depth Clarification</strong></td>
<td>Analyzing and understanding a problem to come to an understanding which sheds light on the values, beliefs, and assumptions which underlie the statement of the problem</td>
<td>• Defining terms in multiple ways&lt;br&gt; • Identifying assumptions&lt;br&gt; • Establishing referential criteria&lt;br&gt; • Seeking out specialized information&lt;br&gt; • Seeking reasons&lt;br&gt; • Deferring judgment&lt;br&gt; • Providing examples and nonexamples</td>
<td>• It is difficult to determine without having an idea of our policy options...&lt;br&gt; • I was thinking along the lines that computer use prepares children of occupations/lifeskills that will be necessary in the next 50 years.&lt;br&gt; • We may need to separate Risk Analysis from Proposals for each of our 4 areas, &quot;to be consistent.&quot;</td>
<td>• Also, can we assess the cost of implementing your recommendations? Can we compare those costs with the estimated costs of not implementing the recommendations? Why would a school district want to do this? Unfortunately, they won’t necessarily do things because it is “the right thing to do”. ...if they won’t see a pay-off.&lt;br&gt; • On the other hand, is there a relationship between intellectual learning and computer use?</td>
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<td><strong>Inference</strong></td>
<td>Induction and deduction, admitting or proposing an idea on the basis of its link with propositions already admitted as true</td>
<td>• Drawing conclusions&lt;br&gt; • Making generalizations&lt;br&gt; • Formulating a proposition which proceeds from previous statements&lt;br&gt; • Applying criteria to reach a conclusion</td>
<td>• If we consider the social aspects of kids spending too much time on the computer, we could look at missing other social activities and the lack of friends.&lt;br&gt; • After reviewing our research, my 4 areas of concern as “computer use increases are (in order): #1 Social/peer interaction&lt;br&gt; • Therefore to decrease negative emotional effects of computer use by blocking access to inappropriate materials.</td>
<td>• proposal to Decrease the Negative Social Effects: Send children to camps, encourage them to play sports, and help them be with real life friends.&lt;br&gt; • So for teachers, a positive effect of increased computer use might be more opportunities to provide individual support and encouragement. Negative effect might be...&lt;br&gt; • I was thinking along the lines that computer use prepares children of occupations/lifeskills that will be necessary in the next 50 years. Vocational wellness will depend on people’s ability to use computers.</td>
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| Judgment | Code: J | Making decisions, statements, appreciations, evaluations and criticisms | • Judging the relevance of solutions  
• Making value judgments  
• Judging inferences  
• Judging credibility of data  
• Corroborating  
• Sizing up | • There is a wealth of information that will be helpful.  
• C’s idea of a problem statement is good.  
• I believe that physical wellness is more important than emotional.  
• I agree. Good job! | • about you(r) last policy, i’m going against(t) replacing ergonomic systems because they are unnecessary. You can use other methods that can be used as substituted to decrease the problems with comp. usage. You can train the teachers "to teach better computer techn. while using it. and much more things..."  
• Although all of your recommendations are good, I am not sure they are "proposals" that a school district can implement. In my opinion they need specifics that can be "implemented."

| Strategies | Code: SC, SI, SF | Proposing co-ordinated (SC) or individual (SI) actions for learning, the application of a solution, or for allowing through on a choice or a decision | • Deciding on the action to be taken  
• Proposing one or more solutions  
• Interacting with those concerned  
• Seeking corroborations or feedback (SF)  
• Acting on a strategy | • Let me know what you think about bounding the study?  
• ... if you read this and you have any suggestions for narrowing our search criteria, I am sure we would all welcome any suggestions.  
• I’m going to the library to research computers and the negative effects on children.  
• Identify information needs.  
• As I read all our analyses, I see that we all need to define computer use consistently. | • I was just thinking, while we are brainstorming I have something that might help us put this assessment together a little easier. It is called the Design Process, often used to help figure out problems or define ideas to meet an objective.  
• Was thinking we could brainstorm along the lines of the 7 dimensions of wellness proposed by FIFWG.  
• Cover all bases (Make sure we have looked at all viewpoints/alternatives).  

Adapted and modified from Henri (1992) and Ennis (1987)
# APPENDIX H
*Indicators of Level of Processing*

<table>
<thead>
<tr>
<th>Surface Processing</th>
<th>In-Depth Processing</th>
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<tbody>
<tr>
<td>Repeating the information contained in the statement of the problem without making inferences or offering an interpretation</td>
<td>Linking facts, ideas and notions in order to interpret, infer, propose and judge</td>
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<tr>
<td>Repeating what has been said without adding any new elements</td>
<td>Offering new elements of information</td>
</tr>
<tr>
<td>Stating that one shares the ideas or opinions stated, without taking these further or adding any personal comments</td>
<td>Generating new data from information collected by the use of hypotheses and inferences</td>
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<tr>
<td>Proposing solutions without offering explanations</td>
<td>Setting out the advantages and disadvantages of a situation or solution</td>
</tr>
<tr>
<td>Proposing judgments without offering justification</td>
<td>Setting out the advantages and disadvantages of a situation or solution</td>
</tr>
<tr>
<td>Asking questions which invite information not relevant to the problem or not adding to the understanding of it</td>
<td>Providing proof or providing examples</td>
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<tr>
<td>Offering several solutions without suggesting which is most appropriate</td>
<td>Perceiving the problem within a larger perspective</td>
</tr>
<tr>
<td>Perceiving the situation in a fragmentary or short-term manner</td>
<td>Developing intervention strategies within a wider framework</td>
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<tr>
<th>Examples</th>
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<td>I'm not sure how many graphics we would like to include, but we may want a computer and a young adult.</td>
<td>Good thinking on the &quot;scenario&quot; technique. I definitely agree. The text says &quot;They are useful in describing and forecasting technology and society, and in impact analysis&quot;, which is exactly what we need to do.</td>
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<td>We also definitely need &quot;a clearly-worded technology assessment problem statement. Would this just be drawn from the title, &quot;Health and Wellness Implications Of Computer Use by Children: Recommendations for School Districts to Promote Lifelong Wellness&quot;?</td>
<td>ENVIRONMENTAL: due to numerous and often continuous print outs of web pages and information the web, enforce recycling practices and possibly move toward the &quot;Media Lab&quot; paper that is a medium that can print on, erase, and re-use.</td>
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<td>Same thing with the &quot;opinion management&quot; technique. None of the others seemed relevant. Or not so obviously so at least.</td>
<td>Take also in conc(s)ideration, that the(y) have wellness programs over the computer now. for example every 10 min. a screen pops up saying that is time to get up and do some stretching, or light exercise, or it can talk something about nutrition.</td>
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<td>I remember hearing about an article involving kids and the effects that computer monitors have on them from long term viewing. I will try to find it, unless that varies from the direction we are going with this project.</td>
<td>K-5 children get PE and when they don't have PE they have recess. 6-10 have at least one semester of PE but not recess. 11 and 12 do not have to take PE and may have no physical exercise.</td>
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<td>Why? What is your point? What would be an example?</td>
<td>Can we compare those costs with the estimated costs of not implementing the recommendations? Why would a school district want to do this?</td>
</tr>
</tbody>
</table>

Adapted and modified from Henri (1992). Examples are from transcripts. Names have been deleted from text.
Algorithm for Coding Function

Does the unit provide evidence of a learning process as it relates to TA or the TA assignment?

If Yes

Does the unit refer to a learning strategy, TA or the context of the TA problem beyond the report?

If Yes

Does the unit refer to the end product, i.e., the Web page or report?

If Yes

Does the unit relate to the mechanics, management, or logistics of producing the report, e.g., roles or deadlines?

If Yes

Does the unit contribute substance about TA or the TA context to the report?

If Yes

Does the unit relate to the mechanics, management, or logistics of working together or contributing to a group goal?

If Yes

If No

Organization

If No

Social

If No

Cognitive

If No

Metacognitive

If Yes

Does the unit refer to thinking, acting, or working alone or together?

If Yes

Does the unit show self-awareness, self-evaluation, or self-regulation?

If Yes
Algorithm for Cognitive Skill Coding

APPENDIX J

Is the unit a conclusion, a proposition, a generalization, judgment, or a decision?

If No

Does the unit extend, extend, compare, or delve deeper into TA or the TA problem, e.g., ask probing, specialized questions?

If No

Does the unit restate or reword previous statements, relate them to personal experience, identify relevant facts or resources, or ask a relevant, yet general question?

If Yes

Elementary Clarification - E -

If No

In-depth Clarification - C -

If Yes

Strategy - S -

Is the unit a decision?

If Yes

Judgment - J -

If No

Does the unit refer to coordinated or individual action?

If Yes

Is the unit a result of a line of reasoning? Is there evidence for the consensus employed previous statements or criteria to support the proposition or conclusion?

If Yes

If No

Does the unit refer to coordinated or individual action?