

KNOWLEDGE CONSTRUCTION, SOCIAL IDENTITY AND SOCIAL NETWORK
STRUCTURE IN COMPLETELY ONLINE GROUPS

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by

SEAN PATRICK GOGGINS

Dr. James Laffey, Dissertation Supervisor

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The undersigned, appointed by the Dean of the Graduate School, have examined the
Dissertation entitled

KNOWLEDGE CONSTRUCTION, SOCIAL IDENTITY AND SOCIAL NETWORK
STRUCTURE IN COMPLETELY ONLINE GROUPS

Presented by Sean Patrick Goggins

A candidate for the degree of Doctor of Philosophy of the School of Information Science
and Learning Technologies

And hereby certify that in their opinion it is worthy of acceptance.

Professor James Laffey

Professor Sanda Erdelez

Professor Joi Moore

Professor Chi-Ren Shyu

DEDICATION

This dissertation is dedicated to my wife, Cynthia and our daughter, Sydney.

Mom – Thank you for everything. Raising seven children is one of the tasks on earth requiring more perseverance and good luck than completing a dissertation; especially when I am one of the seven. I suppose my interest in groups goes back a long way.

Bob – Thank you for keeping for being a wonderful grandfather to Sydney.

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Abstract

Working, learning and informal information-seeking behavior is rapidly moving online. It will increasingly involve collaboration within small groups meeting online. While this process is being driven by technological innovation, the important socio-technical issues of human-computer, human-human and human-information interaction under the new conditions are less well understood. I am interested in how small groups form online and how the characteristics of this formation affect their knowledge-related abilities.

Completely online groups (COGS) are phenomena that have emerged in computer supported collaborative learning (CSCL) environments. This mixed methods study examines the development of eight completely online groups in a CSCL course held at the University of Missouri during the summer of 2008. The principal contribution of this work is a new and deeper understanding of completely online groups and the diverse development trajectories they follow. This work also contributes a methodologically rich research design that leads to the comprehensive description of the context and experiences of completely online groups.

Group development is framed as the confluence of knowledge construction, social identity and social network structure. Knowledge construction and social identity are both examined using content analysis techniques (Krippendorf, 2004) on over 1600 discussion board posts made by three groups during the course. These quantitative findings are integrated with ethnographically informed analysis of field notes, transcripts from 42 member interviews and other artifacts from the socio-technical experience of the

eight groups examined in this study. Network structure is revealed through examination of bi-directional activity logs (showing both read and post activity) and the analysis of those logs using social network analysis (SNA) measures and sociograms (Wasserman & Faust, 1994).

Once group structure and trajectory are established for the eight groups, the study incorporates the constructs of social ability (Laffey et al, 2006), information horizons (Sonnenwald, 1999) and group efficacy (Hardin et al, 2006) to identify and describe differences between the 25 members in this study and the eight groups they were organized in. Survey data, ethnographic analysis of discussion boards, content analysis, social network analysis and critical incident interview data are integrated and presented as group level case studies for three of the groups. Finally, small group development trajectories for all eight groups are compared and contrasted.

The results presented include patterns of completely online small-group development, and the relation of those patterns to differences in social ability, group efficacy and information horizons among the groups and their members. Completely online small-group development is characterized through detailed analysis of social-network structure, patterns of group-knowledge construction and trajectories of group-identity formation. The goal of this research is to build the research and design community's understanding of how socio-technical systems influence—and may be designed to support—creative collaboration and learning among people who never meet face-to-face.

CHAPTER I

Chapter One – Introduction

Overview

Groups in the physical world have been, and continue to be the subject of much research. In the internet age, many groups exist completely online, yet research to understand the particular characteristics of online groups has been sparse. In the following chapter, we will highlight this paradox, characterize the research communities who have explored online group development, issue a call to arms to explore completely online group development, and explain what makes online groups different than physically situated groups. In the end, we will describe the specific problem being addressed by this study, the purpose of this study, and the research questions that will guide us through it. Limitations of this study and a reference guide for terminology are included after that.

The Paradox of Current Online Group Development Research

A recent search of Yahoo! Groups for “Halo”, a popular video game, returned 2,832 distinct groups, ranging in size from a single person to several thousand members. Google Groups provides a searchable listing of over 700 million online postings to USENET groups from the past 20 years (Google, 2008). In more bounded communities like corporations and research communities, distributed collaboration and group work is emerging as a byproduct of globalization (Meredith, 2007; Friedman, 2005). Within these larger communities are small groups. As we enter an age where group work among people who never physically meet each other is becoming an expectation of daily life,

such groups are not widely studied nor well understood. To meet the needs of completely online groups, the characteristics of completely online group development and the types of socio-technical design that influence completely online group development must be investigated.

Research Communities and Small Groups

Researchers have explored computer support for cooperation/collaboration from numerous perspectives, most notably as computer support for cooperative work (CSCW), computer support for collaborative learning (CSCL) and small group research. In the two decades since the Association for Computing Machinery (ACM) established a biennial conference on CSCW, eight primary threads of inquiry have emerged: theories, computer science, shared workspaces, social spaces, use of email and office tools, groupware design, management of information systems and video-mediated communication (Jacovi, Soroka & Marmasse, 2006). These primary threads of inquiry occasionally include ethnographies of small groups or descriptions of tools intended to support particular types of groups, most often small teams situated in larger organizations. For example, Whittaker's (1996) study of how small groups formed and maintained knowledge repositories in Lotus Notes demonstrated that member beliefs about the importance of a moderator for information sharing were not supported by the observed practices of information use. In another case, Muller's (1999, 2005) description of group work in a shared email box articulated the power of appropriating available tools to meet an immediate small group collaboration need. These studies are representative of how group work is examined in the CSCW community: Largely as ethnographic analysis of tool appropriation. Few studies in CSCW (Goggins, Laffey & Tsai, 2007; Goggins,

Laffey, Reid & Tsai, in Press; Nardi, 2006) have examined how groups develop in a completely online context.

The Computer Support for Collaborative Learning (CSCL) community has examined small groups in an online context from the perspective of joint knowledge construction (Kimmerle & Cress, 2008), the influence of argumentation scaffolds on group micro-processes (Stegner, Weinberger & Fischer, 2007; Nussbaum, Winsor, Aquino & Poliquin, 2007) and the use of technology for reflection (Yukawa, 2006). These studies did not examine completely online groups, but instead focused on the appropriation of technology to support particular goals. While learning itself is recognized as social (Wenger, 1999; Lave, 1991; LaTour, 2007), the development of a powerful social unit, the small group (Stahl, 2006; Poole & Hollingshead, 2005; Hare, Blumberg, Davies & Kent, 1994), is as little examined in the CSCL literature as the CSCW literature.

The dearth of online group development research is one common thread in the CSCL and CSCW communities. Koschmann (2008) follows in the footsteps of other researchers (Stahl, 2006; Bereiter, 2002) by suggesting the traditional boundaries between CSCL research and CSCW research are founded in old ways of thinking about work and learning as distinct, serially executed periods of human life. The preponderance of group development research conducted sans technology makes no explicit distinction between work and learning, but instead characterizes group types according to finer grained contextual details (Hackman, 1990; Arrow, McGrath & Berdahl, 2000; Poole & Hollingshead, 2005; Napier & Gershenfeld, 1989; Johnson & Johnson, 1989). Arrow et al's (2000) characterization of group context is typical, with

internal and external locus of control on the y axis, and emergent or planned status on the x axis, they break small groups down into four basic categories which exist on a continuum along both axes. This is shown in Figure 1.

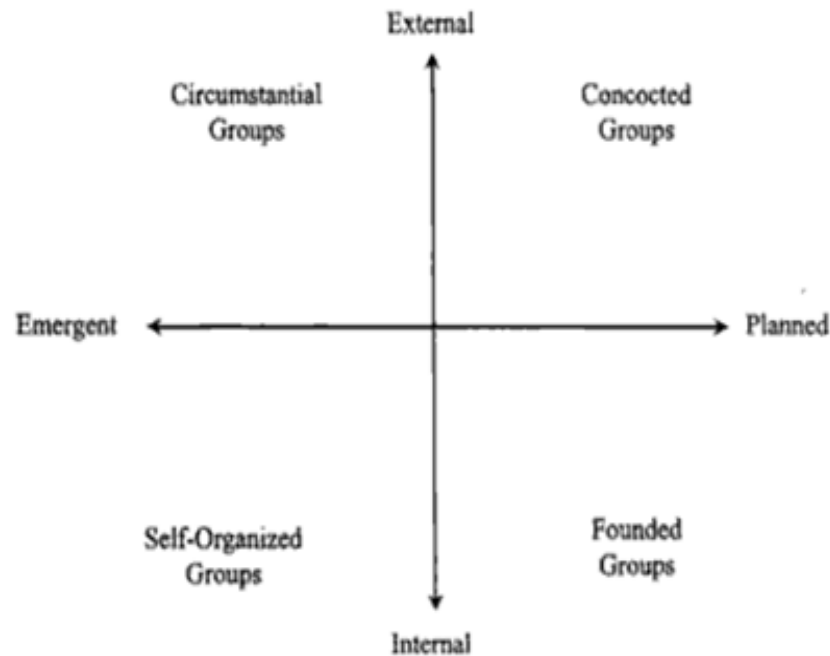


Figure 1 - Spectrum of Group Types from Arrow et al (2000)

As Arrow's work demonstrates, a good deal is already understood about group development in the physical world. One of the most common frames for understanding group development in the physical world is through the lens of problem solving. Group problem solving strategies cut along two lines – rational and intuitive (Napier & Gershenfeld, 1989). Rational problem solving incorporates six stages of development: Problem identification, diagnosis, generating alternatives, selecting solutions, implementation and evaluation & adjustment. Intuitive problem solving is viewed as more appropriate when groups are stuck, or are trying to solve an unstructured problem.

Brainstorming, brainwriting, trigger groups and synetics are among the intuitive problem solving strategies groups may employ.

Group development models provide another frame that has been used to explain group development in the physical world. Gersick (1988) challenged decades of thinking about the rhythmic formation of groups – what Knowles & Knowles (1955) and Tuckman (1965) characterized as "storming, forming and norming" – by describing group development as *punctuated equilibrium*, or long periods of inertia peppered with windows of deadline or event induced structural change. This punctuated equilibrium begins with an initial meeting, followed by an inertial period, a midpoint where transition (punctuation) takes place and, usually, the successful completion of an activity.

Completely Online Group Development: A Call to Arms

Gersicks' exposition of context as a vital contributing factor in group performance, while revolutionary at the time remains largely unexplored in group settings where *all interactions* occur in the context of a socio-technical system. Carabajal, LaPointe & Gunawardena (2003) point to the dearth of completely online group development research to date. They suggested that the intersection of task, social, technological and other factors that are unique to online groups should be explored further in order to build understanding about the causes of observed variability in online group performance. Advancing knowledge of group development online will require integration of knowledge from Small Group, CSCL and CSCW research, and focus on the small group as both a context for collaboration and a primary unit of analysis in research.

Studies examining online group development, though small in number, suggest that there are differences between online groups and other groups. For example, Michinov & Michinov (2007) studied the online development of a group of 15 students in an MBA program, explicating the midpoint transition not as Gersick found it in her studies – as a motivating but intense period of change in the middle – but rather as a "valley of despair". The valley was followed by the completion of the task, as occurred for 7 of Gersick's 8 original groups. The striking difference is the abject negativity in the communication threads for these groups at the conclusion of their work. While not generalizable, the observation is *inconsistent* with Gersick's findings and the findings of others who have examined group development in the physical world (Arrow, 2004; Baskin, Barker & Woods, 2005).

Stahl (2006) suggests that small groups are “engines of knowledge building”. Empirical research designed to understand groups of this size in an online setting will ultimately provide the perspective necessary to design more effective tools for distributed group work and knowledge building. To achieve these ends, Stahl points out the need to develop a theory of mediated cooperation through a design based research agenda of analysis of small group cognition. Stahl’s focus on small group cognition in online cooperation is compelling, as it extends existing notions of organic systems of knowing, as suggested by Hutchins (1995).

Carabajal et al, Stahl and others state that empirical research to better understand small online group development is needed. Like both Stahl and Gersick, this study will examine planned, task-oriented groups. Like Wenger (1999), this study will examine work practices and relations among group members to develop an understanding of the

nature of community, or at least groupness, demonstrated by our groups. Distinct from these prior efforts, the groups we examine will exist in a completely online environment.

What Makes Online Group Development So Different?

Completely online small groups are distinguished from their physically situated counterparts in three significant ways. First, the opportunity to exchange social information and coordinate tasks online is constrained in different and challenging ways when compared with the physical world. The social orientation of participants in an online setting is reflected through constructs like social presence, social navigation and social awareness. Consequently, understanding small group development in completely online settings requires some measure of the socio-technical system, individual characteristics and assigned tasks corresponding to particular groups. This will enable comparison across contexts at multiple levels. Laffey, Lin & Lin (2006) explicated social ability as a construct for articulating comparisons of individual participant experiences with tools, tasks and online fellows. Social ability is constructed at the individual unit of analysis, though Laffey et al (2006) suggest that further development of the construct is called for. Social ability is, then, both a construct we will explore at the individual unit of analysis in building our understanding of completely online small groups, and a construct we will seek to elaborate at the small group unit of analysis through our findings.

Second, completely online groups are composed of people who are likely to be in different geographical locations, different organizational units (or different organizations), and consequently have access to different social networks and different information resources. Sonnenweld (2001, 2003, 1999) characterized these constraining and enabling forces experienced by individual information seekers as *information*

horizons. Information horizons theory suggests a collaborative relationship between the information seeking behavior of an individual and their information resources, which are defined for each individual based on the particular context within which they find themselves. For physically connected groups, each individual's context is **unlikely** to be dramatically different than his or her fellows. In a completely online group, however, each individual's information context is *likely* to be substantially different. This contrast in the information horizons between completely online and physically situated groups suggests both challenges and opportunities for completely online group development.

The third significant distinction between completely online groups and physically situated groups is the differences in how feedback is made available on group performance online. In physically situated groups, awareness of progress exists in the natural form of co-presence which reminds people about deadlines, group accomplishments and the affective group belief regarding their effectiveness. Physically co-present groups benefit from feedback that is rich and visible across a myriad of communication channels in each group interaction. These factors permit physically co-present groups a fairly intuitive awareness of who is truly engaged, how the group is functioning and the numerous cues to ensure awareness of whether or not the group is progressing toward their goals. Awareness of group progress and assessment of group efficacy in completely online groups, unless there are special design features in the group tools and processes, is difficult because all feedback must be explicitly constructed and interpreted. Hardin, Fuller & Valacich (2006) have developed an instrument with high construct validity to measure virtual group efficacy. Group efficacy is a measure with promise for providing insight regarding how well feedback is flowing within groups, and

whether or not that feedback is leading to feelings of effectiveness within groups.

Groups who believe they are effective are likely to be on a trajectory of development that is, in most circumstances, desirable. Understanding the extent to which members of a group believe the group is effective will, in this way, contribute to our understanding of group development.

Small group development in completely online settings, while presently understood through the lens of physically situated group development and limited prior research on completely online groups, continues to be substantially a mystery. This study will contribute to our knowledge of completely online group development by leveraging the construct of social ability as an indicator of group member engagement in the online collaboration within and between small groups. Social ability measures will be enriched by an exploration of group member information horizons, both within the socio-technical system under study, and across the unique information horizons of each group member. Group outcomes will be measured using Hardin et al's (2006) construct of group efficacy, and by evaluation of group work products using a rubric. Knowledge of group efficacy will contribute to our understanding of group development by providing insight into the results delivered through group work, and providing an understanding of a salient series of progress points along the trajectory of group development.

Statement of Problem

Small groups working together to achieve a goal in a completely online setting are becoming more common in educational, work, professional and social settings. Despite this trend, little is known about the individual or socio-technical considerations which contribute to online group development or promote online group efficacy. Past research

has described online community engagement, presented social network analysis and measured the effects of specific tools, pedagogy, group structure or media on individual user experiences. Most research on groups has examined group development through a theoretical frame forged from observation and analysis of *actual people*, instead of the artifacts they leave behind in a technologically connected, interpersonally disconnected online world. The proposed study seeks to build new knowledge of *completely online group development* through examining established measures of individual social ability and group efficacy, socio-structural variables represented by participation in the group work, and qualitative descriptions of the experiences and artifacts of online group formation, development and effectiveness.

Purpose of Study

This mixed methods study will extend prior research on socio-technical systems, human information behavior, the nature of learning in groups and group development. A triangulation mixed methods design will be used, a type of design in which complementary data are collected on the same topic. In this study, a survey will be used to examine levels of social ability in an online learning environment, which predicts that participants who are more able to be social are more engaged and satisfied. A group efficacy survey will be used to assess member perceptions of how effective their teams are in this course, which predicts the likelihood their groups will be effective in completing their assigned tasks. Concurrent with these data, participant interviews, discussion board (content) analysis and social network analysis will explore the experience of groups and the information horizons of group members in distributed work teams. The reason for collecting both quantitative and qualitative data is to bring

together the strengths of both forms of research to develop and corroborate our understanding of *completely online group development*, and other contextual elements at both the individual and group level.

Statement of Research Questions

1. How do completely online groups develop?
 - a. In what ways (individual member knowledge contribution or group cognition?) and to what extent is knowledge developed within online groups?
 - b. What identities do group members develop, to what extent does group identity form, and how is identity shaped during the online group work?
 - c. What social network structures are formed **within** online small groups and **across** online small groups during group work?
 - d. To what extent do social network structures change over the course of group work?

2. What is the role of social ability in online group development?
 - a. How does the social ability of a member influence their participation in a group?
 - b. How does the social ability of all members influence group development?
 - c. How does group development influence the social ability of group members?

3. What is the role of the member's information horizon in online group development?
 - a. How does a group member's information horizon within the course management system context influence group development online?
 - b. How does a group member's global information horizon – the course management system and all other components identified – influence group development online?
 - c. How does group development influence the information horizons of group members?
4. What is the role of group efficacy in online group development?
 - a. In what ways and to what extent do group efficacy scores influence group development online?
 - b. How does the group efficacy of all members influence group development?
5. To what extent does social network structure, observed through online communication patterns, reflect the observed knowledge construction, identity formation and information horizons of group members?

To enhance understanding, the key constructs explored in the research questions, and their relationships to each other, are presented in figure 2.

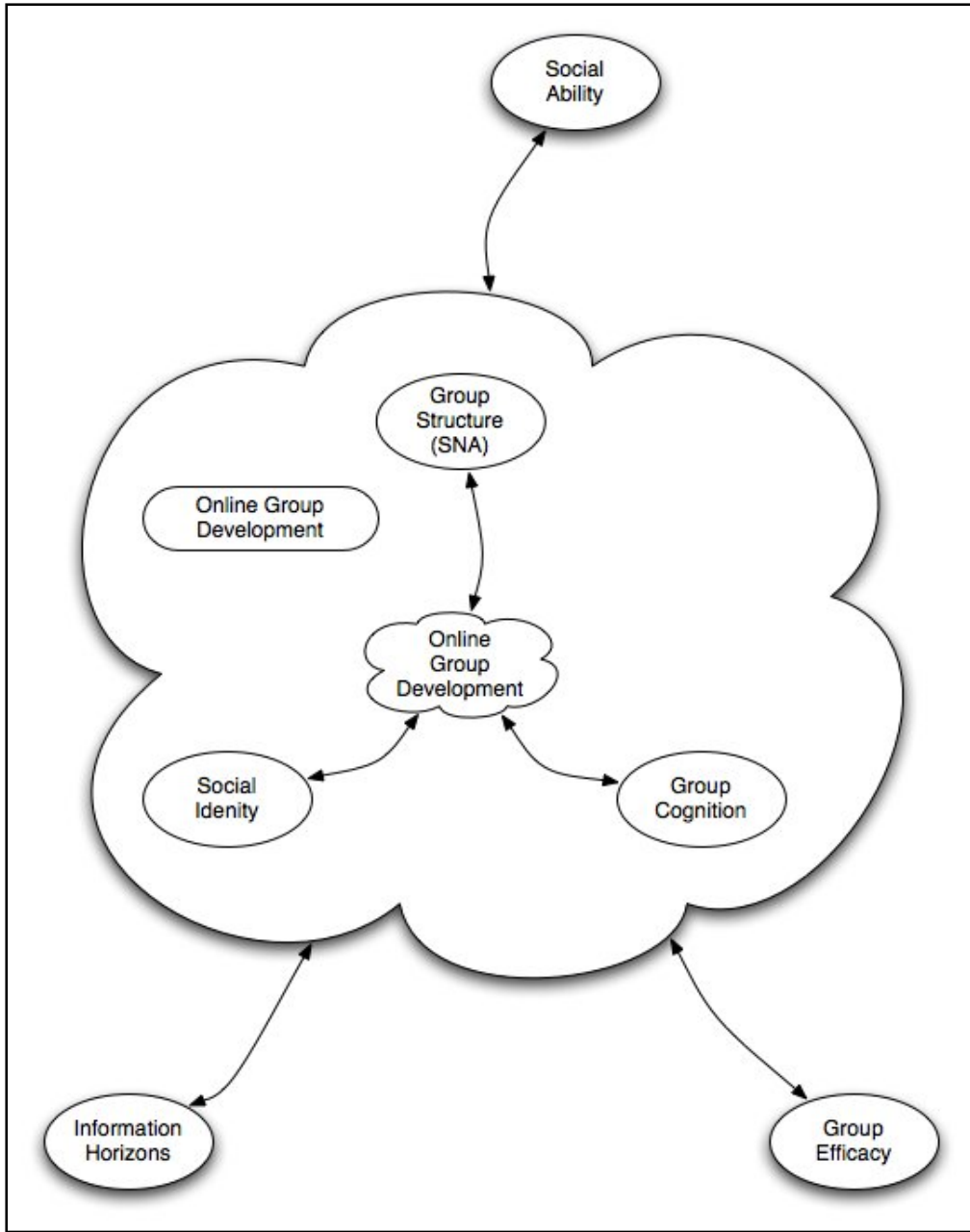


Figure 2 - Visual Representation of Key Constructs

Limitations

This study has two significant limitations. First, the groups to be studied are of a particular type and the observations and insights gained in this study may not apply to other forms of online groups. The groups are formed within the context of a higher

education course and are temporally limited (8 weeks) with little likelihood of future group work. The resulting rich description, basic statistical analysis and complex social network analysis will be the basis for further study across more diverse group types, but as comprehensive as the methods are, the contribution of this research will be most directly relevant to the class of groups Arrow et al (2000) refer to as *concocted groups*. Second, the sample size is small, and the t-tests to be performed on the two surveys before and after group work will have sufficient power to support a cronbach's alpha of .05, and no more.

Definition of Terms

Completely online groups – Groups which never expect to meet face to face, and perform all communication with each other using networked technology. In this era, skype and telephone are considered networked technology. If two people in a completely online group serendipitously meet, it's still a completely online group.

Contribution (online) – A post made in the online discussion board. Online participation is, in contrast, a read event in the online discussion board. Both are recorded by the CANS system.

Group Cognition – A social phenomenon where people working together perform a cognitive act, usually made visible through spoken or written language. Online, group cognition may be operationalized similarly to group knowledge development. It was explicated by Gerry Stahl in the 2006 book titled *Group Cognition*.

Group Development – A general term to describe the trajectory of a group of people. There are over 45 theories touching on group development. For the purpose of this study, it is operationalized as a superconstruct consisting of group knowledge construction

(including group cognition and individual knowledge contributions to a group), social identity and social network structure.

Group Efficacy – How effective a group believes it is, as a group. Hardin et al (2006) have developed a survey to operationalize this construct, which will be used in this study.

Information Horizons – Sonnenweld’s theory that within any context and situation, there is an information horizon within which individuals may act. These information horizons vary by individual, and may include personal relationships, networked information and mass media information.

Participation (online) – A read made in the online discussion board. Online contribution, in contrast, is a post event in the online discussion board. Both are recorded by the CANS system.

Small Groups – Groups of 3 to 5 people collaborating.

Social Ability – Social ability is an online group member’s capacity to associate with other group members and to use the members, resources and tools of the social context to achieve something of value.

Social Identity – A construct developed by Henri Tajfel and John Turner to understand the social psychological dimensions of intergroup relations. An individual’s social identity is constructed of group affiliations (in-groups) and non-affiliations (out-groups).

Socio-Technical System – A socio-technical system is a software system which people utilize for collaboration, cooperation and coordination with others. The complete system consists of both technology and interpersonal (social) interactions. For the purpose of this study, the socio-technical system will be Sakai/CANS with an online course in CSCL.

CHAPTER II

Chapter Two – Literature Review

Group Development

Definitions of Group Development

Group development has been defined in many different ways by researchers over the past 100 years. Schiller and Mandviwalla (2007) identified 45 theories utilized in virtual team research, only a few of which address online group development as we do – at the small group unit of analysis. The wide diversity of theory is a consequence of the wide range of inquiry into and definitions of “online/virtual/distributed groups”, but it also suggests that online group research is at an early stage in its history. Supporting this claim, a May, 2008 scholar.google.com search returned 17,300 hits for “group development”, 33 for “online group development” and 9 for “virtual group development”. Given the low maturity of online group development research, theory on small group development in general was examined. Poole & Hollingshead (2005) identified 9 different categories of small group development theory, including: Psychodynamic, symbolic-interpretive, functional, social identity, conflict, feminism, temporal, evolutionary and socio-structural (network). Online group development, and small group development in general, are studied under a myriad of theories or, in over 40% of publications on virtual groups, without any theory at all (Schiller & Mandviwalla, 2007).

Group development has been explored to different extents in the traditions of small group development research, Computer Support for Collaborative Learning

(CSCL) and Computer Support for Cooperative Work (CSCW). Our theoretical frame is an integration of these perspectives. Group development research has explicated group development as stages of storming, forming, norming and performing (Knowles & Knowles), as punctuated equilibrium (Gersick, 1988), as the evolution of a complex system (Arrow, McGrath & Berdahl, 2000), and from the perspective of social networks (Katz, Lazer, Arrow & Contractor, 2005; Katz, Lazer, Arrow & Contractor, 2004). CSCL is still developing a theoretical framework for how being in a group impacts learning, though Stahl (2006) advocates for a design based research agenda to build a theory of small group development. CSCW theory is similarly emergent, with many researchers referencing social psychology and community development literature to explicate group work.

Next we will review salient theories for framing group development. Then, we will describe our framework for understanding group development, which is an integration of social identity, knowledge development and group structure. Finally, we will explain each of the key constructs with which we will be studying online group development: Social ability, information horizons and group efficacy.

A socially grounded theory of group behavior is posited by Wenger (1999), who observed that practice is the construction of meaning in everyday life, and that our understanding of that meaning construction in any context – online or in person – must reconcile the duality of established protocols with the participation of actors who apply and transform those protocols in the context of community. These systems involve the construction of meaning, and the negotiation of individual and group identity.

Shared meaning, in the context of a specific set of tasks, is conceptually consistent with what other researchers have identified as knowledge construction (Gunawardena, et al, 1997; Stahl, 2006). It is the appropriation of available information and history, combined with the application of what Wenger would call reified practices to develop knowledge about a particular case.

Wenger also describes the effect of communities of practice on individual identity. There are powerful interactions between individuals who belong to communities, their participation (or “non-participation”) in those communities, the negotiation of a social identity within each community and the integration of multiple community memberships into an individual’s identity. Participation in a community and contribution to the reification of community practices affect individual identity, and vice versa. Online group development, then, may be viewed as a negotiation within and between online participants, which occurs through a process of building understanding, negotiating practices and mutually influencing identity.

Capacity to negotiate meaning and identity is highly dependent on the types of tools available for interaction. In a shared physical setting, this includes the ability to work through many different problems at once, taking advantage of the richness of verbal and non-verbal communication that takes place when people are seated around the same table. The tools available in an online setting constrain communication and negotiation, making the construction of shared meaning (knowledge) more difficult.

Completely online groups are further constrained by their relative invisibility compared with physically situated groups. When a group of people is together in a room, or even a campus, they have an intuitive and shared sense of who the members are, what

they know and what they are doing. This leads to opportunities for negotiation of shared knowledge and identity with at least an elementary understanding of what the group's structure and processes look like. Online, membership and engagement are difficult to discern.

Our view of completely online groups is that, like other groups, they actively negotiate the construction of knowledge and the various aspects of identity, but they do so in ways that reflect the constraints of having all communication and affect mediated by online tools. In addition, we recognize that groups in an online setting have limited visibility to their structure. In an online group you can't look around the room and see who is attending to their blackberry or surfing the Internet for poultry prices. Completely online group development, as we have just framed it, is the examination of how online groups build knowledge, identity and structure and how the members understand those processes.

Group Development as Knowledge Development

Group cognition is a particularly potent means for operationalizing online group development, as it has emerged directly from the CSCL literature (Stahl, 2006). Stahl (2006) describes the evolution of a methodology for studying small groups who interact through socio-technical systems by presenting a series of case studies he conducted with various research teams over a decade. In one study of online groups, an existing CSCW tool called *BCSCW* was used to design a collaborative learning space called *Synergeia*. The tool was designed to stress the construction of knowledge in an online environment, with threaded discussion boards intended to support thoughtful, deep knowledge building. The study found that knowledge negotiation in a learning environment includes

expectations of small group artifact refinement prior to presenting artifacts to a larger, class group. The technology assisted, partially online learning groups were instructed to reach agreement prior to posting artifacts, leading to substantial evidence of negotiation around both the discrete work products and the portfolio of group work products.

Having various levels of artifacts to negotiate around seemed to support the collaboration, which the researchers argue has critical design implications for CSCW systems, particularly in the area of fine grained security role definition. For example, defining which small groups are able to modify artifacts, and the capability to lock completed work products is important in many work settings.

In another case study, Stahl (2006) applied lessons learned from the prior study in *BSCW* to the design of a new system called *BCSCL*. The *BSCL* study expanded on the frame of group negotiation in general and identified three core concepts of *knowledge for negotiation* in *CSCL*: Negotiation as voting, negotiation as discourse and negotiation as knowledge building. The results characterize voting as an inadequate method for negotiation, as it represents a pooling of individual views instead of an agreed upon compromise. Discourse is also inadequate, as it takes on a tone of bargaining over positions, showing little advancement from voting in the construction of knowledge. Viewing acts of knowledge building as knowledge negotiation turned out to be an insightful frame for identifying productive group work. Stahl observed that when new knowledge is co-constructed in an online environment, it is observable both through discourse, and the establishing of common ground around which future discussions on more detailed aspects of the same work may be based. Knowledge construction in online collaboration interacts with group formation in this way.

One core claim of Stahl's (2006) work is that group cognition is a construct that emerges from the observable interactions of group members. Through various analytical strategies, ideas that cannot be solely attributed to a single individual or artifact become visible. Content analysis is particularly effective for making group cognition visible in the analysis of online discussion boards.

Gunawardena, Lowe & Anderson (1997) used content analysis to examine the construction of knowledge in an online debate. First, they examined existing techniques for identifying the negotiation of meaning and co-construction of knowledge in online learning environments. Their study determined that existing models were inadequate for understanding knowledge construction in computer mediated communication, but through their analysis, they developed a new model for examining online interactions for the co-construction of knowledge. Their approach is based on a constructivist theory of learning, which emphasizes that knowledge construction is evidenced by the introduction of new ideas, not the regurgitation of existing knowledge. Their model includes five progressive phases: Sharing/comparing, discovery & exploration, negotiation of meaning/co-construction of knowledge, testing and modification of proposed synthesis and agreement on constructed meaning. Marra, Moore & Klimczak (2004) compared Gunawardena et al's model for analyzing content with a model established by Newman, Web & Cochran (1996), determining that the Gunawardena et al (1997) model provides a more holistic view of discussion board flow & knowledge construction, although it requires the researcher to prepare a coding guide and procedures focused on a specific operationalization of knowledge construction in advance, as they did.

The importance of structuring negotiation for knowledge creation among groups is also identified in the CSCW literature. Barthelmeß & Anderson (2002) articulate the differences between coordination, cooperation and co-construction among groups, noting that co-construction of knowledge is consistent with notions of negotiated practice. More significantly, a number of studies have examined the question of knowledge development among work groups.

Cohen, Cash & Muller (2000) conducted an ethnographic study of adversarial collaboration between law firms using a tool called PeopleFlow, which included features for selective sharing of documents between adversaries, and the management of availability information in an electronic workspace. They demonstrated that the co-construction of solutions in adversarial situations included an integration of availability management, document control and the strategic granting of access to ideas developed for reaching a solution by one party or another. The co-construction of knowledge occurred between adversarial groups in much the same way as Stahl's learning groups' regulated access to shared files until they felt they were ready for the whole class to see.

Halverson, Ellis, Danis & Kellogg (2006) studied the management of change requests in a software development environment. They observed that change tracking is useful for coordination work, but also that the whole change tracking system (people, process & technology) acted as an object around which new understanding of the software systems under development was negotiated between team members. In some cases, new knowledge of complex interactions between system components was developed solely as the result of tracking a change or defect in existing code.

Group knowledge construction also involves an understanding of how group knowledge and group development is influenced by the contributions that individual members make to the group. Contributions of knowledge from group members to a group have been characterized as a means for members to satisfy personal goals either directly or indirectly through such contributions (Napier & Gershenfeld, 1989; Poole & Hollingshead, 2005), as cooperative acts of positive interdependence or personal responsibility (Johnson & Johnson, 1994) and as a means for simply demonstrating presence through participation (Picciano, 2002).

Star & Griesemer's (1989) notion of boundary objects is of particular salience when examining individual contributions of knowledge to the group. Wenger observed that boundaries between individuals and groups are negotiated in many cases around particular objects, and that the negotiation of meaning is likely to perturb practice as a result. Lee (2007) did an ethnographic study to understand how a team of museum exhibit designers used physical artifacts and social practices to collaborate, explicating intermediate work products as *boundary artifacts*, which she suggests may precede the development of boundary objects during co-construction involving multiple communities of practice. The results of her study specified five key types of boundary artifacts used to facilitate the exchange of information and the development of shared understanding between members in these communities of practice: Self-explanation artifacts, inclusion artifacts, compilation artifacts, structuring artifacts and borrowed artifacts. Compilation artifacts represent joint synthesis of knowledge in collaboration. Boundary artifacts in general represent the negotiation of knowledge within a group, originating from the perspective of an individual making a contribution to the group.

How groups build knowledge together, and what individuals contribute to group *knowledge* development provides a powerful window for viewing completely online *group* development. This is because the construction of that knowledge is uniquely *visible* online. Artifacts built by groups, and discussions recorded within groups provide a record of how and when knowledge is contributed by individuals, and when it emerges from the group itself as new, co-constructed knowledge (group cognition). Group artifacts are not only evidence of group cognition, but they are a common ground around which group members frame their discussion, and build up the common language and understanding that is necessary for group development to occur. Knowledge emerges from these practices, and is embedded in the artifacts of these practices simultaneously. In many cases, the artifacts become protected evidence of the group's accomplishments, remaining unreleased to non-members until there is consensus regarding their acceptability among all members. In all cases, completely online group development and knowledge construction are visible in the discourse the groups engage in – through artifacts, discussion boards, chats or wiki's.

Group Development as Social Identity

Social identity is another theoretical frame through which the construct of *group* is understood. Michinov et al (2004) and Michinov et al (2007) operationalized social identity explicitly, through the assignment of members to groups and the subsequent measurement of motivation related to group membership, and implicitly, by qualitatively assessing social identity in online group evolution. Michinov et al (2004) was an experiment with 72 subjects ages 10 – 11 in French elementary schools, which demonstrated that mere assignment into a group influences group identification, task

orientation and morale among subjects. Michinov et al (2007) observed an online group activity for a 15 member group, administered an attitude questionnaire and interviewed subjects in a case study that demonstrated how challenges to the social identity of group members occurred at the midpoint of collaboration, and were subsequently met, in part, through the introduction of additional socio-emotional supportive conversation. The precise way that social identity influences completely online group development is still not thoroughly researched or understood, and our investigation of this construct is substantially based on the theoretical work of Tajfel (1978, 1979 & 1982) and Turner (1979, 1982).

Tajfel (1978, 1979) conducted a series of social-psychological experiments on hundreds of subjects in the 1970's, and along with Turner is generally credited with establishing the foundation of our knowledge on intergroup and intragroup relations through these experiments (Hogg, 2006). The significant, generalized result of their studies is an understanding of the process of social identity formation and the structure of individual social identity. The process of social identity formation includes an interactive relationship between how people self identify into groups that match their view of themselves (in-groups) and also reinforce their identities and sense of belonging through the exclusion of themselves from groups they have no affinity for (out-groups). The cycle is self-perpetuating between individuals and these groups. The process of identifying with some groups, and not with others reinforces the roles of the groups, and the identity of the individuals within those groups (Tajfel, 1974). In a recent extension of Tajfel & Turner's work from the 1970's, Jackson (1999) performed three experiments to explore the role of social identity in group development, with 221 subjects in experiment

one, 290 subjects in experiment two and 271 subjects in experiment three. Study one made negative allocation of resources based on group membership, study two made positive allocation of resources based on group membership and study three integrated both positive and negative allocations based on group membership. Across all treatment conditions social identity was highly correlated with in-group membership. This demonstrates empirically the central position of group membership as a component of social identity, which is, in turn, a component of individual identity (Hogg, 2006).

How people refer to themselves, and to others – as individuals or as group members especially – is a telling indication of identity. Postmes, Spears and Lee (2000) studied 140 participants in an online, non-graded voluntary course. Students participated at their own pace and without deadlines. The researchers performed content analysis on the messages sent between students in a person-to-person messaging system, identifying clusters of students in communication with each other. Their results included the conclusion that cohesiveness in online groups emerges in the form of a shared meaning structure, and that consistencies in these interactions in computer-mediated communication (CMC) may be sufficient to infer emergence of identity. They further note that CMC groups are discernable through patterns of communication, and that prototypical characteristics of emergent groups tend to be accented over time.

Prentice, Miller & Lightdale (1994) conducted two studies to understand the distinctions between common bond groups, held together by relationships between members, and common identity groups, held together through member identification with the group. The first study was of members at selective and non-selective university eating clubs and the second study involved subjects from a wide array of university

organizations. Participants were asked to fill out a group attachment scale, developed as part of the study. The results indicated that individuals in common identity groups were more attached to their group itself than to the individual members of their group, while individuals in common bond groups were as attached to the individual members of their group as to the group itself (or more so).

Ren, Kraut and Kiesler (2007) explore this distinction between online groups held together by common group identity and those held together by common individual bonds through a detailed examination of existing literature, and subsequent discussion of implications for the design of group support systems. How online tools support each type of attachment has implications for group development and group member characteristics. For example, core members in identity based online communities tend to be identified via their expertise, while core members in bond oriented communities are identified by their relationships to other group members. They conclude that current research suggests that online group bonds do not take one form or another, but evolve over time.

Brown & Duguid (2000) emphasize that the constitution of the group is often overemphasized, to the detriment of understanding the importance of practices in the evolution of ideas, and the evolution of group and individual identity. What people do as members of a group is more important than the simple fact of membership.

Our view of online group development and social identity integrates these ideas. We view online group identity as a special case of social identity, made visible through the communication interactions in an online setting. The spectrum between individual and social identity is negotiated online through mostly written communication. Groups develop as relations between individuals, as well as relations between people who

identify as members of a group. The ways that individuals refer to each other, to the group and to themselves in communication is a window into their individual identity, as well as the identity of the group. When people refer to each other in communication, the identity relation is between two individuals, or what Tajfel (1979) refers to as inter-individual communication. Inter-individual communication may precede communication where group identity is forming. For example, references to group work products using the “our work” phrase represents an important shift toward the development of group identity. Communication reflecting individual identity transitions is discovered in the use of phrases like “we” – when members of a group start communicating about the group, instead of as individuals engaged in communication, then *group* has formed not just in the structurally observable sense, but in the sense that individual identity has been influenced by group membership. Identity is also influenced in the other direction, as when groups are assigned a priori. In these cases, there is presumptive group membership that often leads to “instant shared repertoire” (Goggins et al, 2007). Group identity and individual identity influence each other, and the interplay between them is an important indicator of group development, available for analysis through examination of group member communications.

Group Development as Network Structure

Network theory provides a particularly helpful frame for understanding the relationships between individuals and groups as they develop. This type of analysis holds great potential for the study of completely online groups, particularly where online activity logs are available. Unlike network analysis of physically situated groups, which has been criticized for relying on data with low reliability, online groups for whom use

logs are kept may be analyzed using a computer record of their activities which can be reliably recorded and holds specific meanings. Network theory rests on five core positions (Katz, et al, 2004):

1. Behavior is best predicted by examining the relations people find themselves embedded in,
2. The focus of analysis should be the relationships between units in a group
3. Analytical methods must assume that there is interdependence among individuals in a network, so normal assumptions of independence are not valid
4. Understanding a social system requires analysis of the structure of an entire network, not simply the ties between two members (dyadic ties)
5. Group relations are fuzzy, which means that where a specific group's boundaries are, and whether a particular individual is a member of a particular group isn't clear-cut. Group assignment requires some judgment on the part of the researcher. Fortunately, there is ample prior work to use as a guide for such judgments.

SNA has numerous specific forms, each informed to different degrees by graph theory, probability theory and algebraic modeling. The essential concepts represented by SNA are the actor – who can be an individual, group or event, the relational tie (between actors), dyads (two people), triads (three people), groups, subgroups and networks.

Next, we will briefly review the core concepts used in SNA, describe the small number of studies which have used SNA to describe online group development and

review more computationally focused work that addresses the analysis of communication patterns and social networks from a myriad of online network data types.

Socio-Centric density in a valued network describes the total of all *actual connections* divided by the number of possible ties, resulting in an average value. If values (number of connections between nodes) are dichotomized, important data is removed (connection strength between nodes), but the resulting 0-1 numbers provide a measure of network completeness that is easier to compare with other networks.

Network centralization measures indicate how tightly the graph (social network) is organized around its most central point. High in degree centralization indicates that the group is focused inward on a few core members. High out degree centralization means that a few core members are producing most of the connections to others.

Betweenness is a measure of the importance of a node to making connections between other nodes. For example, if there are two clusters of individuals in a social setting, a person with high betweenness would be a member of both clusters. This would indicate that they are a “connection point” for ideas between two clusters within the larger group.

Core-periphery analysis extends the established centrality SNA measures of degree, closeness, betweenness and eigenvector-based measures by leveraging the concepts of group centrality and two-mode centrality (Wasserman & Faust, 1994). Core/periphery measures posit that there is some group in the core, and some other group in the periphery of a network with one center. Core nodes are distinguished by creating a complete graph with each other.

DeLaat, Lally, Lipponen & Simons (2007) experimented with social network analysis methods in an online learning environment using traditional notions of density derived from coarse grained usage logs generated by WEBCT to imply relations between individuals. Their study examined the relative network position of individuals in a 9 node online social network, with density and position used to describe how people are connected. Their results suggest that SNA does provide helpful information regarding the structure of whole classes in an online environment, though they did not explore the emergence of cliques or other groupings within the larger structure. The study was primarily a methodological proof of concept. Hossain, Wu & Chung (2006) explored actor centrality with participation in online groups by performing text mining of a corpus of email communication from ENRON. They analyzed 252,759 messages from 17,568 users, cataloged individual message types for strength of coordination (with messages managing shared resources being scored highest) around the Dabhol Power Corporation pipeline project, and explored the link between actor centrality and coordination score. The groups that emerged from this corpus were analyzed as though they were naturally forming, though the authors did not explore the organizational structure within which the participants acted. In this case, that is reasonable, since ENRON no longer exists, and records of prior organizational structure are not readily available. They counted coordinating phrases as an indication of centrality, and established that actors with a high degree of centrality based on these measures were also critical project coordination points.

Relations among actors in a network can be fed back to members by capturing, analyzing and visualizing information that is known about those relations. Both formal

and informal online networks and communities (Ahmad & Teredesai, 2006; Aviv et al, 2003; Bakstrom, Falkowski, Bartelheimer & Spiliopoulou, 2006; Hildrum & Yu, 2005; Hossain et al, 2006; Yuan, Gay & Hembrooke, 2006; Yuan & Gay, 2006), can be made visible to participants (leading to increased activity awareness) and researchers (leading to improved designs) in a wide range of presentations, using an emerging set of social networking oriented data mining techniques.

Prior research has applied data mining algorithms to large, publicly available datasets. Backstrom et. al (2006) used DBLP, a research citations service, and LiveJournal, a social network site, to develop social networking data mining algorithms focused on membership, growth and evolution in large social networks. Membership in these networks was broad, and included participation among a diverse set of individuals. In the case of DBLP, Backstrom looked at triples of time (year), venue (conference) and author (who had not published at the conference) to predict the probability that an author would publish at the next year's conference. They applied simple decision trees based on distance measures to execute this prediction. Their work also assessed indicators of which conference papers would most likely lead to bursts of activity from one research community to another. They found that a high percentage of 'hot terms' is a useful predictor of topic migration between communities.

Hossain et. al (2006) used a less structured data set from a closed community to extrapolate the role of actor centrality in project coordination. Using the ENRON email corpus, they determined that actor centrality is a significant indicator of coordination efficacy. They used the centrality measure of betweenness (extent to which each node lies on the shortest path between nodes) to imply control, degree (number of connections

going in and out of a node) to implicate activity and closeness (reciprocal geodesic distance based only on the directed links) to measure independence. Defining these types of relations from an email corpus required analysis of the content of each email, and the extrapolation of frequencies for phrases considered to be ‘coordinating phrases’.

Tantipathananandh, Berger-Wolf and Kempe (2007) took a simple corpus of unstructured, online discussion boards from a university and identified evolving social networks, using the statistical identification of subgroups and changes in subgroups over time. Methods for identification of persistent structures and interloping members are specifically noted in their analysis. Membership stability is assessed absolutely, by comparing original member participation with specific windows of time beyond zero, and periodically, analyzing gross changes in membership from time t_n to time t_{n+1} . Density was used to indicate cohesiveness within the group, and cohesion was used to indicate connectivity of group members with other groups. The structural equivalence of two subgroups is measured as the Euclidian distance between their vector representations. This study is of interest because it looks at subgroup membership evolution in a closed community over time. The closed nature of this community provided an opportunity to experiment and see results with fewer variables than other studies of more open communication records like email corpus’s and discussion boards.

Falkowski, Bartelheimer and Spiliopoulou (2006) defined the identification of communities in dynamic networks as an NP-hard problem, meaning that an optimal solution can only be discovered using small data sets. They developed a set of data mining algorithms, which proved effective on two well-known small data sets of evolving social networks. To perform comparisons over time, group similarity is

compared at various time intervals using Jaccard algorithms and similar derivatives. What is notable about this choice is the comparison of group composition similarity over time in a dynamic network. Their work also assumes that an individual may only participate in one network at a given point in time. In other words, this work applies the simplest, least complex measure available (distance and membership change) to compare groups.

While Falkowski et al relied on Jaccard algorithms to identify networks, Liben-Nowell & Kleinberg (2003) applied Jaccard similarity measures to web content to attempt to predict future links between web pages in an evolving social network of physicists. Link prediction in a social network seeks to predict the edges that will be added to a social network at some future time. This study found that current network topology is an effective predictor of future network state. Like Tantipathananandh et al, Falkowski et al and Liben-Nowell & Kleinberg relied on small, closed groups for the development of their social network analysis.

Using data mining algorithms and techniques to understand online social networks has emerged and been substantially refined in recent years. Hossain, Wu and Chung (2006) showed that actor centrality in an online setting, as in physically co-located settings, is highly correlated with the ability of a person to coordinate the actions of other team members. Understanding the movement of people from the fringes of an online network into a particular social community (Backstrom et al, 2006), understanding the spread of ideas (Ahmad et al, 2006), the evolution of subgroups within larger groups (Falkowski et al, 2006), the discovery of process related information useful for understanding group activities (van der Aalst, 2005), and the development of social

capital in a number of online network types (Hildrum et al, 2005; Lin & Laffey, 2004; McCrickard, Chewar, Somervell & Ndiwalana, 2003; Staab, Domingos, Goldbeck, Li, Finin & Yoshi, 2005; Yuan et al, 2006) have all been the subjects of previous work that applies data mining to the challenge of understanding and visualizing online social relations.

Several gaps in the research on social network analysis techniques applied to understand online group development remain, however. With the exception of the author's prior study, upon which the use of SNA in this proposal is based, there are no examples in the literature of a rich array of social network analysis techniques being combined with more descriptive methods to build an *understanding* of online groups. A few studies, noted earlier, observe simple measures of network structure. Other studies examine large networks in different ways in order to find clusters of people, without really delving into what the identification of those clusters *means* for group or community development. In some senses, basic measures of distance, density and centrality in an online setting are *assumed* by these prior works to directly imply personal relationships in the same way they might in the physical world. Also striking is the diversity of sources of network data used in prior studies. Though the SNA measures discussed are sometimes similar, the origins of the data are substantially different from study to study. What is needed is an analysis of network structure with deeper context of what it means for group development, and broader understanding of the critical factors that influence that group development.

Group Development as Network Structure – Capturing Network Data

To support the kinds of social network analysis we propose, we first must describe the source of our network data, which has been developed over the past four years at the University of Missouri. The Context Aware Notification System (CANS) is a notification system for collaborative work and learning systems that is designed around the importance of awareness of user activity, a user's social context, and personal notification preferences. CANS (Laffey, Amelung & Goggins, 2008) was built to provide information to users about who is doing what, and when they are doing it, in an online environment. As a side effect of this goal, CANS also captures a good deal of information about who interacts with whom during specific timeframes, and specific projects in an online course. The detail of this network data is greater than the detail available to researchers in prior studies.

Over the past year and one-half CANS has been deployed in a distance education setting in online university courses offered via Sakai (<http://sakaiproject.org>). Sakai is a community source software development effort used as a course management system (CMS) (analogous to Blackboard or WebCT) for the online courses. These environments include discussion boards noted in previous research, but in this case the discussion is more keenly focused on the activities and software constructs required for teaching a particular online course.

With this understanding of what we mean by group development in clear view, we will now describe the constructs to be studied in relation to completely online group development. Those constructs are: Social ability, information horizons and group efficacy.

Social Ability

Blanchard and Markus (2002) studied community formation and practice in a virtual community, finding that, as with physically connected communities, virtual sense of community is enhanced by mutual recognition among members, informational and socio-emotional support and identification with the community. In virtual communities, however, their research suggests that identification and recognition of individual group members is more important to sustaining the community than the items related to member reported sense of community.

Sense of community is one of several factors, which also include social presence, social navigation and connectedness that influence social interactions in completely online groups, and may have a corresponding impact on group development. Laffey, Lin & Lin (2006), conducted a study of 107 students in online courses, ultimately explicating the construct of “social ability” in an online setting as the relationship between tasks, tools and individuals. Their results showed that students who participated in learning situations with higher degrees of collaboration also scored higher on the scale of social ability. Laffey et al (2006) show that social ability is a construct that parsimoniously represents the contributions of social presence, social navigation and connectedness to explain the ways individuals participate socially in online groups, given a particular set of tasks and a particular technology for interaction.

Laffey et al’s (2006) notion of social ability quantifies the social nature of an online course, but may be applied to a wider view of online collaboration. Social ability is highly correlated with learning satisfaction and behavior intention within several courses structures, such as courses that emphasize teacher-student dyads and courses that

emphasize collaborative work among students. Social ability is also highly correlated with behavioral intentions to use technology for interaction in courses.

Having a measure of the social nature of the socio-technical environment within which groups exist is critical for the study of completely online group development, since one of the significant differences between completely online collaboration and face to face collaboration is the muted capacity of online environments to communicate social information. Social ability is an individual's perception of the social nature of the group experience and provides a measure of the relative extent to which social interactions take place among individuals and within small groups in the course context. As a result, social ability is a construct that captures the social and collaborative nature of the online environment, so that measuring social ability at different times during collaboration will provide insight into the relative levels of social engagement experienced by different members, or within different small groups.

Information Horizons

Information horizons theory (Sonneweld, 2001) builds on the concepts of context, situations and social networks to explore human information behavior. Sonneweld's information horizons theory describes 5 propositions related to human information behavior (Sonnenwald, 2001; 2003).

1. Human information behavior is shaped by and shapes individuals, social networks and situations and contexts.
2. Individuals or systems within a particular situation and context may perceive, reflect and/or evaluate change in others, self and/or their environment.

Information behavior is constructed amidst the flow of such reflections

3. Within a context or situation is an "information horizon", within which we can act. When an individual decides to seek information, there is an information horizon in which they may seek information. Information horizons, and subsequently information resources, are determined socially and individually and may be different for different contexts, even for the same individual.
4. Human information seeking behavior may be viewed as collaboration between an individual and their information resources. Some resources lead to others.
5. Information horizons consist of a variety of information resources, many of which have knowledge of each other. They may be conceptualized as densely populated spaces. In a densely populated solution space, many solutions are assumed and the information retrieval problem expands.

For groups collaborating in an online course, the role of information horizons is different than it is for physically situated groups because in the online case, each member is likely to have a substantially different information horizon than the others. In a physically situated group, the most central and influential information horizon for group members is the location and organizational context for the collaboration. In an online group, each participant is likely to have a distinct context, a distinct personal situation and distinct social networks. The online tool where the group meets represents one of many contexts, readily available to members, which will influence the contributions of those members to group work.

Extending Sonneneweld's work, Savolainen & Kari (2004) developed a taxonomy of information horizon zones in their analysis of the information seeking behavior of 18 Internet users. Zones represent relative importance of information sources, with zone 1

indicating the most significant sources, zone 2 representing intermediate sources and zone 3 representing peripheral sources. They then placed 21 specific information source types into 5 defined categories and 1 miscellaneous category. Their study concluded that human sources of information remain most significant among their informants, followed by print media and the internet. The primacy of interpersonal relations for information implies that the social connections people have still play a significant role in scoping the information available to them in day-to-day life. The diversity of social network connections in a completely online collaboration suggests that completely online groups will likely have information horizons that are distinct from groups formed in the same locale or from within the same organizational context.

Group Efficacy

Studies attempting to influence the quality and quantity of collaboration among physically distant online learners have approached the problem in three main ways – Increasing social presence through the design of collaborative learning contexts (tools) with more social affordances (Kreijns, et al 2002, 2004, 2007; Rohde, 2003; Martinez, et al, 2006; Soller, 2001), adaptations of pedagogy to support online collaborative learning (Strijbos, Martens & Jochems, 2006; Dillenbourg, Baker, Blaye & O’Malley, 1996; Stahl, 2006; Dillenbourg et al, 2008) and increasing social awareness through **special tools** introduced alongside the primary learning context (Carroll et al, 2003; Carroll et al, 2006; Amelung, 2005; Ferscha, Holzmann & Oppi, 2004).

Though these and other studies had a positive influence on the tools available to support online collaboration, few studies (Michinov, Michinov & Toczec-Capelle, 2004; Meier, Spada & Rummel, 2007) have attempted to address the effect of collaboration on

group efficacy. Numerous studies have evaluated the collaborative processes used by online groups, demonstrating that effective processes lead to improved collaboration or increased satisfaction (Meier et al, 2007; Kreijns, et al 2004, 2007; Richardson, 2003; Swan et al, 2006; Baskin, Barker & Woods, 2005; Carrol et al, 2006; Chewar et al, 2005). Whether these improved processes or increased levels of satisfaction have a positive effect on the work produced by collaborative groups remains an open question.

The dearth of information explicating the relationship between system innovations supporting social interaction, collaboration or social presence and subsequent group efficacy is a gaping hole in CSCL, CSCW & Small Group research. Much CSCL research today is moving forward with at least a tacit assumption that providing better tools for online collaboration will lead to better results for the groups who collaborate using those tools. Though closing this hole in the research is not the central purpose of this study, our examination of group efficacy is expected to contribute to the community's understanding, which can be applied to future research.

Carrol, Rosson & Zhou (2005) suggested a measure of collective efficacy, which applied Bandura's concept of self-efficacy to a community in Virginia. They conducted a two wave survey of a stratified sample of 870 households in the Blackburg, VA region, monitored household email and web activity and carried out participant interviews. The surveys consisted of 13 items in a Community Collective Efficacy Scale (CCE), which defined collective efficacy as people's belief in how well their community can succeed in joint endeavors. Using principle components analysis, they identified 4 factors that indicate the extent to which a community feels efficacy: Managing conflict, Development, United action & Social services. The CCE was shown to have external

validity, with individuals who report higher levels of CCE being more convinced that their community can accomplish things and more involved in their community. Further, they built a series of path models indicating the interactions between constructs measuring involvement (activism, informedness, belonging, association) and collective efficacy. The four path models indicate that the CCE has both direct and indirect relations with the constructs measuring community involvement.

Gibson, Randel & Early (2000) conducted a study of 166 executive MBA students in groups of 5 to 6 assigned to complete a multi-party role playing game known as the “Porsche Exercise”. The goal of the experiment was to determine which method of assessing group efficacy was most potent: Aggregating individual assessments, or assessing group efficacy through discussion. Groups in this study had a history with each other, and were expected to continue to work together with each other in the future. The exercise and the program were conducted in a face-to-face setting. The study consisted of a 2x3x2 design, with 2 methods of assessing group efficacy (aggregate or group discussion), three types of group efficacy (time, agreement among members and effectiveness of solution) and 2 measurement times (beginning of the activity and the middle of the activity). The results of their study indicated that group efficacy measures that rely on group discussion are more robust.

In contrast, Whiteoak, Chalip & Hort (2004) conducted a laboratory study with 282 undergraduate students in 94 groups to compare 3 methods of assessment for group efficacy in a physically situated collaboration: Aggregation of individual scores of self-efficacy, aggregation of individual perception of group efficacy, and a group discussion method. Their study was a 3x2x2 design, with three group efficacy measurement

methods, two levels of task difficulty and two stages of measurement. The group performance was on a computer based organizational simulation, and each group got 4 attempts. Participants received performance feedback after each attempt, and were able to alter their configuration as a result. Group efficacy was measured on a multi-item group efficacy scale that described nine possible levels of performance attainment. Analysis of variance showed statistical significance at $p < .01$ for all within and between measures contrasts. Their conclusion was that there is not a statistically significant difference in the 3 different types of efficacy measures studied.

Hardin, Fuller & Valacich (2006) developed a four item online group efficacy survey based on the prior work of Whiteoak et al (2006) and Gibson et al (2000). They surveyed 53 people in 17 teams in a senior level management information systems course. The teams were randomly assigned. They conducted their survey 3 times during the course of the group collaboration. The first survey was taken of individuals, the second survey required the group to reach consensus on their group's efficacy, and the third survey was related to individual performance, with group efficacy derived, as in Whiteoak et al (2004), from aggregation of these individual scores. For outcomes, they assessed group work products. The results of their study included the determination that, in virtual settings, group efficacy is more strongly related to group performance when measured by aggregation of individual group scores than when obtained by consensus among members.

Understanding group efficacy within a group is the conceptually simple exercise of figuring out whether or not a particular group believes they'll be successful in a context. Since there are so many intervening factors in that assessment, prior research

has attempted, mostly, to get at a group's efficacy indirectly. In an online setting, the diverse methods used in physically situated groups don't apply. With small groups of size 3 inside a total group between 20 and 25 people, complex path models and factor analysis are simply impractical. Hardin et al's (2006) survey of group efficacy in an online course, which is based on research constructed in physically situated groups, will provide insight as a measure of the internal sense of the group's effectiveness at two points along the trajectory of completely online group development.

Research Challenges

The review of literature in chapter 2 highlights several research problems and challenges for understanding completely online group development through group knowledge construction, social identity and group structure. First of all, completely online group development, while salient for an increasingly virtual world of collaboration, has been investigated by only a small group of researchers, including the authors of this proposal, and in a more tangential way by Michinov & Michinov. Those researchers who have addressed questions related to online group development have typically done so from the narrowed perspectives, such as knowledge construction by groups, group social identity formation or observable network structure. In most cases, these studies have looked at groups ranging in size from 3 to hundreds, creating challenges for the researcher seeking to make comparisons of these studies. The CSCL, CSCW and small group development literature have asked questions that relate to online group development, but there is not yet a cohesive community of researchers focused on understanding *completely online group development*. Second, research on group development in the physical world emphasizes the salience of context for understanding

how groups develop (Arrow et al, 2000; Hollingshead & Poole, 2005). It is unclear, however, what the dimensions or boundaries of context in a completely online group might be. Most studies that examine questions involving online groups are evaluating technology to support groups who occasionally do meet in the real world, and not completely online groups, making the construction of online group context highly variable from study to study. When completely online groups are studied, they are typically large, as in the case of DBLP mining conducted by Backstrom et al (2006) or not composed of sets of small groups, but instead a single, larger group, as in the case of Michinov & Michinov (2007). Third, completely online groups are composed of people who likely exist with different degrees of social and information connection to the world and to their group. While groups in the physical world typically have a common frame of reference around which to solve problems, the social and information context of completely online groups may be very different from member to member. Last, the outcomes of completely online small group work are difficult for the members to evaluate, and the efficacy of the groups functioning is not nearly as visible as it is in the real world. This dimension of online group development has been explored a few times, as by Hardin et al (2006), but many questions remain.

As an attempt to overcome the problems and challenges discussed above, the proposed study will take an innovative, comprehensive view of completely online group development. To have a deeper understanding about online group development, including how groups form, how they develop identity and what observable structures they take, there is a need to look at each of these dimensions by examining a set of small groups in the same completely online context. By observing groups in the same socio-

technical context, salient differences between groups in knowledge construction, group identity and structure will provide insight into the range of completely online group development trajectories available for further examination. In addition, taking into consideration the social ability of group members, we will be able to associate characteristics of the tool, task and individual that may influence those trajectories. Finally, examination of the information horizons and group efficacy measures of groups and individuals within groups will allow similar insight into how the high variability of information context found in small group members and member views of group efficacy are associated with different Completely online group development trajectories.

Chapter Summary

Chapter two presents the definitions and description of completely online group development, social ability, information horizons and group efficacy. The case is argued that completely online group development is not examined as a comprehensive construct in prior work, but instead viewed from a myriad of more narrow perspectives. This is distinct from the group development literature in general, which has explicated the characteristics and constraints of group development in the physical world comprehensively. Moreover, the factors that may influence completely online group development are unexplored, particularly those related to the influences of socio-technical context (social ability), information horizons and group efficacy. Completely online group development requires a more thorough examination.

CHAPTER III

Chapter Three – Methodology

Overview of Chapter 3

The central aim of this study is to characterize completely online group development and the influence of group context and group member context on that development. This study provides a rich description, categorization and quantification of *completely online group development* that is operationalized through three constructs: group knowledge construction, group identity formation and group structure. To operationalize context for the group and the group members, this study examines the influence of social ability, information horizons and group efficacy on group development online. The influence of social ability on group development is measured quantitatively at two points (before group work and during group work), and also assessed qualitatively through interviews. The influence of information horizons on group development is examined qualitatively and through a survey instrument developed following group member interviews. Finally, the influence of group efficacy on group development is measured quantitatively at two points (at the beginning of group work and in the middle of group work), and also assessed qualitatively through interviews.

Research Context & Sample

This study was conducted in the context of an online graduate student course on Computer Support for Collaborative Learning, offered in the summer of 2008 at the University of Missouri. All students were invited to participate in the interviews described, with an incentive of an online gift certificate of \$10 for completing a series of

3 interviews. Fourteen students were interviewed. Eleven of those students were interviewed three times each, and three students were interviewed once. Three surveys were conducted during the course of the research, with students offered a chance to win a 4GB iPod Nano in exchange for completing all requested surveys. Twenty-five students registered for this course and 24 of those students participated in the surveys.

The socio-technical system that facilitated the CSCL course was Sakai. The CANS system was used to provide activity notification and awareness information. CANS also generated several thousand records indicating when and what students read and contributed to the course. When a student logged into Sakai, and posted a message or read a message, CANS made a note of it. All assignments and discussion to support group collaboration in the CSCL course were facilitated through Sakai, using a JForum discussion board. JForum is integrated with both CANS and Sakai. Some groups elected to use other means for collaborating, including external wikis. So long as they granted access to the instructor this was allowed. Access to external tools was also requested for the researcher, and granted by all group members in all cases. The work conducted in those tools is included in this analysis.

The CSCL course utilized group work extensively, making it an appropriate study site for the gathering of data about remote small group collaboration. Students were divided into eight small groups at the end of the first week of an 8 week summer session, and completed all course activities in the context of that small group for the last 7 weeks of the course. At several points in the course, data were gathered in correspondence with course activities. The structure of the course was as follows:

[1] Week 1 – Module 1 – Explore what CSCL is (Individual Activity)

- [2] Week 2 – Module 2 – Reviewing and advancing CSCL work through Discussion (Small Group Activity. **The membership of the small group was selected randomly**). Each group took a position related to a research paper, and engaged in a debate with another group assigned an opposing position.
- [3] Week 3 – Module 3 – Group activity to construct a coherent story of past online learning individually, and to then design an online experience that is better, using available 2D and 3D collaboration technologies
- [4] Week 4 – Continue module 3
- [5] Week 5 – Module 4 – Design a 2 day online learning module to be delivered to 2 other teams in Module 5.
- [6] Week 6 – Continue Module 4
- [7] Week 7 – Module 5 – Students delivered modules designed in Module 4 to two other student groups. The groups also participated in the module designed by a different group. During this period, each group of three to four students had three different, unrelated work tasks to attend to.
- [8] Week 8 – Module 6 – Group and individual reflections. In the past, reflections were individual. In order to explore the construct of group collaboration further, the CSCL course participants were given the option to construct a collective reflection on a Wiki or discussion board, as a team.

Statement of Research Questions

The research questions we will explore in a Sakai learning environment are:

1. How do completely online groups develop?

- a. In what ways (individual member knowledge contribution or group cognition?) and to what extent is knowledge developed within online groups?
 - b. What identities do group members develop, to what extent does group identity form, and how is identity shaped during the online group work?
 - c. What social network structures are formed **within** online small groups and **across** online small groups during group work?
 - d. To what extent do social network structures change over the course of group work?
2. What is the role of social ability in online group development?
- a. How does the social ability of a member influence their participation in a group?
 - b. How does the social ability of all members influence group development?
 - c. How does group development influence the social ability of group members?
3. What is the role of the member's information horizon in online group development?
- a. How does a group member's information horizon within the course management system context influence group development online?

- b. How does a group member's global information horizon – the course management system and all other components identified – influence group development online?
 - c. How does group development influence the information horizons of group members?
- 4. What is the role of group efficacy in online group development?
 - a. In what ways and to what extent do group efficacy scores influence group development online?
 - b. In what ways and to what extent does online group development influence group efficacy?
- 5. To what extent does social network structure, observed through online communication patterns, reflect the observed knowledge construction, identity formation and information horizons of group members?

Figure 3 provides a visual orientation to the key constructs reflected in our research questions.

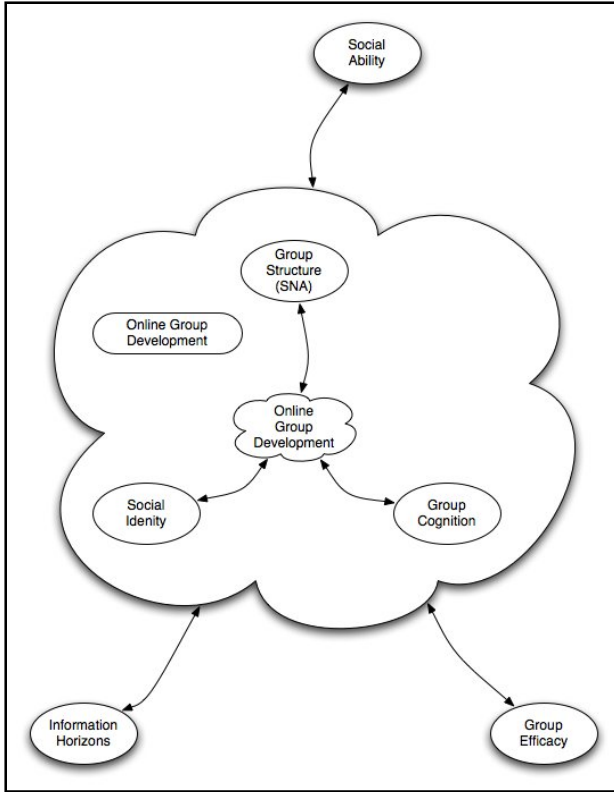


Figure 3 - Visual Representation of Key Constructs Research Design

This study followed a mixed methods concurrent multi-level design (Creswell, 2005) using multiple data sources gathered at multiple levels (the course, the small group and the individual). Both qualitative and quantitative data were simultaneously collected, triangulated and analyzed to describe online group development and answer the research questions.

Methods

Unit of Analysis and Sample

The focal unit of analysis in this study is the small group of three to five collaborators in an online learning environment. Stahl (2006) notes the critical role played by small groups in the development of new ideas and innovation in numerous settings. Stahl also observes that there is insufficient research at this unit of analysis for

us to understand the nature of technology mediated small group development. The small group is the mediating unit of analysis between the community and the individual, and has been demonstrated in prior research (Goggins, Laffey & Tsai, 2007) to be a critical unit for the negotiation of shared meaning online.

Data Collection Procedures

The data of this study were obtained (1) from examining the CANS logs of online course participants, (2) from 3 serial interviews [30 minutes each] examining the group experience of all key constructs of the study with 11 student participants (all members of 1 group, and representative members of each other group), (3) from single [1 hour] interviews focused on information horizons with 3 student participants, (4) from analysis of discussion board, wiki & chat content and corresponding field notes taken during the course for each of the 5 to 8 small groups formed in the CSCL course, (5) from surveys on *social ability* (administered once during week one of the course, and once in a “combined survey” during week 7), *information horizons* (administered in a “combined survey” during week 7) and *group efficacy* (administered in the first week of group work and again in a “combined survey” during week 7), (6) from analysis of group work products using a rubric, (7) student reflections on their group experience gathered following each group module and (8) demographic information about students, obtained voluntarily within one of the surveys. Table 1 provides an overview of the data collection activities related to each of the four key constructs: Group development, social ability, information horizons and group efficacy.

<u>Group Development</u>	<u>Social Ability</u>	<u>Information Horizons</u>	<u>Group Efficacy</u>
<input type="checkbox"/> Content Analysis of collaboration artifacts (discussion board posts, chat transcripts, wiki versions and others) to identify evidence of knowledge construction and social identity construction <input type="checkbox"/> Social Network Analysis of communication patterns represented in Sakai/CANS data <input type="checkbox"/> Analysis of serial interviews with 11 participants <input type="checkbox"/> Fields notes taken during the course to provide narrative description of group development. <input type="checkbox"/> Student reflections	<input type="checkbox"/> Social ability survey instrument administered to all participants twice <input type="checkbox"/> Analysis of serial interviews with 11 participants	<input type="checkbox"/> Analysis of information horizons from 3 interviews. ... Development of survey based on those interviews <input type="checkbox"/> Information horizons survey for CSCL course context <input type="checkbox"/> Analysis of serial interviews with 11 participants	<input type="checkbox"/> Group efficacy survey administered twice <input type="checkbox"/> Rating of Assignments completed by small groups using a rubric. <input type="checkbox"/> Analysis of serial interviews with 11 participants

Table 1 - Data Collection Methods

Appendix D contains a graphical depiction of data gathering and analysis activities that took place during the 8 week CSCL Course.

Data Cleaning & Management

The quantitative data collected from the Social Ability Surveys, CANS data, group efficacy surveys and information horizons survey were cleaned up, with missing cases and outliers being accounted for and removed. Next, we calculated descriptive statistics to understand the frequencies and tendencies in each data set. These included the overall level of social ability, the overall level of group efficacy, the most dominant factors in group member information horizons and samples of group social network structure.

CANS data were cleaned and converted to UCINET 6.0 structure, with value-matrices constructed for each module, each group and the whole course. These different matrices support a wide variety of analysis, discussed in detail in Chapter Four.

The qualitative data were catalogued, inventoried and methodically loaded in NVivo 8, following guidelines noted by LeCompte & Schensul (1999). The data managed this way included discussion board contents, interview transcripts, field notes, wiki version chat transcripts and other course management system artifacts. All working notes produced during the data analysis session were managed in NVivo.

Operationalizing Online Group Development

Online group development in this study was operationalized using group knowledge construction, social identity and group structure.

Group knowledge construction includes consideration of knowledge contributed by individuals, and knowledge constructed by the group, referred to in this study as *group cognition*. In general, individual contributions are identifiable as discrete presentations of knowledge that contribute to discussion or support a group goal. In contrast, group cognition is identifiable through interactions between members that result in the synthesis or emergence of an idea from the group.

Social identity is operationalized using a taxonomy developed in a previous study (Goggins et al, 2008), which principally incorporated Tajfel's social identity constructs of interpersonal, intragroup, intergroup, intergroup-social-comparison and interindividual communication. The taxonomy developed in the prior study also incorporates Postemes, Spears and Lee's (2000) identification of cohesiveness in communication as an indicator of group status and Ren, Kraut & Kiesler's (2007) distinction between groups held

together through a common sense of purpose and groups held together through interpersonal relationships. This taxonomy is represented as a qualitative data-coding scheme during analysis.

Finally, the construct of group structure is operationalized using CANS logs to represent the social network that develops between individual group members and their groups, as well as the networks that develop between groups. Following practices established during prior studies (Goggins, Laffey & Tsai, 2007; Goggins, et al, 2008) we import CANS logs into a MySQL database. Since the raw CANS logs tell us who read which post, but not who created the post being read, we then use a custom java program to add information about the object (post) creator for each CANS transaction. Next, the CANS data are exported into separate files for each course module and imported into UCINet 6.0 for windows. UCINet 6.0 permits us to quantify social networks using various measures we will explain in the data analysis section. From within UCINet, the social networks will be evaluated and visualized using NetDRAW. A previous study (Goggins, et al, 2008) established that social networks in online courses *can* be visualized and quantified. We use the same techniques in this study to contribute to our operationalizing of group development.

The data gathered from the CSCL course during this study provides rich, comprehensive descriptions of online group development. We operationalize group development as group knowledge construction, group identity formation and the identification and quantification of group structure.

Operationalizing Social Ability

Social ability is operationalized via the social ability survey developed by Laffey et al (2006), and by interviews with participants, during which we asked questions regarding their practices of social navigation, their experiences of social presence and their feelings of connectedness while in different environments. The social ability survey instrument has high construct validity, and shows predictive validity between social ability (including the sub-constructs of social navigation, social presence, social connectedness) and learning satisfaction with $p < 0.01$. Social ability is a construct that is still under development, and we will rely on the established validity of the instrument in our quantitative research, and seek to contribute to the evolution of that instrument as a secondary objective of our qualitative work. Survey results are converted to raw data that can be imported into SPSS, identifying individuals and their group membership. Laffey et al (2006) report cronbachs alpha of .92 for social navigation, .84 for social presence and .95 for connectedness on the social ability instrument. The 30 question social ability survey we will use is included in Appendix A.

Operationalizing Information Horizons

Information horizons was operationalized through a context specific information horizons survey, that was constructed following interviews with 3 course participants, and subsequently administered to all course participants. This protocol follows the methodological roadmap laid by Sonneweld (2001) for examining information horizons within a community. We modified this road map slightly and ask informants to characterize their information horizons within the online course management system (Sakai) in one picture, and their global information horizons (Sakai, plus everything else

they use during information seeking) in another. We did this to develop a rich understanding of both the global information horizon, and how the information within Sakai was perceived by comparison.

Operationalizing Group Efficacy

Group efficacy was operationalized through a twice-administered survey and interviews. The survey was Hardin et al's (2006) *group efficacy for virtual teams survey*, which demonstrated a correlation between group efficacy and actual group performance with power for detecting large effects ($r > .5$) within small groups at a significance level of .10. The group efficacy questions used by Hardin (2006) and in this study are in Appendix C.

Data Analysis

Each of the seven core types of data was analyzed using multiple strategies. Below, we describe each analysis method in general, and finally describe in more detail how we used the method(s) to answer each question.

Analysis Methods

This section describes the following analysis methods: Content analysis, top down ethnographic coding, bottom up ethnographic coding, ethnographic reconnaissance and social network analysis. The methods for examining information horizons are tightly coupled with the construct, so they are presented together in the Analysis of Questions section.

Content Analysis

Our use of content analysis is modeled after Stahl's work on group cognition, but unlike Stahl's video analysis of physically situated collaboration, this study involved

analysis of completely online, asynchronous knowledge creation through the analysis of *those* available artifacts. Video is the artifact for analysis of knowledge creation in face-to-face settings. In online collaboration, the virtual communication artifacts (discussion boards, chats) and collaboration artifacts (wikis, group work products) created by groups are the most salient representation of the interaction and progress of the group and its members. Profile indicators (Krippendorff, 2004) were created for each of the constructs for which content analysis is done.

For both the group cognition and social identity aspects of the content analysis, there were two coders and the scores for each were entered into SPSS so that inter-rater reliability could be calculated at two points of analysis as prescribed by Krippendorff (2004, p.227). First, two raters coded all discussion boards for three of the eight completely online groups using established coding schemes for group cognition and group identity. Second, inter-rater reliability was calculated on all of the discussion boards that were coded by both raters.

Top Down Ethnographic Coding

Top down ethnographic coding involved building a coding scheme deductively from a conceptual framework, and then applying that coding scheme to a specific set of data. We executed this in 2 steps. First, the data were grouped loosely according to the conceptual category in which they may be situated. In this case, by course module and specific activity type. Second, data were coded at a finer grained level, both from the perspective of the coding scheme, and the unit of analysis (Wolcott, 1999; LeCompte & Schensul, 1999).

Bottom Up Ethnographic Coding

The type of bottom up coding we used included six key steps (LeCompte & Schensul, 1999; Wolcott, 1999; Mishler, 1986). We (1) constructed a chronological narrative for three of the groups, identifying all narrative clauses or units that cannot be moved elsewhere, (2) categorized the narrative clauses, (3) identified interaction “moves” among participants, (4) analyzed the text to define what the function was and to identify relations among functions, (5) developed themes and (6) interpreted the meanings of the themes in the context of the other data available and the codes developed through this process.

Ethnographic Reconnaissance

Wolcott (1999) characterizes ethnographic reconnaissance as a form of ethnography that turns the accepted ethnographic doctrine that “*no amount of time in the field will reveal the whole story or get everything right*” on its ear by asserting that “*there is no length of time too short to derive some insight from the field experience*”. While this method recognizes that the more time available for field work the better, it encourages the researcher to use whatever small time allowed for field research to the maximum advantage by constructing field notes, pursuing instincts and surveying the larger situation in the course of also pursuing more specific research questions. Ethnographic reconnaissance, in the context of this study, supported the planned gathering of ethnographically framed data in the course of more focused data gathering efforts without compelling the researcher to engage in a full on ethnographic study or analysis. This is precisely the purpose of ethnographic reconnaissance, as described by Wolcott (1999).

Social Network Analysis

In an online course with CANS, each time a participant reads another participants work, a link is created between them in the social network. If the student posts, another link is created. The links can go in both directions, and the connections in each direction have values corresponding to interaction frequency. For example, if reader A views a post from reader B, 4 times, then the link is “4” in the direction from A \rightarrow B. If B reads A, 7 times, the link is “7” from B \rightarrow A. This is called a “valued network”, which has more analytical merit than a network without connection strength information (Wasserman & Faust, 1994).

SNA has numerous specific forms, each informed to different degrees by graph theory, probability theory and algebraic modeling. The essential concepts represented by SNA are the actor – who can be an individual, group or event, the relational tie (between actors), dyads (two people), triads (three people), groups, subgroups and networks. Different types of analysis of the relationships between these conceptual entities in a real network of people are what distinguish the various forms of SNA from each other.

Socio-Centric density in a valued network describes the total of all *actual connections* divided by the number of possible ties, resulting in an average value. If values (number of connections between nodes) are dichotomized, important data are removed (connection strength between nodes), but the resulting 0-1 numbers provide a measure of network completeness that is easier to compare with other networks. Density will allow us to compare groups within the course as they are assigned, and also as they naturally occur.

Network centralization measures indicate how tightly the graph (social network) is organized around its most central point. High indegree centralization indicates that the group is reading a small number of people's posts. High outdegree centralization means that a few centralized people are making a majority of the contributions.

Betweenness is a measure of the importance of a node to making connections between other nodes. In our case, a person could have high betweenness if they were reading or contributing to discussions across multiple different subgroups. This would indicate that they are a "connection point" for ideas between two clusters within the larger group.

Core-periphery analysis extends the established centrality SNA measures of degree, closeness, betweenness and eigenvector-based measures by leveraging the concepts of group centrality and two-mode centrality (Wasserman & Faust, 1994). Core/periphery measures posit that there is some group in the core, and some other group in the periphery of a network with one center. Core nodes are distinguished by creating a complete graph with each other.

Within our social network there were eight a Priori subgroups. Different social network statistics measure the existence and strength of subgroups based on activity. In the case of our exploratory work in the use of SNA statistics for discovery of subgroups in completely online groups, we tried a number of different measures. F-Groups and Factional groups were most useful, and are explained in detail in chapter four.

Analysis of Questions

The table 2 describes the analysis strategy that will be used for each research question.

Table 2 - Research Question Analysis Strategies

<u>Question</u>	<u>Analysis Strategy</u>
1. How do Completely online groups develop?	
a. In what ways (individual member knowledge contribution or group cognition?) and to what extent is knowledge developed within online groups?	Bottom up ethnographic coding of discussion board, wiki, chat and field notes. Bottom up ethnographic coding of student reflections Content analysis of discussion board, wiki, chat and field notes.
b. What identities do group members develop, to what extent does group identity form, and how is identity shaped during the online group work?	Bottom up ethnographic coding of discussion board, wiki, chat and field notes. Bottom up ethnographic coding of student reflections Top down ethnographic coding of discussion board, wiki, chat and field notes Content analysis of discussion board, wiki, chat and field notes
c. What social network structures are formed within online small groups and across online small groups during group work?	Social network analysis of CANS data, converted into a bidirectional value network
d. To what extent do social network structures change over the course of group work?	Social network analysis of CANS data, converted into a bidirectional value network
2. What is the role of social ability in online group development?	
a. How does the social ability of a member influence their participation in a group?	Top down ethnographic coding serial interview transcripts Social ability survey Cans data – Raw participation counts

<u>Question</u>	<u>Analysis Strategy</u>
<p>b. How does the social ability of all members influence group development?</p>	<p>Categorization of group development, which emerges from bottom up coding, will be used to distinguish between groups along categorical lines.</p> <p>Comparison of social ability survey mean of members in different group categories, as coded from bottom up ethnographic analysis.</p> <p>Top down coding of group development interviews for social ability constructs.</p>
<p>c. How does group development influence the social ability of group members?</p>	<p>Categorization of group development, which emerges from bottom up coding, will be used to distinguish between groups along categorical lines.</p> <p>Comparison of individual social ability scores before and after group activity to identify any statistically significant difference.</p> <p>Top down coding of group development interviews for social ability constructs.</p>
<p>3. What is the role of member's information horizon in online group development?</p>	
<p>a. How does a group member's information horizon within the course management system context influence group development online?</p>	<p>Case study analysis and description of vignettes regarding IH gathered from interviews</p> <p>Synthesis of IH Maps</p> <p>Ethnographic survey analysis of IH survey</p>
<p>b. How does a group member's global information horizon – their course management system and all other components identified – influence group development online?</p>	<p>Case study analysis and description of vignettes regarding IH gathered from interviews</p> <p>Synthesis of IH Maps</p> <p>Ethnographic survey analysis of IH survey</p>

<u>Question</u>	<u>Analysis Strategy</u>
c. How does group development influence the information horizons of group members?	Case study analysis and description of vignettes regarding IH gathered from interviews Synthesis of IH Maps Ethnographic survey analysis of IH survey
4. What is the role of group efficacy in online group development?	
a. In what ways and to what extent does group efficacy scores influence group development online?	Categorization of group development, which emerges from bottom up coding, will be used to distinguish between groups along categorical lines. Use of ethnographic reconnaissance (Wolcott, 1999) to describe possible connections between group development and group efficacy Scoring of group work products using a rubric.
b. In what ways and to what extent does online group development influence group efficacy?	Categorization of group development, which emerges from bottom up coding, will be used to distinguish between groups along categorical lines. Dependent sample t-tests of group efficacy data. Use of ethnographic reconnaissance (Wolcott, 1999) to describe possible connections between group development and group efficacy Scoring of group work products using a rubric.
5. To what extent does social network structure, observed through online communication patterns, reflect the observed knowledge construction, identity formation and information horizons of group members?	Social network analysis, including measures of centrality, betweenness, density, clique and core & periphery measures. Integration and triangulation of SNA data with social ability, information horizons and group knowledge development to provide a descriptive analysis of findings (Goggins, Laffey, Reid & Tsai, 2008).

Question 1

Across each aspect of question 1, bottom up ethnographic coding of discussion boards, wiki's, chats and reflections of participants in small groups was conducted. The result of this analysis was a fined grained depiction of the experience of group development, culled from the records of online collaboration maintained in Sakai.

Question 1.a was answered using content analysis (Neuendorf, 2002; Krippendorff, 2004). Gunawardena et al's (1997) coding scheme for online knowledge construction was used to characterize group construction of knowledge during group work. Descriptive statistics for those parameters were calculated, and used to describe group cognition patterns, which emerged from the data. A profile with indicators of individual knowledge construction was built, with descriptive statistics generated to describe knowledge construction. (See section describing content analysis method for discussion of inter-rater reliability.)

Question 1.b was answered through content analysis techniques as well, but with profile indicators for Tajfel's (1982) five types of social identity. Descriptive statistics for those parameters were calculated, and used to describe different types of group identity construction. In addition, top down ethnographic coding of discussion boards, wikis, chats and field notes was used to answer question 1.b. The top down codes used for ethnographic analysis were derived from Tajfel's five types of social identity. (See section describing content analysis method for discussion of inter-rater reliability.)

Social network analysis techniques (Wasserman & Faust, 1993; Scott, 2000; Carrington, Scott & Wasserman, 2005) were used to answer questions 1.c & 1.d, regarding social network structures within small groups and between small groups.

The research applies four specific SNA measures to help make online group structure visible: Density, betweenness, core-periphery and subgroup measures. Density & betweenness are measures that consider individual nodes (people) in a network, and core-periphery and clique statistics address groupings and relationships between groupings. The data for generating these networks are from CANS. The SNA analysis described above will be calculated for each module in the course, and compared over time.

The social network analysis was conducted using UCINET. Though the use of STATNET, a component of the open source tool, "R" was explored briefly for this report, we decided to continue our work with UCINET in order to permit easier comparison of the analysis with prior work.

We enhanced the strength of tie data compared with previous work, however. In addition to analysis of straight node to edge bidirectional relations, we also found stronger ties between people who respond in close time proximity to the posts of others. We calculated the total times between all events and the prior event and prior post in seconds. Next, we created a standard distribution of those time windows such that each edge was ranked in its tie strength in groups of 10, from the 100th percentile down to the 10th percentile. The comparison of non-valued networks with networks that have strength of ties on each edge is therefore possible and provided interesting contrasts.

In order to capture the contrasts from module to module, and also measure the trajectories across modules, all network data is captured by module, and a series of module groupings. In this way, the salient calculations are performed for individuals in

the whole course social network. Network statistics are calculated in these distinct but sometimes logically overlapping module-time windows:

- Module 1
- Module 2
- Module 3
- Module 4
- Module 5
- Module 6
- Modules 2,3
- Modules 3,4
- Modules 4,5
- Modules 2,3,4
- Modules 3,4,5
- Modules 2,3,4,5

Module's 1 and 6 are not combined with other modules because they represent distinct and more individually focused activities. The sequential integration and growth of other modules in this analysis permitted comparison and contrast of members within a module, and also trajectories across and between modules. In this way, the development of the group structure was observed from multiple temporally bound perspectives.

Question 2

Top down ethnographic coding and a social ability survey were used to answer question 2.a. The social ability survey was taken prior to and during group activity, with a dependent sample t test performed on the two data sets. Question 2.a was answered using correlations and descriptive statistics to depict the relationship between the initial measures of social ability CANS usage counts, including logins as well as read and post events, as measures of participation. Did students with high initial social ability participate differently than those with lower scores?

Questions 2.b and 2.c were answered by placing each of the small groups into categories that emerged from bottom up coding of discussion boards. We then compared social ability means and configurations between different categories. While our small sample size resulted in some factor changes from T1 to T2 with $p < 0.05$ and moderate power, we believe this exploratory study to be more powerful when presented with our qualitative analysis of the influence of social ability on group development in both directions. For question 2.c, a dependent sample t-test was used to verify statistical significance of the difference in social ability before and after group work. Qualitative analysis consisted of top down coding of the group development interviews for social ability concepts, and the subsequent integration of that data analysis with the results of these surveys.

Question 3

Our application of Sonnenwald's (2001) methodology for operationalizing information horizons was aligned with the prescribed methodology, with data analysis at every step. First, informants were interviewed regarding where and from whom they sought information during the course of their activities in the context of this online course. The interview technique we used was a critical incident review, where the informant described a specific situation within the information seeking context. Our protocol reviewed two such incidents: One incident of information seeking completely bounded by the course management software (CMS) and one incident of information seeking related to the course but not bounded by the CMS. During the course of these interviews, the researcher worked with the informant to develop a visual map (boxes, lines, directionality) of the interactions they had with these information sources or people.

We adapted this approach to the circumstances of this study (course participants exist all around the world), and asked informants to build a map of the information sources and people they contact while working in the CMS. Informants were asked to share that map with the researchers prior to the interview. We then asked informants for an information map that included the sources and people they interact with while working on the course, but to consider in this diagram people and information sources outside of the CMS.

Second, the interviews were analyzed to develop a comprehensive list of information sources (both people and information resources) used by all informants in each context. Third, this list was sent as a survey of all course participants, asking them to individually rank the resulting list of 28 information resources in order of priority of importance. One was most important, 28 was least important. Fourth, responses to the surveys were assembled into a data matrix and analyzed for patterns of information seeking processes, with rows representing users and columns representing information resources. Fifth, the ethnographic survey data (LeCompte & Schensul, 1999) was collected and integrated into a full view of the within course and global information horizons of participants.

Question 3.a was answered by examining this full view of informant information horizons to identify incidents where engagement in the course management system influenced the development of the group. It was also answered through analysis of the survey results to determine if there were any observable patterns in online group development that seemed to go along with specific information horizons within the CMS. For example, did students who view the discussion boards as containing course

information and no other kind of information experience different types of group development.

Question 3.b was answered similarly, except incidents where the information horizons of course participants outside the CMS influenced group development were examined. Like question 3.a, survey results were searched for patterns in online group development that seemed to go along with specific information horizons, except in this case the focus was outside the CMS.

Question 4

Question 4.a was answered through a series of analysis steps that built upon each other. First, bottom up coding was conducted on discussion board transcripts, wiki's and online chats from the course. From this bottom up coding activity, we identified three distinct groups for close, case study level analysis. In bottom up coding, the codes and subsequent group categories are not determined a priori. Prior studies of online groups have revealed emergent group categories (Goggins et al, 2008), so we had some degree of confidence that interesting categories would emerge. Second, group work products were scored according to a rubric, providing an indication of the quality and effectiveness of each group on each assignment. Third, ethnographic reconnaissance (ER) data, acquired across the breadth of this study (see earlier methods section for an explanation of ethnographic reconnaissance) was used to describe possible effects of group efficacy on group development.

The analysis steps for question 4.b were the same as for question 4.a, but we approached the data from the opposite direction and incorporated dependent sample t-tests that were conducted on the group efficacy survey data to determine if group efficacy

changed in a statistically significant way as the collaboration progressed. In the case of question 4.b, if groups experienced significant gains or losses in group efficacy scores from T1 to T2 demonstrated changes in accomplishments, as measured on rubrics of group work products, or fell into a specific set of group categories, that could provide some insight about the effect of group development on group efficacy. For question 4.b, ethnographic reconnaissance data were used to describe the possible effects of group development on group efficacy.

Question 5

Question 5 was answered in four steps that progressed toward a goal of relating social network structure to the other two aspects of *completely* online group development in this study: Knowledge construction & identity formation, as well as information horizons. First, the four key social network structure measures of density, betweenness, core-periphery and cliques were calculated for the entire course of 20 – 25 people at 1 week intervals throughout the course, and for the entire course. Second, the network structure measures of each a priori assigned group were noted at specific points in time (weekly) during the course. In addition, changes in social network structure from module to module for each group's members were noted. Recall that this social network structure showed the actual relations of individuals to each other based on what was being posted and read in the online course. Comparisons of this actual behavior to a priori groups illustrated distinguishing structural characteristics of each a priori group, as it did during prior studies (Goggins et al, 2008). For example, some a priori groups in the prior study had a large number of highly active members in the core social network of the

course, while other a priori groups were distinguished by the relative scarcity of communication from within the group to and from other a priori groups.

Third, the structural qualities of the a priori groups and their members, as discerned from SNA, were triangulated with findings from content analysis and ethnography for knowledge construction and social identity development. Network structure measures were related to categories derived from bottom up ethnography, and measures of knowledge construction and social identity derived from content analysis. The extent to which different patterns of knowledge construction or identity formation correspond with identifiable social network patterns identifiable from our bi-directional usage logs, there is potential for developing tools to predicatively identify completely group development patterns.

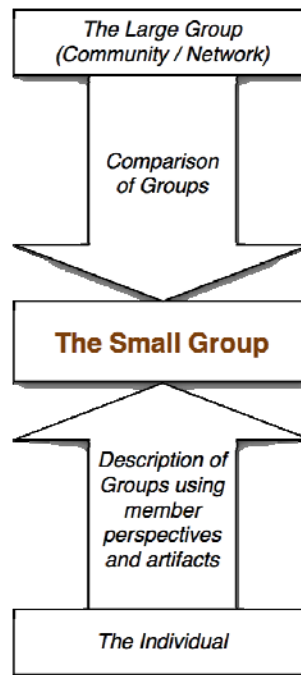
Fourth, the structural qualities of the a priori groups and their members, as discerned from SNA, were triangulated with findings from information horizons (IH) surveys. Network structure measures were related to categories derived from IH surveys. The extent to which specific information horizons related to particular group structures or member location within those groups may lead to additional research questions (for future studies).

The analysis methods for question 5 are exploratory, as the only precedent for integrating these research methods to study online groups was developed by this research team (Goggins et al, 2008). Based on this prior work, we believe this kind of exploratory method may provide otherwise unobtainable insights into the development of completely online groups, which is the motivation for incorporating this question into this study.

Summary of Analysis Execution

This section will describe the processes, reliability measures and data analysis methods used for this dissertation. Those methods include statistical analysis of survey results, constant comparative analysis of texts and interview transcripts, social network analysis, information horizons analysis and the development of case studies. Some analysis is focused inward, from the group toward the individual members' interactions within the online setting. Other analysis is focused outward, from the group toward comparison with other groups in the course. A visual description of this dichotomized analysis strategy is shown in figure four.

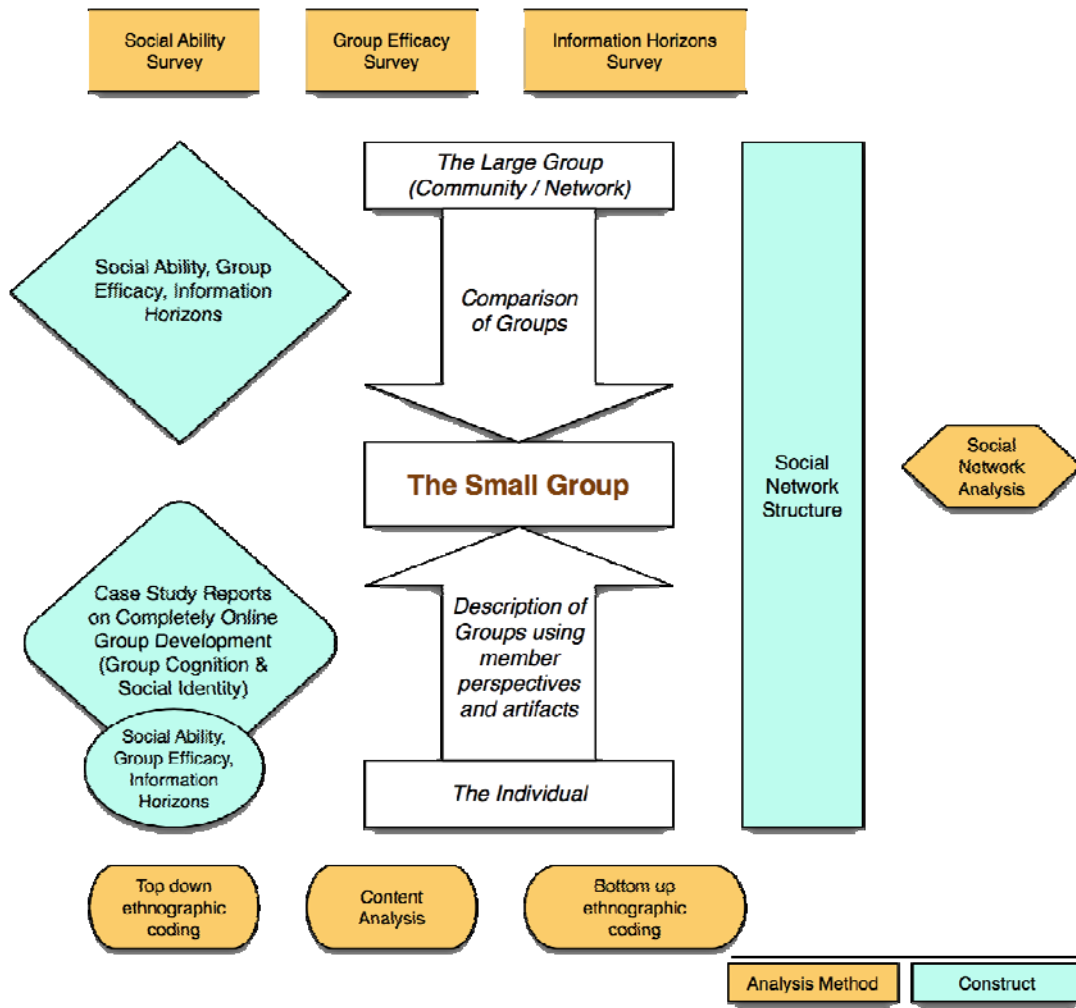
Figure 4 - High Level Description of Analysis Strategies



The small group is the principle unit of analysis in this study, but we also examine the small group from bottom up descriptions of the group and its members and from top down comparison of the groups with each other. In some cases, the data are analyzed

from all three perspectives. The salient constructs, units of analysis and analysis strategies used are depicted in figure 5. This diagram shows the small group at the center, and the research constructs discussed earlier in this chapter in blue. The visualization of the unit of analysis for each construct extends from the top of the page to the bottom. Analysis methods are darker, and in a yellow color. Analysis methods are also located nearer the unit of analysis which they each use.

Figure 5 – Visualization of analysis strategies and constructs in this study related to small groups, networks and the individual



Quantitative analyses were conducted for all eight groups in the course. These include one tailed t-tests on surveys taken before collaboration began (T1) and toward the end of small group collaboration (T2). Social network analysis was conducted at the course (macro), small group and individual levels of analysis (micro). The social network analysis conducted in this work addresses small group development and includes a very rich set of bidirectional online interaction data. The use of bi-directional online usage logs for social network analysis is a unique dimension of this study. Finally, content analysis methods, considered by some to be abductive research method (Krippendorff, 2006) are more generally categorized as quantitative.

Ethnographic and content analysis for three groups with high contrast on group performance measures and participation measures resulted in three detailed case studies. Both top down and bottom up ethnographic coding took place using nVivo 8, service pack three and service pack four.

The remainder of this chapter is structured as follows: (1) A description of the criteria, measures and procedures used to identify three groups with high contrast on performance and participation for ethnographic and content analysis, (2) a description of analysis conducted for each of the three high contrast groups and (3) a description of the analysis conducted for all eight groups.

Three groups were selected for ethnographic and content analysis. The results are reported in three case studies that characterize three quantitatively and qualitatively distinct group development trajectories in the same course context. The three groups selected for these case studies are referred to through the rest of this report as:

1. Barriers Group – A group of three with initial low performance and late stage high performance, but consistently low group identity. This group broke down and required instructor intervention.
2. Individualist Group – A group of three whose performance and participation fluctuated dramatically during the eight weeks.
3. Get-Along Group – A group of three who performed consistently in the middle of the pack, and developed a very strong group identity.

Selection of Groups for Ethnographic and Content Analysis

These three groups were selected for ethnographic analysis, content analysis and case study reporting from the eight total small groups formed for this study of completely online groups. The eight groups utilized a diverse set of online collaboration technologies, many of them outside the formal course management system. These technologies included four different online wiki systems, Google groups, Skype, email, text messaging and the exchange of word documents through various means. The volume of data that emerged within these external systems, as well as within Sakai, was greater than the volume experienced during pilot studies. Three groups were selected for ethnographic analysis from among the eight in order to focus the bottom up and top down ethnographic analysis for this report. The three groups were selected based on contrasts observed in two quantitative features of their development: Performance on group work products and raw course management system usage counts derived from CANS logs.

Group performance for all eight groups was assessed by two raters using a rubric for module four's work products. Module four was selected for rubric assessment

because it had the highest degree of knowledge co-construction and group interaction required among the six modules. Table 3 provides a description of each of the modules, along with a description of limitations and opportunities for observing knowledge co-construction or group identity formation in each module.

Table 3- Module Qualitative Characteristics for Research Analysis

<u>Module</u>	<u>Description</u>	<u>Group Identity</u>	<u>Knowledge Co-Construction</u>
Module 1	Introduction	Groups not formed	Minor interchanges
Module 2	Conceptual Framework. Groups formed, and participate in a debate about collaboration online. Positions are assigned.	Groups work together for the first time to construct and defend an opinion	Limited knowledge construction activity planned
Module 3	What is CSCL? Review Experiences and Identify Approaches	Task focused. Partially collaborative. Groups work as a unit.	Task focused. The task is knowledge aggregation of online experiences.
Module 4	Designing a CSCL Lesson	Highly collaborative group creative work expected.	Tasks are focused on co-construction of a creative work product
Module 5	Implement CSCL Lesson	Groups participate in two modules and teaching a third. This is a very task focused time.	Groups are expected to work on three different tasks at once.
Module 6	Review and Reflection	Individual and group reflection on activities	Individual and group construction of reflection statements.

Table 3 illustrates the salient differences between the modules. Module one does not include much group work. Module six does not explicitly require collaboration. Modules two and three will be helpful for analyzing group formation. Modules three and five are highly task focused, and provide less opportunity for the groups to co-construct knowledge and demonstrate their group identity than module four. Module four, then, is

the best candidate for assessing the quality of group work, since the module involves intense collaboration on three small group work products.

Once module four was selected for analysis, two raters proceeded to evaluate three work products within the module for each of the eight groups. The description of module four is available in Appendix F and the rubric used for evaluation of the three work products is available in Appendix G. The purpose of module four was for the group members to develop an online learning module that they would then teach to two other groups during module five. The three work products evaluated for each of the eight groups are a learning scenario, a CSCL script and an evaluation criteria document. The results of the work product evaluation for those modules are in Table four.

Table 4 - Group Assignment Scores, Module Four (Red/underlined is negative, green/bold is positive and yellow/plain is neutral) shows the comparative performance of group members against a rubric applied to the three work products in module four.

Assignment	Individualist Group	Canada Group	Adams Group	Police Group	Orange Group	Barriers Group	Catskill Group	Get-Along Group	Basis for Code
Scenario	24	<u>12</u>	30	<u>12</u>	24	33	18	<u>15</u>	score group
Script	<u>4</u>	28	<u>24</u>	20	24	<u>28</u>	22	20	trajectory
Assessment	3	6	0	3	6	3	18	3	
Total	<u>31</u>	46	54	<u>35</u>	54	64	58	<u>38</u>	score group

Table Four shows that the overall performance of Individualist Group and Get-Along Group is relatively low, and that the overall performance of Barriers Group is high. Canada Group, Adams Group and Orange Group have performance in the middle of the pack. Police Group performs low and Catskill Group performs at a high level. In our search for contrasts for the group case studies, Individualist Group, Police Group, Barriers Group, Catskill Group and Get-Along Group remained under consideration

following the analysis of group performance vis-a'-vis the rubric. These groups reflected interesting contrasts in performance.

Comparison of the participation (reading the work of others) and contribution (replying to the work of others) as made visible through the CANS logs helped to identify Individualist Group, Barriers Group and Get-Along Group as the best candidates to provide interesting contrasts and qualitative group development patterns through detailed ethnographic and content analysis. Figure six shows the trajectories of each group's participation.

Figure 6 - Contrast of Participation Trajectories of Three Case Study Groups

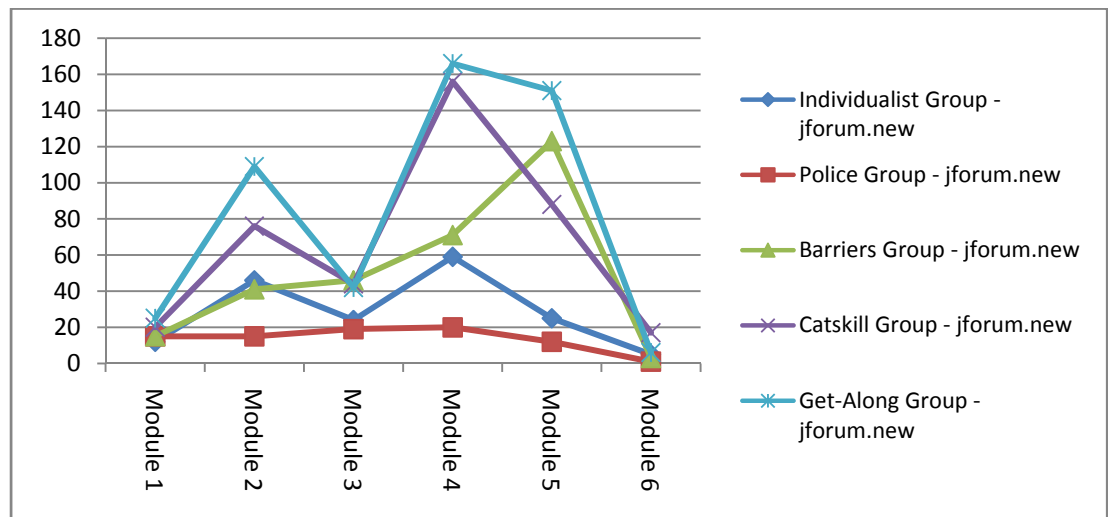
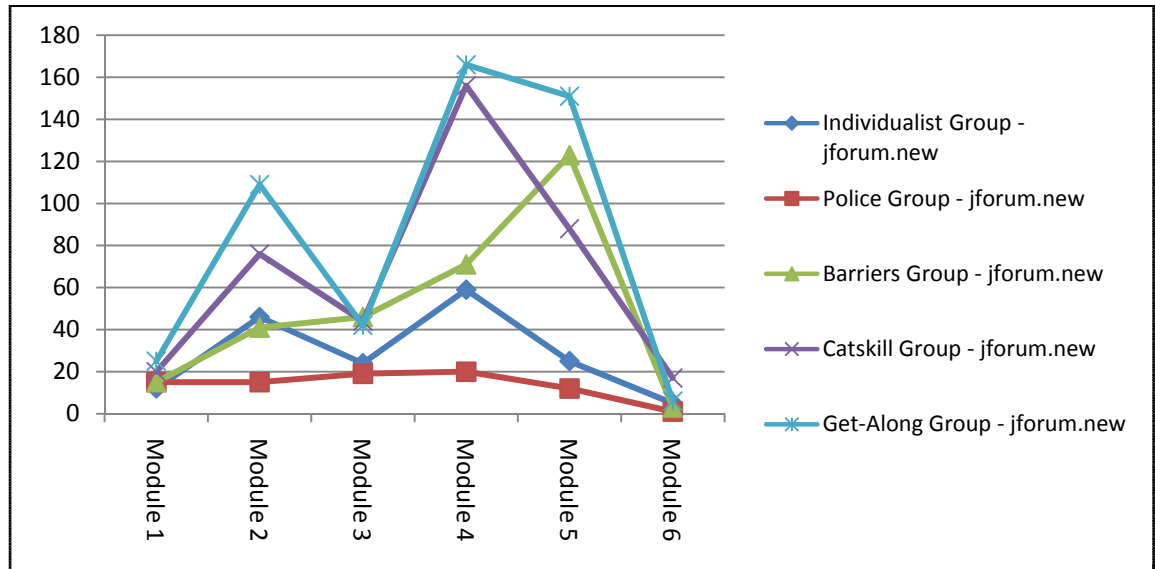


Figure six shows that Get-Along Group is a significant outlier in terms of contribution during modules four and five. It further shows that Barriers Group has a trajectory of participation between modules four and five that is on a positive slope, while the other groups see participation decline between these two modules. Finally, it shows Individualist Group remaining high in participation through module four, but declining rapidly in modules five and six.

Analysis of contributions between these five remaining groups provided additional evidence of likely strong contrasts between Individualist Group, Barriers Group and Get-Along Group. This is depicted graphically in figure seven.

Figure 7 - Contrast of Contributions between Five Groups



Get-Along Group clearly remained highest in contributions, as they were in participation; while Barriers Group's trajectory contrast with the other groups is the same for contributions as it is for participation. Individualist Group's contributions follow essentially the same patterns as their participation does, as well. The contribution data draw attention to Police Group, whose rate of contribution is consistently low compared with other groups. While their performance is low, like Individualist Group and Get-Along Group, the participation and contribution contrast between Individualist Group and Get-Along Group are greater than the contrast between Individualist Group and Police Group or between Get-Along Group and Police Group. Barriers Group's participation, contribution and performance all appear distinct among the eight groups, making Barriers Group more likely to show high contrasts in the detailed ethnographic and content

analysis as well. Taken together, performance, participation and contribution factors show clear quantitative contrasts between Individualist Group, Barriers Group and Get-Along Group that will be elaborated on qualitatively through ethnographic reporting and quantitatively through content analysis.

Description of Analysis for Each of Three High Contrast Groups

For the case study analysis of each group, we went through each of the major data sources in order and took notes inside nVivo using codes, placed key points to make in the dissertation on note cards and also kept a summary of key findings on a notepad. This redundancy and constant comparison of the data follows Strauss's (1967) general guidance for grounded theory analysis. The technique allowed the development of bottom up ethnographic codes and top down ethnographic analysis described in greater detail earlier in this chapter. The specific analysis steps performed on each of the discussion board, reflection and interview artifacts for each of the groups are:

- Student Reflections
 - Bottom up ethnography for knowledge construction
 - Bottom up ethnography for group development, paying particular attention to the evolving trajectory of the group across modules
 - Ethnographic recon for any group activity that occurred
- Interviews
 - Top down ethnography for social ability
 - Top down ethnography for Information Horizons
 - Top down ethnography for Information encountering
 - Triangulation of group identity development findings from other sources

- Triangulation of knowledge construction findings from other sources
- Discussion Boards
 - Inter-rater validated content analysis for knowledge co-construction using Gunawardena et al's (1997) coding scheme for each discussion board post for all three groups
 - Inter-rater validated content analysis for group identity formation using a previously developed coding scheme for each discussion board post for all three groups.
 - Bottom up ethnography for knowledge construction
 - Bottom up ethnography for group identity development
 - Top down ethnography for group identity development
 - Ethnographic recon for group efficacy
 - Ethnographic recon for information encountering
 - Ethnographic recon for information horizons

Once completed with analysis for these data sources, we categorized the codes for each case study according to the data source type, then looked for triangulation across the data sources. Over 600 specific codes and categories were applied to the data, with an average of more than seven specific instances for each code. There are, then, over 4,000 total coding instances in the qualitative analysis. These coding instances were then grouped under key constructs, group constructs (like team memberships) and course constructs (like modules). Finally, an outline for each case study was assembled. The writing of the case study relied on Stake's method for case study analysis, and used an adaptation of his outline for providing detailed description of the specific cases (Stake,

1995). Each case addresses the trajectory of the group, describes identifiable patterns and sometimes reified practices developed by the group and builds a picture of small group themes based on the analysis. These cases richly describe the development of three different completely online groups, incorporating the specific and sometimes unanticipated experiences of each group.

Approximately 1,687 discrete discussion board posts were coded at the post unit of analysis using both Gunawardena's (1997) coding scheme, and a coding scheme based on Tajfel's (1979) constructs of social identity. The codebook used is available in Appendix E. Reliability data using Krippendorff's Alpha as a measure are presented in Chapter Four.

Social network analysis from the within group perspective illuminated the distinct roles, participation levels and structural characteristics of members within groups. This analysis pushes our understanding of individual roles within a group and group dynamics beyond the simple counting of contribution and participation measures, and toward an understanding of the relationship between group members and the salient differences in relational trajectory found in each of the three case study groups.

The construct of social ability surfaced in discussion board, interview and reflection texts of members. Variations in task difficulty, member attentiveness and tool selection and adaptation influenced the trajectory of groups, suggesting, in some cases, needs for refinement of the social ability construct.

There are both within group member differences and between group differences in reported information resource use. These contrasts emerged from information

horizons's analysis, including information horizons surveys and information horizons interviews.

Group members were consistent in their reporting of the efficacy of their own group. Survey, reflection and interview data are used to triangulate findings about group efficacy within small groups. Efficacy viewed through the lens of effectiveness on group work is also examined in module 4 using a rubric as previously discussed. Effectiveness of the group is also examined in module 2 for each of the three cases, relying on the reporting of other members and course reflections.

Description of Analysis for All Eight Groups

All eight groups were compared on the constructs of network structure, social ability, information horizons and group efficacy. In addition, module four's work was evaluated using a rubric for all eight groups, as previously noted.

Social network structure across groups looks at various subgroup measures that indicate which members are in proximity to which other members, based on distance measures derived from CANS logs. Since CANS logs record every read and post within the course management system, some records for transient members were removed. The data cleaning process is described in Appendix H.

CANS events reflect different kinds of relations. Both discussion board read events and discussion board post events are captured. The person who is reading, the person who is posting and the relations between them are discernable. When performing social network analysis with this type of highly detailed interaction data, the semantics of the interactions must be considered in the calculation of distance between actors in the network. This includes consideration of how timely interaction is (more timely

interaction would suggest a stronger tie), how frequent the interaction is and what the type of interaction is. The calculation of these distances, or weights on the edges between nodes in our social network is the subject of the next section.

Time between Posts and Tie Strength

To categorize the time between posts and use them as a component of our measure of tie strength, SPSS frequencies were run on the time values. Table five shows how the time values (in seconds) are distributed in the available posts:

Table 5 - Time Distribution of CANS Posts Relative to Prior CANS Post in Same Discussion Board Topic

N	Valid	39239
	Missing	0
Mean		42880.29
Median		4665.00
Mode		1
Std. Deviation		112551.463
Variance		1266783182
		3.995
Range		999940
Percentiles	10	2.00
	20	102.00
	25	312.00
	30	658.00
	40	2000.00
	50	4665.00
	60	9529.00
	70	22163.00
	75	33426.00

	80	45427.00
	90	95268.00

The distribution used in the subsequent calculations are the 10, 20, 30, 40, 50, 60, 70, 80 and 90th percentiles. We will refer to these as tentiles or tentile distributions in the following section.

Two edge cases were eliminated to prevent skewing the percentiles. The Minimum value in the data is 0, and the maximum value in the data is 1,000,000 - the limit of time span to double data type conversions in MySQL's structural programming language. One million seconds is approximately 6.5 days, which, in the context of an 8 week course is a rather long event to event distance. Placing edge cases of over 6 days at the bottom of "response timeliness" is appropriate in this context. The minimum edge case of zero occurs every time there is a new discussion topic created. The time from the last post, which is the first post in a new topic, is in both this measure, and in fact, zero. In total, there were 736 events out of a total of 39,975 events excluded as edge cases, or 1.84%. Including them in the calculation of tentiles would have slightly skewed those tentile boundaries toward the edge cases, which is the reason they were eliminated in our calculation of tentile distribution. Edge cases were, however, included in the final analysis. These cases represent real events and thus authentic ties between members.

The zero based edge cases show stronger ties between the poster and themselves. This is called a diagonal tie in SNA parlance, and it is a type of tie that may have relevance in a completely online setting, and should therefore not be eliminated a priori. Members do in fact read and respond to their own posts, and this does tell us something interesting about their online behavior and small group development. The emergence of

virtual narcissism is as real as narcissistic behavior in the physical world, though the presence and effects of the behavior are less apparent to others. At the other extreme, the 1,000,000-based edge cases represent weak ties between two members.

Since the lower numbers in this case represent faster response, social presence theory suggests they would also indicate a stronger tie. Short, Williams & Christie (1976) developed social presence theory, which identifies the saliency of a user's social presence as an indicator of a socio-technical system's social effects. Social presence theory has become a central construct motivating the development of tools that promote higher degrees of social interaction in online learning. Social presence theory guides numerous studies of the social nature of online learning, and is typically operationalized as a characteristic of the tools or contexts, and the extent to which they promote the feeling of "being there" among users (Kreijns, 2004; Laffey et al, 2004).

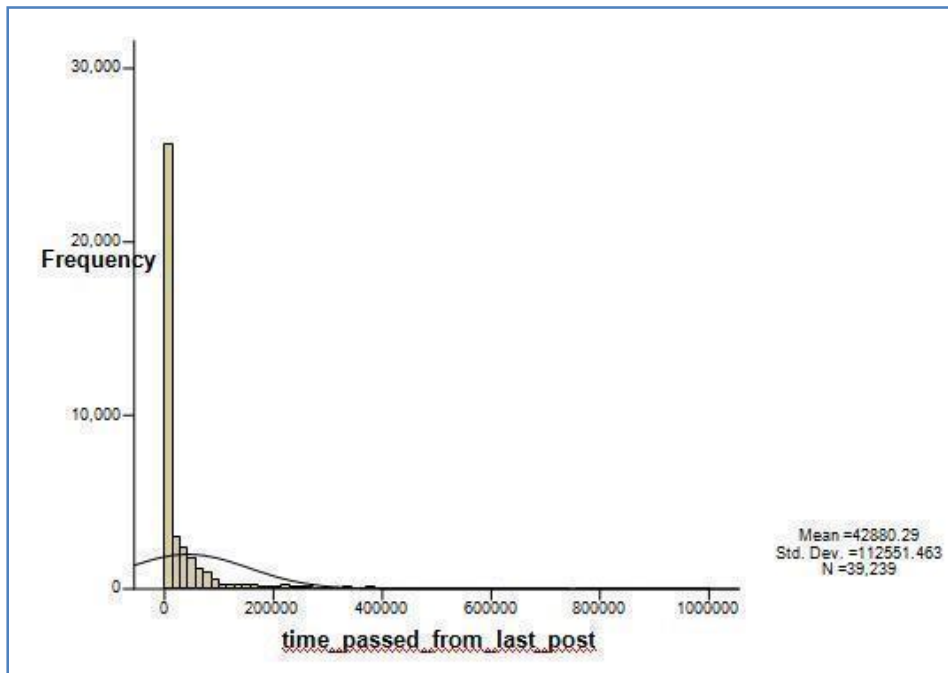
This feeling of being there is enhanced by quick responses from peers; therefore timeliness of responses are considered in calculating tie strength. Since quicker responses indicate stronger ties, our study will weight these percentiles inverse to the default SPSS behavior, with low numbers representing the top percentile. This is displayed in table six.

Table 6 - Inversion of Default SPSS Percentile High to Low Direction, Reflecting the Semantics of the Time - Distance Measure in this study

Percentiles	90	2.00
	80	102.00
	75	312.00
	70	658.00
	60	2,000.00
	50	4,665.00
	40	9,529.00
	30	22,163.00
	25	33,426.00
	20	45,427.00
	10	95,268.00

Figure eight provides a more visual representation of the distribution of values, which is skewed toward the low end of the range. This would be expected in a compact, 8 week online graduate student course.

Figure 8 - Distribution of all post response times in seconds, across all CANS logs



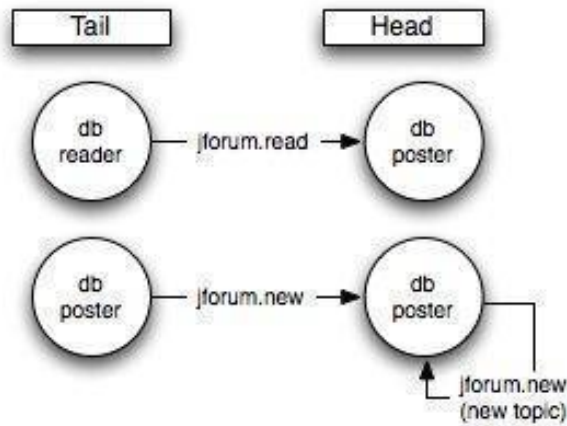
Considering the Different Weights for Reads and Responses to Members

Weighting the strength of tie between members required the careful consideration of what measures to use. Recency of response indicates that there is a greater sense of social presence among the members who are being responded to, so this is particularly salient for posting behavior that takes place a short time after the preceding post in a particular topic (Kreijns, 2004). Reading another's post is a more passive behavior, though nonetheless an indication of social presence. For example, well documented social loafing and lurking phenomena suggest that the strength of connection between two individuals in a group is higher in the cases where both participation and contribution are observed (Cress, 2005).

Figure nine shows that the tail in our social network analysis (the person viewing or responding to a post) may be either a read event or a post event, but the head (the artifact being responded to) is always a db poster. New topics are in this manner circular.

The two types of events analyzed in the social network analysis are `jforum.read`, which indicates one person reading another's post and `jforum.new`, indicating the creation of a new post. The new post is in response to another post if it is not the first post in a topic. The specific post it is in response to is discoverable by navigating backwards to the most recent preceding post in a topic.

Figure 9 - Read and response directionality, role and event type



As noted, the literature suggests that responses to another member represent a stronger tie than reading. We think of reading as participation, and posting as contribution. Representing this in the social network analysis, without overstating the increased strength associated with contribution is important to the objectives of this research.

The simple count of how many times one person reads and posts with another person in a completely online setting matters, and is in fact the measure of tie strength used in the papers that laid the foundation for this work. Somebody who responds 30 times to one individual, but always does so after two days may in fact have a strong relationship to that individual in this context, but possibly a poor internet connection.

The number of tie events between individuals, posting and reading, should also be measured. Posts or responses to another indicate stronger ties at this level of analysis as well.

Integrating the value of a response itself with the distance information available based on recency and post type was addressed in our analysis. The time dimension of the tie strength measure is a continuous variable that provides useful information regarding attentiveness and social presence between individuals. Event instances – the simple act of reading or posting without consideration of the time dimension – is a discrete variable: One event is one event. The type of discrete event may also reflect different strength of tie.

Tie strength for the total number of connections, then, has greater variability at the aggregate level - total ties between individuals and time distance between those ties, than the discrete read and post-type level. This difference in the analytical positioning of tie strength measurement has implications for the development of tools to measure group performance that will follow. The calculation of tie strength used in this report is described below.

Calculation of Tie Strength

To determine the tie strength measure to use throughout our social network analysis, we experimented with three different calculations, ultimately choosing the one that demonstrated the highest degree of differentiation among members within the network. The three measures used in our initial experimentation with these data are:

(Raw Tie Frequency) Raw number of reads and posts between individual members

(Raw Tie Time Lag) Average seconds of response from one individual to another

(Tentiled Time Lag) Tentiles of response time, with a score of 100 being applied to the top 10% of posts, and a score of 10 being assigned to the bottom 10% of event time since most recent posts.

Following our initial experiments, we disregarded raw tie time lag completely, as it distorted the strength of the relationship toward the time lag quite powerfully. We conducted more complete exploratory analysis on these combinations of measures:

1. Raw tie frequency and Tentiled time lag, with posts weighted double
2. Raw tie frequency alone, with posts weighted double

The tentilation of the time lag data modulated the distorting effect of raw time lag in our next experiments. However, the first experimental analysis still placed too much power in the time lag, simply because the raw numbers for the tentiles were larger than the raw numbers for tie frequency. We calculated descriptive statistics on the tentiled time lag and tie frequency with posts weighted double. The results are shown in table seven.

Table 7 - Edge list statistics used to calculate tentiles and weight the time distance as a component of total distance between nodes

		total_events	timeTentileWeighted_event_count
N	Valid	731	731
	Missing	0	0
Mean		29.29	47.6118672
Median		11.00	42.2222000
Mode		6	20.00000(a)
Std. Deviation		57.789	23.90848310
Variance		3339.597	571.616

Skewness		5.246	.617
Std. Error of Skewness		.090	.090
Kurtosis		41.670	-.267
Std. Error of Kurtosis		.181	.181
Minimum		1	10.00000
Maximum		736	137.87880
Percentiles	10	3.00	20.0000000
	20	5.00	26.4114400
	30	6.00	31.7466800
	40	9.00	37.0263600
	50	11.00	42.2222000
	60	14.00	50.0000000
	70	21.00	58.9176800
	80	32.00	70.7857300
	90	62.20	82.3211900

a Multiple modes exist. The smallest value is shown

A small number of participants in the online course were extremely active both posting and reading other discussion board posts. This is reflected in the dramatic difference between the mean and the median for the raw event counts (with posts counted at double strength). The mean is nearly three times the median. With the nature of this data better understood, our next goal is to choose a mechanism for appropriately weighting the raw tie frequencies dominantly, since the pilot studies for this research use only raw tie frequencies to measure strength of tie. Social presence theory (Kreijns, 2004) suggests that shorter time lags in an online context indicate a stronger tie.

We chose to derive a combined measure reflecting these goals in two parts. First, we normalized both measures by dividing each score by the median. This resulted in the

raw tie frequency being of nominally greater weight than the tentiled time lag overall, since the median for raw tie frequency is much lower than the mean. This appropriately accounts for edge cases that drove the mean substantially higher, and reflects a more network member focused, instead of statistically focused, measure of central tendency.

Second, we chose to make the measure of raw tie frequency three times as powerful in the determination of tie strength as the tentiled time lag. This choice is based on the pilot study, which relied solely on raw tie frequency. With both of these factors in play, the resulting data are heavily biased toward the raw tie strength for parties with many raw ties, but acts as a modulator for individuals with infrequent connections (below the median of 11), adding considerably to the weight of those relationships. The resulting distribution of the data for these measures is shown in table eight.

Table 8 - Normalized Edge List Weighting Statistics, Posts Double Weighted, Across the Whole Course

		normalized_total_events	normalized_timeTentile Weighted_event_count
N	Valid	731	731
	Missing	0	0
Mean		7.989303	1.13361588658718
Std. Error of Mean		.5829306	.021054456924066
Median		3.000000	1.00529047619000
Mode		1.6364	.476190476190(a)
Std. Deviation		15.7607022	.569249597544453
Variance		248.400	.324
Skewness		5.246	.617
Std. Error of Skewness		.090	.090
Kurtosis		41.670	-.267

Std. Error of Kurtosis		.181	.181
Minimum		.2727	.238095238095
Maximum		200.7273	3.282828571429
Percentiles	10	.818200	.47619047619000
	20	1.363600	.62884380952340
	30	1.636400	.75587333333340
	40	2.454500	.88157999999960
	50	3.000000	1.00529047619000
	60	3.818200	1.19047619047600
	70	5.727300	1.40280190476220
	80	8.727300	1.68537452380940
	90	16.963620	1.96002833333360

a Multiple modes exist. The smallest value is shown

The same method was used for the determination of distance weights within modules. Descriptive statistics were calculated for the module set, and the resulting medians were used to determine the appropriate weights. In this manner, the measures within modules are internally consistent for the social networks developed in that subset of time, and distinctions between participant relationships within those time-bounded parts of the course (modules) will reflect only the relationships within that module. Those details are outside the scope of this report. In summary, our method of determining tie strength improves upon prior methods by including a time dimension as a component of tie strength.

In summary, we are using a measure of tie strength that improves upon the methods used in prior studies. The method used to calculate tie strength mitigates against the possible introduction of issues that would limit the opportunity for this study to benefit from the established process used in the pilot studies. We do this by relying

mostly on those established measures, but using time between posts to identify possible contrasts in tie strength not revealed in prior studies.

Description of Each Social Network Analysis Method

Social network measures to be utilized in the data analysis were explained conceptually earlier. In this section, our objective is to elaborate on the specific methods utilized to conduct social network data analysis. All social network statistics were calculated using UCI*NET for Windows, version 6.207. All diagrams were developed using NETDRAW.

Some social network measures evaluate the total network, others look at the nodes, and still others measure or speculate on subgroups. We will look at node level and subgroup level statistics when discussing the small groups in the case studies. Overall network measures will be discussed with quantitative statistics for all eight groups, following the detailed case studies.

SocioCentric Density, Overall Network Measure

Sociocentric density is a measure that describes the overall network, and will be applied to analysis of each module in the overall course. Denser networks have more ties, while sparse networks have fewer ties. The networks evaluated in this research are valued networks. Valued networks will have continuous relations between nodes. The strength of tie calculations discussed previously implicates the network as a valued network. For calculating network density, however, these values are dichotomized. A network with every node connected to every other node would be very dense. Since the network in this study is small and closed, higher network density measures are expected.

Network Centralization & Degree Centrality: Overall Network Measure With Node Level

Statistics

Centralization is a measure of the network itself, while degree centrality measures the relative position of nodes (participants in the online groups) in the network. Higher degree centrality means that a person is more or less central to the network. There are two types of degree centrality – in degree and out degree. High in degree centrality implies that an individual is looked to by others. High out degree centrality suggests that a person is in contact with many of the nodes in the network with high frequency.

For examination of completely online small groups, our analysis of network centralization takes place at the whole course level. Network centralization measures the consolidation of power in a small number of participants. High network centralization suggests power concentration; low network centralization suggests diffusion of power. The interpretation of group social network positions and degree centrality is addressed in research question five.

When the analysis shifts to the individual and individual group memberships, in degree and out degree centrality are salient measures. Degree centrality suggests differences between individuals within a social network. For example, in Module five, members of each small group interact with two other small groups. Individuals with high in degree centrality may have a more central role across these activities than a member with lower in degree centrality, since the number and strength of connections will be higher for individuals whose posts are read by more members. If a member of one small group launches the lesson for two other small groups, they will likely show up with higher in degree centrality than a member who does not because a large number of people will be reading their posts. In contrast, if one member of a group is responsible for

making posts to all three discussion boards in module five, they are likely to show higher out degree centrality than their peers.

Betweenness (Freeman Betweenness Centrality), Node Measure

Freeman betweenness centrality is an individual measure of centrality. If a person is the lone connection between two canonically distinct social networks, that person has high betweenness. For example, if all interactions in the course were mediated by the instructor, the instructor would have high betweenness and the other members of the collaboration would have very low betweenness.

Core-Periphery, Node Measure

There are two types of core-periphery measures, categorical and continuous. Our analysis will focus on categorical core-periphery measures as defined by Borgatti & Everett (1999). Categorical core-periphery measures provide a high level analysis of which course members are part of small, dense networks that access a wider range of other course members. The core is an internally dense network that also has members who are connected to the non-core members of the course.

Subgroups and Cliques, Subgrouping Measure

Two social network analytical measures are used to identify whether groups defined a priori are identifiable from the social network data. Finding a priori groups in some cases will help build understanding about the applicability of these algorithms to the study of completely online groups. Identification of differences in the discernability of the three case study groups using these methods will help to paint a more complete picture of group cohesion in the case studies.

F-Groups

F-Groups are a social network analysis technique that takes advantage of the value data we have available to describe ties between individuals and incorporate the notion that larger groups are composed of triads. F-Groups identify strongly transitive and weakly transitive subgroups in a network without a priori definition of those subgroups. A strongly transitive tie is one where if there is a tie XY and a tie YZ, there is also a tie XZ that is equal in value to the XY and YZ ties together. A tie is weakly transitive if XY and YZ are stronger than the XZ tie, but XZ is still higher than a cutoff value (Hanneman & Riddle, 2005). The network data for each module is run through F-Group analysis in UCINET, and that analysis is presented in the case studies and referenced in the significant findings in this report.

Factions:

Factions are an experimental social network statistic that partitions the social network in to an a priori specified number of subgroups. The algorithm seeks a minimal value, therefore there will be many different subgroupings returned for each factional analysis. The subgroups will not always be the same. Identification of the most appropriate number of subgroups for a data set involves trial and error. When the factional analysis returns 1 or 0 errors at the end of the analysis run, the number of factions is near optimal. The most cohesive subgroups are returned by finding the minimum number of subgroups that return 0 or 1 error at the end of the run (Buckner & Cruickshank, 2008).

Since factional analysis will return different subgroups on every run, seven to 14 runs were made for each data set. If the same subgroups are returned with some

frequency, or in the case of our analysis of completely online small groups, if members of a group end up in the same faction consistently, this may be interpreted as an indication that the a priori defined subgroups are identifiable from the activity logs CANS provides. If some groups are identifiable using factional analysis while others are not, this suggests a divergence in the cohesiveness of those two groups. Factional analysis is conducted for the course, and described in the context of the three case study groups.

Social Ability, Group Efficacy and Information Horizons Survey Data Analysis

For the Social Ability and Group Efficacy surveys, responses were gathered prior to collaboration in small groups, and toward the end of small group collaboration. T-Tests were conducted on both measures. Twenty-Three of 25 course participants responded to these two surveys.

The social ability T-Tests and statistical tests for significance by individual item and social ability factor were calculated for the entire course using SPSS. The group efficacy T-Tests and statistical tests for significance by individual item were also calculated for the entire course, using SPSS.

Throughout the social ability data, lower numbers represent higher factor scores. This is consistent with likert scale mapping from 1 to 7, with 1 representing “strongly agree”, and 7 representing “Strongly Disagree”. In the case of two factors, Written Communication Skills and Comfort Sharing Personal Information the scale indicates higher social ability when inverted. This is the result of the ways the questions were asked. In our analysis, we have inverted the scores so they are consistent with the other three factors.

Information horizons surveys were conducted following information horizons interviews with three course members. Their description of within course and out of course information resources were integrated into a survey that 20 of 25 course members responded to. Information horizons interviews and survey data are presented in the three case studies, as well as in the context of the entire course.

Chapter Summary

This chapter explains the research context, sample, data collection and data analysis strategies for this study. The study took place in an online course at the University of Missouri during the summer of 2008, using Sakai and CANS. The sample included 24 of 25 student participants in a summer course. The students participated in the course, completed surveys on social ability, information horizons and group efficacy, and a participated in telephone interviews. Top down and bottom up ethnography and content analysis was used to analyze the artifacts of online collaboration. Statistical and ethnographic survey methods were used to analyze survey data for social ability, information horizons and group efficacy. Interaction data (CANS) was analyzed using techniques of social network analysis. The method used for processing and analyzing social network data derived from CANS logs was explained, and the basis for specific choices in this analysis was described. Together, this data set and analysis represents a rich view of completely online group development in a course context.

CHAPTER IV

Chapter Four – Results

Overview of Chapter 4

Research question one seeks to build knowledge about “completely online group development” by examining social identity, group cognition and social network structure. Research questions two, three and four, explore the relationship of social ability, information horizons and group efficacy to online group development. A quick reference of the constructs addressed in each research question is presented in table 9.

Chapter 4 starts with three case studies of groups within the course and uses content analysis to build understanding of social identity and group cognition. We use social network analysis to expose social network structure in the groups.

Table 9 - Summary of Constructs in Research Questions: Quick Reference

Core Construct in Question	Core Constructs Addressed in Sub questions
Question 1: Group Development	Group Cognition Group Identity Social Network Structure
Question 2: Social Ability	Participation Group Development
Question 3: Information Horizons	Group Development
Question 4: Group Efficacy	Group Development
Question 5: Social Network Structure	Group Cognition Group Identity Information Horizons

Following the case study reports, data from all eight groups in the course are analyzed and presented at the small group, whole course, and individual unit of analysis. Group distinctions are discussed in the final section of the chapter, which looks across the entire course and the full range of research questions.

Case Studies

To set the stage for connecting the rich, phenomenological construct of group development to social ability, information horizons and group efficacy measures we open this chapter with case studies of three of the eight small groups: Individualist Group, Barriers Group and Get-Along Group.

The three cases enrich our understanding of group identity formation and knowledge construction, but also provide the strongest format for presenting findings focused on the small group unit of analysis across our range of research questions. Each case emerges from the data and tells the story of one small group. A description of the group's trajectory and a characterization of the themes and patterns that help to define each group's experience rounds out each case. In each case study, data that directly address our research questions are presented, though each question is not addressed by each case.

The three case studies add richness to quantitative data by describing social identity, knowledge construction and social network structure that emerges from ethnographic and interview data. The case studies are the story of the practices that contribute to group development for three of the groups. They also provide phenomenological descriptions of that group development and its relationship to group social ability, information horizons and efficacy.

A Note on the Use of the Term "Performance"

At times in this chapter we use the term "performance" to describe the results of group activity. All assignment performance measures for group work and survey scores are relative: they compare the groups in the study context with each other.

Case Study of Barriers Group

Activity in module two centered on a structured debate between two groups. Barriers group performed poorly in the debate. During the module and upon reflection at the end of the module, Barriers Group members described their work as shallow and not well developed. In the last activity of module two, a third party (another team in the course) evaluated the arguments of each team in a specific instance of the debate (there were four debate instances, two teams each). The rater had the task of dividing 10 points between the two teams in the debate. In many cases, the points were assigned 5-5 or 6-4 between the two teams in an argument. Barriers group's reviewers judged that they lost the argument 3-7. The text of a feedback from the reviewing team to Barriers Group reflected this poor showing:

Although [Barriers Group] made several good analyses, they failed to properly explain or go further to support their critique. The structure of the arguments was so confusing that it was very difficult to follow what point was being argued, much less whether an effective argument was being made.

Barriers Group emerges from this inauspicious beginning.

Introducing the Members of Barriers Group

Malakai

Malakai is a European female over the age of 40. She has pursued graduate education for a number of years, lives on campus, and is now in the middle of a PhD program. Malakai is eager for Socratic dialogue and a disciplined examination of research questions. Her online style is forthright and determined. Malakai has lived in the United States for a number of years. Notably, Malakai is an experienced, highly motivated doctoral student.

Steve

Steve is a Middle Eastern professional male and is seeking a PhD in the same department as Malakai. He is between 30 and 40 years old. Steve's English reading and writing skills are not as advanced as Malakai's; his admission to the program required that he actively develop his English skills. Steve's goal is to advance adult education in his home country. Steve is brand new to the PhD program, and is in the process of understanding what it means to be a doctoral student.

Yoda

Yoda is an Asian female, under 30, who is pursuing a master's degree. Yoda's partner is pursuing an advanced degree at the same university that Yoda attends. Yoda's expressed interest at times is to obtain a degree with the least possible effort, and as swiftly as possible. Yoda's scholarly practices are not as advanced as Malakai's or Steve's. Yoda, like Steve, is still learning to communicate effectively in written English.

There are three important points of diversity in the group. First, there is age diversity ranging from a young masters student to a PhD candidate with a great deal of life experience. Second, the members are from three distinct parts of the world: Europe, Asia and the Middle East. Third, the members of this group are at different stages in their graduate education: Early Masters, Early PhD and late PhD. The gender composition of the group is also as diverse as possible, with two females and one male. While the gender contrast is notable, it does not emerge from discussions with members or analysis of discussion board data as a significant factor in the group's development.

Description of Barriers Group Development

Trajectory

Barriers group's collaboration included some early warning signs that there could be difficulty. Most easily observable were low participation rates and the geographic dispersion of the group.

Early levels of participation and contribution by members of Barriers Group were not consistent. Member participation and contribution levels aligned very closely late in the course. Some of this change may be attributed to the complete breakdown in Barriers Group's ability to function, and the subsequent corrective behavior of individual members seeking not to be identified as the source of the earlier breakdown.

Two members of Barriers Group are in situations for collaboration that complicate the group's development. One member, Yoda, is in Asia for the first 3 ½ weeks of the team's collaboration. In addition, both Steve and Yoda are taking three graduate school courses over the summer, placing exceptional time pressure on them. This time pressure has the greatest impact at the very beginning of the course and in the middle of the course, around module four. Yoda describes her workload at that time as overwhelming, and actively seeks participation that is more efficient. She describes her group as inefficient, and suggests this inefficiency is a key component of the group's troubles:

Researcher: So, um, how was your experience in the group? How did you, did your group come together and have an idea that you all agreed to in the debate?

Yoda: Because it is not efficient, we did not get time before the deadline. So we did not have much time to get a real consensus.

Researcher: Okay.

Yoda: So I mean, some parts were just from me and some from other people so we hadn't time to agree on each part.

Analysis of the interactions across the course and discussion with other members suggests strongly that the fundamental issue is not one of efficiency, as Yoda describes, but one of different expectations for participation. Malakai sees the same events from a different perspective:

Researcher: How do you think the actions of the other team mates affect your ability to work together as a group?

Malakai: Its obviously destroyed our ability to work as a group. On the other hand, I had hoped among the more hopeless situations, so I will keep trying different ways to reach them . I think I have come to the point now where I have recognized their abilities, their limitations, their perspectives, and I work within that framework.

These early struggles become a sustained theme in the relations between members. There is no evidence that the members ever align around a common understanding of why they struggle; they simply accept that they struggle. By the end of the collaboration period, nearly seven weeks after it began, Yoda and Malakai express general disrespect for each other in group communication and in the interviews, with Yoda characterizing Malakai as bossy, and Malakai reporting disinterest in the course material and collaboration from Yoda: *“Yoda did not show up. She messaged Steven and I later, saying that “I am not in the mood for a meeting””*.

Barriers Group Themes and Patterns

Two patterns and three themes emerged from analysis of Barriers group’s data. They are as follows:

1. Pattern – Tools as Power Proxies
2. Pattern – Capacity and Performance Incongruity

3. Theme – Cultural and Interpersonal Aspects of Performance
4. Theme – Exaggerated Punctuated Equilibrium
5. Theme – Physical Distribution Changes

Pattern – Tools as Power Proxies

Barriers Group's choice of collaboration tools was directed by Malakai, and perceived by Yoda and Steve as an explicit exercise of power. Malakai selected a tool that required the team to gather, synchronously, around her desktop. The resulting artifacts were then in Malakai's complete control. Yoda characterized this as a controlling decision on Malakai's part. Yoda notes:

Yoda: Because it just allows one person to input, the other person can't just give the ideas, but they cannot involve typing also, so I don't so much like that software, I like Google Document more. [the tool] makes [Malakai] a team leader, because [Malakai] brought up the idea. So she looks like the team leader, and she asked Steven and me about our ideas.

Researcher: So do you think that was helpful and positive for your group, or do you think that...

Yoda: Originally I thought it was positive, but it was easy for, I mean it was easy for [Malakai] to feel like she has taken to much work, or she can lead the other two, so I still like Google Documents, so that every member of the team have the right to login and to edit, and to work on the document.

Researcher: So [the tool] provided a command and control sort of, a here's the view you two people look at it and I'll guide you through it. Whereas Google Docs seems, perhaps more Egalitarian, in that each group member can contribute as much as they choose. So shared view is a more controlling technology.

Yoda: Ya

The framing of tool selection as a move for power occurs in a later discussion with Yoda.

The same tool is initially well received by Yoda:

Yoda: I think in this group, the style... The efficiency has changed a lot. In the very beginning, it's very difficult to have a meeting, or get a consensus, or it's time

consuming, but now it's much easier to see the obvious change because we use Skype and [the tool]. So for me, I strongly recommend it, the online meetings.

Researcher: So you found ways to use technology to improve the quality of your group's work?

Yoda: Yes, so in the future, I believe I will have more chances to collaborate in groups online, so I will choose technology to assist our group's communication.

Researcher: ..And how have [the tools] affected your groups development?

Yoda: I think it's more because of the change of tools. The tools itself is efficient because it gives us a stronger sense of we are in the same group. We are discussing the same product. You can feel the stronger sense that you are in the same team and we need to work hard together..

The evolving view of tools used by Barriers Group appears to be a function not just of the tools themselves, but of the interactions they enable between group members. At first, Yoda thinks that the collaboration through these types of tools is interesting and powerful. Later, after the people in her group use the tools in a manner that Yoda does not care for, the same tools are viewed differently. At each point in time, the tools are viewed as powerful. It is how the individual members of Barriers group adopt and adapt to those tools that influence group development.

Once technologies were adopted by the group, the ways that members used, or sometimes did not use those technologies influenced interactions among members and contributed to an environment of low trust in Barriers Group. Barriers Group members appreciated that tools made life easier but eventually noticed and were unhappy with the perceived infringements on their individual participation wrought by those tools.

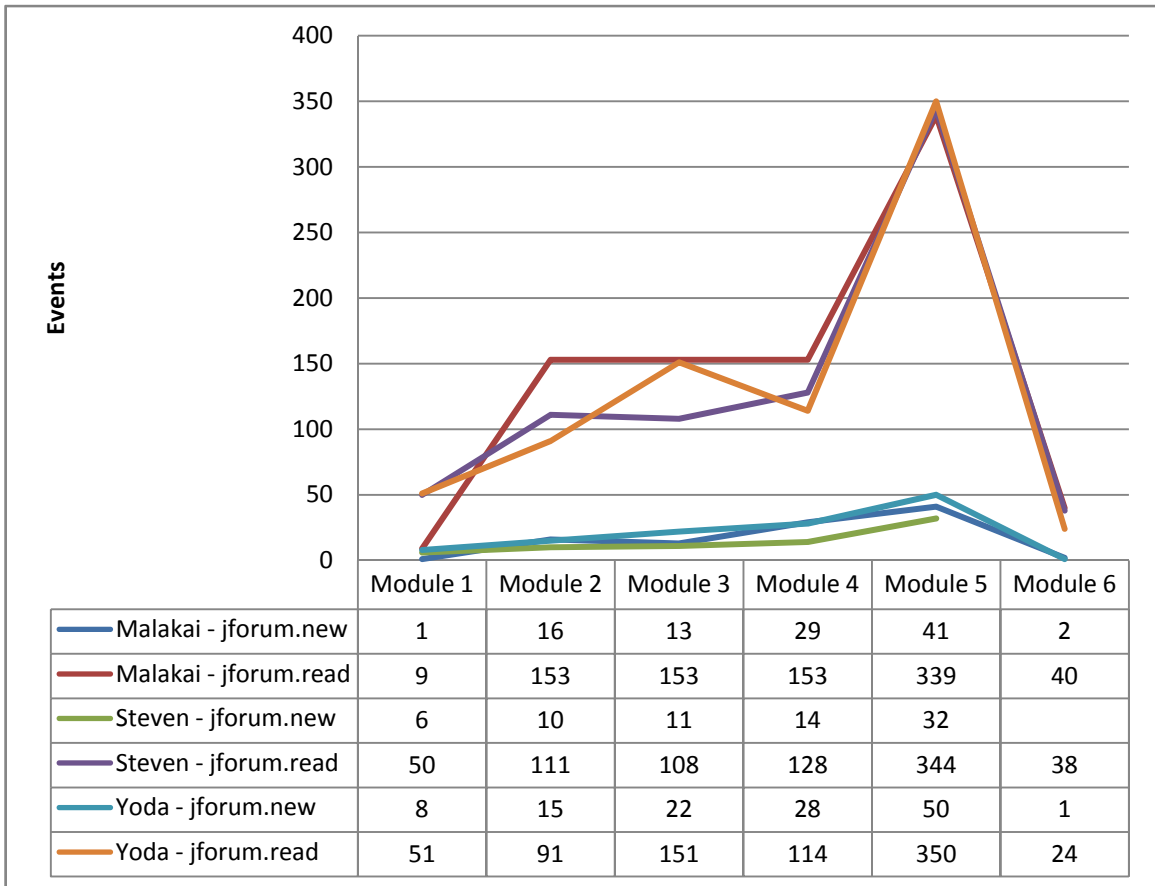
The asynchronous nature of the Sakai system and the openness of the instructor toward using additional tools for synchronous collaboration and shared editing created an environment where members had the power to negotiate with each other about what tools

would be used. A more passive, less engaged member like Yoda was enticed initially, but later regretted the tool choice. This type of tool negotiation is more common in distributed work settings, though our observation of it within these completely online groups provides insight about the power exerted by tool choices in completely online relationships.

Pattern – Capacity and Performance Incongruity

Barriers Group’s experience reinforces prior studies that suggest asynchronous collaboration by distributed teams can mask performance challenges, making them visible only when deadlines are missed. In the case of Barriers Group, it appears that success behaviors were easily “faked” by members who made periodic posts to course discussion boards but were seldom online. Evidence from CANS logs suggests that Barriers Group members were, in fact, “skipping virtual class” with frequency early in the eight week period. The module one participation rates for Barriers Group members are particularly low, as illustrated by figure 10.

Figure 10 - Barriers Group Member Raw Participation and Contribution Rates



The mean number of read events for groups in module one (before they were group members) is 324. If we add up the module 1 events from Figure 10, we see that Barriers Group’s members had 110 read events between them during that time. Barriers Group’s participation is therefore slightly more than 1/3 of the mean, suggesting that participation challenges existed for this group’s members prior to the origination of the group.

While member behavior suggests that full effort was not applied to their early collaboration, this is not the end of Barriers Group’s non-performance story. Several indicators also point to an overall low performance by Barriers Group members in the course. Steven and Yoda’s final scores in the course were a full standard deviation lower than the 25 student mean of 97.6. Steven and Yoda were contributors to the group

assignment in module four, which the group did well on, however. As noted in the opening vignette, the performance of the group on their first group task – the debate – was also plagued by low performance.

Both work product quality, measured by peers and using our rubric, and participation, measured through CANS logs, Barriers Group starts out at the low end of the range for the eight groups. Though their performance ultimately does increase, following a highly disruptive series of events, the discord forged at the beginning is sustained through the end. Further, it appears that the elevation in group performance is driven by Malakai, while the elevation in group participation is a characteristic of each member, driven by the external force of the group's discontentment requiring instructor intervention.

Theme – Cultural and Interpersonal Aspects of Performance

All of Barriers Group's members speak and write English as a second language. This emerged as a performance factor. Yoda reported that because her English is not that good, she frequently missed important issues and created misunderstandings among her fellows in this course and others. Both Steven and Yoda express little confidence in the written communication skills on the social ability survey at the beginning of the course (these results will be discussed in the next section).

It is also notable that Barriers Group's members are each from distinct cultures outside of North America. Two of the members observed that culture may have been a factor in the ways they used technology to collaborate. Yoda sees the intersection between culture when she is in her native Asia and her participation in the course at that time:

Yoda: It changes. My feeling change. When I was in [Asia], my sense of the group was weak, but when I come back, I feel a stronger connection to my team members.

Researcher: What do you think that stronger connection comes from?

Yoda: Because I am in America. The geographic connection is closer for me.

Researcher: Is that related to the times zones or the technology being connected better or...? What aspects of the geography makes the biggest difference...?

Yoda: Both of them, because you know, almost all the members are in America and it's only me in another foreign country. So, um, the intercultural environment is totally different. So, I can tell you, in [Asia] I am another Yoda. The feeling is totally different. Like, in [Asia], I use [native language] to [speak to] other people, but in Sakai I have to use English. So uh, I need to change, I need to transform my mind. So when I was in [Asia], it was harder for me to concentrate with online, than when I am here.

Malakai suggests her European heritage interacts with Yoda's Asian heritage in Barriers Group:

SO this time I asked her (an Asian friend) what's going on and she looked at what Yoda was posting and was doing and she told that Yoda is very spoiled. [in her culture], no matter how ugly you are you can get any man. So, she said that Yoda is very spoiled by that. She thinks she can get away with anything. She has used many manipulations "I don't speak English" and everything else. That gave me another insight into the culture. The gender, I think that if Yoda had been a man, Steven would not have helped the man as much as he helped the woman. I think gender did make a difference as well. And, of course, I am [European], and [in my country] people are very upfront people and that doesn't go well with someone who has a public person versus private persona.

Whether or not culture is an actual factor in the interactions of the members of Barriers Group, both Yoda and Malakai believe it to be a factor. While some of Malakai's statements may be difficult for the reader to digest objectively, recall that in the interview she is struggling to explain the factors influencing her group's development. Whether or not some of the negative stereotypes are salient is not as germane to our research

questions as the beliefs Malakai and Yoda have, and how those beliefs take flight through interactions online.

Data also indicate that members had different expectations about how to use technology and whether the technology used for collaboration should be synchronous or asynchronous. Yoda, Malakai and Steven all noted that beginning to interact synchronously helped the group to develop. This did not occur until the middle of the course, as attempts to collaborate with Yoda while she was still in Asia were not effective.

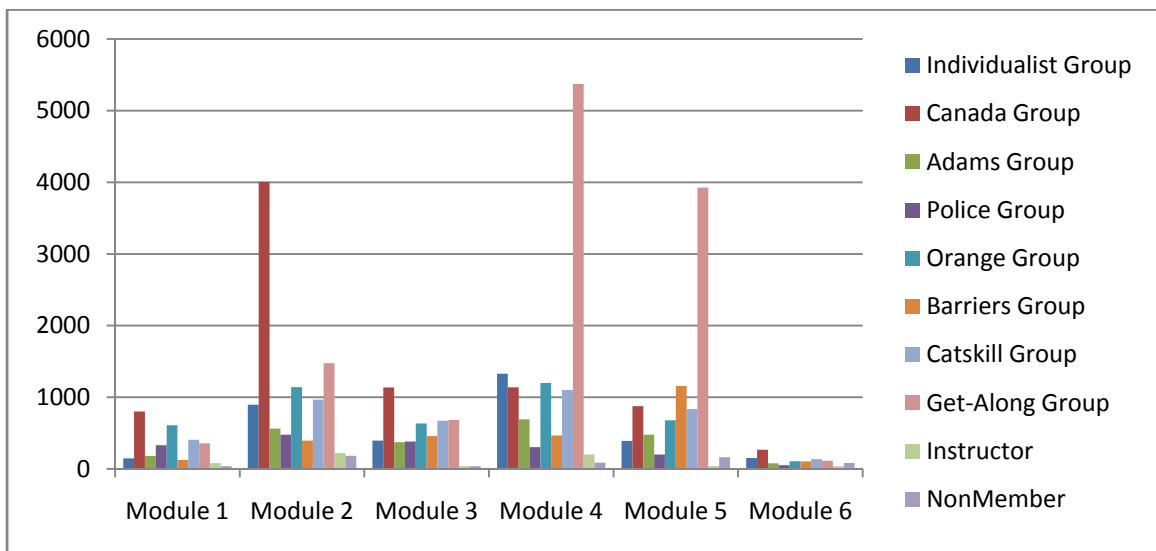
Member expectations about what qualifies as acceptable performance were visible, and some members connected those differences to age and cultural factors during interviews. Yoda and Steven characterized their performance throughout the course as acceptable. Malakai characterized Yoda's performance as unacceptable. Review of the ethnographic analysis from discussion boards, interviews and course reflections suggests that Yoda does have a lower performance standard than Malakai. Yoda sought efficiency, while Malakai sought excellence in the group's work. This difference in views remained unreconciled, even through Barriers Group's difficult time in Module four, characterized below as exaggerated punctuated equilibrium.

Theme – Exaggerated Punctuated Equilibrium

One might view the developments of the Barriers Group through the lens of Knowles & Knowles (1955) Storming, Forming, Norming, Performing model of group development, or through Gersick's (1988) punctuated equilibrium model. The data show low collaboration, low performance and low interaction among the group in the early part of the collaboration. There is less storming and forming than ambivalence evident in the

data. For example, Barriers Group member total interactions online are the lowest among the eight groups in the first three modules where collaboration takes place. It is also second lowest in the first module, suggesting that the members of Barriers Group entered the collaboration with an existing pattern of low interaction. This is illustrated in figure 11, which shows that Barriers Group members were quite low in participation in module's one, two and three.

Figure 11 - Total Events in Course Management System by Module and Group



Storming and forming requires the presence of ideas that compete for attention of the team, and active negotiation between those ideas. Gersick's theory of punctuated equilibrium, in contrast, suggests that a team forms into some structure at the beginning, possibly by happenstance or accident, then continues in that structure until a disruptive event ruptures the structure.

Given the slow, statistically ambivalent start of Barriers Group, they seem to follow Gersick's punctuated equilibrium trajectory more than the Knowles & Knowles model. Like Michinov & Michinov (2007), who studied partially online groups, Barriers Group experienced a more exaggerated mid-collaboration punctuation than what is

reported in Gersick's physically co-present groups. Late in module three the group experienced a complete breakdown that required instructor intervention. This followed a series of struggles for control of the group, including acts of non-participation by Yoda and Malakai's rejection of Steven's attempt to assume a leadership role. Malakai explains:

What I saw wasn't that he was being optimistic, he was being critical. He was being critical of the leadership that he perceived in section-. In any case, I did not see it as he was being optimistic; I saw it as because in module 2 he simply disengaged. He was critical of leadership. I did not want leadership. I would have liked to be a knowledgeable reference but I was not interested in leadership because my perception of collaboration is that we are all leaders. I see a leader tells people what to do more as hierarchical. That came out in module 3. In module 3, he decided he was going to take over. He was going to be the leader and tell us what to do. What happened is he misunderstood the assignment and Yoda did not want to bother. She just wants to skim, do the minimum she can. What she does is read all the posts and simply regurgitates and you don't really see the depth of thinking that we would hope to have in this class. What happened is that they both partnered up and kept trying to tell me to basically be quiet and go with the program. As it turned out, they were wrong. What they were trying to do is take the story we had to read and they were trying to divide them. Essentially Steven took a list of the stories and said "Malakai you work on these, Yoda you work in these, and I work on these." For me, the question was "How can you delegate stories to be read among different team members when you are supposed to come up with a consensus?" Consensus means make a knowledgeable decision. If I haven't read a story, how can I make a knowledgeable decision? I was very perplexed that that is what they wanted to do.

At this point in the collaboration, the group ceases to function effectively, alienation is evident between Malakai, Steven and Yoda and the possibility of the group productively continuing its work without intervention becomes very low. The instructor intervenes, and the group is returned to a workable trajectory.

Perhaps the exaggerated adjustment of Barriers Group is just as great as their dramatic breakdown. Following instructor intervention, their rates of participation and contribution in the online course are more closely aligned than members of any other

group. They dutifully, if unhappily, make their group work. One possible cause of Barriers Group's breakdown is the change in the nature of their distribution. The distribution of the membership changes during module three from a completely online group, to a group where two members, Steven and Yoda, are located in the same on campus office building. Their workstations are separated, but casual access to each other becomes a dimension of the group's development.

Theme – Distributed Team Distribution Changes

Barriers Group is the only group for which the nature of their distributed configuration changed during the collaboration. They are, in fact, the first group to become partially non-distributed in our five studies of completely online groups.

Changes in group distribution contributed to already low levels of trust among group members. When the change occurred, Malakai had just taken a more central leadership role that Yoda initially welcomed. This change in distribution led to Malakai perceiving that Steven and Yoda were collaborating with each other to steer the direction of the group toward a less engaged and more task-satisficing mode of operation.

Whether or not this is the case is difficult to determine, but the phenomena of two members becoming physically co-located had the effect of reducing trust in the group.

Subsequently, Barriers Group experienced a rapid succession of group heaves. This started with the welcoming of a member who took on a leadership role (Malakai), followed by the change in distribution, during which Yoda and Steven ended up in the same building, on the same floor. Shortly after the change in physical configuration of the group, Steven and Yoda referenced the group leader as "Bossy", and instructor intervention followed.

The effects of this change in distribution are intermingled with what was already a group of multi-tasking, overbooked graduate students. What role the change in distribution played in Barriers Group's breakdown is difficult to know, but informant interviews and examination of the data suggest that this change in distribution resulted in lowered trust levels, which may have been sufficient to trigger the subsequent breakdown. A quantitative view of our research questions is presented next to help build understanding of Barriers group.

Quantitative Data for Barriers Group

Knowledge Construction

Content analysis, field notes, interviews, reviews of participant participation and contribution trends clearly show that this group had lower quality and lower volume of knowledge co-construction early in their collaboration. For the whole course, Barriers Group’s knowledge construction, measured through content analysis methods described earlier, is lower than the other two case study groups. Krippendorff’s (2004, p. 227-230) reliability formula, referred to as Krippendorff’s alpha, was calculated for the knowledge co-construction codebook for all three case study groups. This is a measure of the reliability of the codes chosen by two raters. This Krippendorff’s alpha produced a coefficient of 66.9% for initial codes and 96.9% for codes after reliability discussions. Following instructor intervention, Barriers Group’s knowledge construction became the highest among the three case study groups, which is evident by comparing the “Mod 5” column in table 10 with the Overall and “Mod 4” columns. The change in knowledge co-construction by each of the three case study groups is displayed in table 10.

Table 10 - Overall Knowledge Co-Construction For Case Study Groups

	<u>Overall</u>	<u>Mod 4</u>	<u>Mod 5</u>
Barriers Group			
ph1	88.2%	96.0%	80.2%
ph2	9.4%	4.0%	14.8%
ph3	2.5%	0.0%	5.0%
Individualist Group			
ph1	81.4%	85.1%	90.9%
ph2	10.3%	11.8%	10.1%
ph3	8.2%	3.1%	0.0%
Get-Along Group			
ph1	85.8%	84.8%	91.4%
ph2	9.1%	9.0%	5.1%
ph3	5.1%	6.2%	3.5%

Individual members of Barriers Group had posts that demonstrated different levels of knowledge construction. Overall, Malakai’s contributions included the lowest percentage of “PH1” posts, which represent the lowest knowledge co-construction code in Gunawardena’s (1997) coding scheme for online knowledge co-construction. The full codebook is available in Appendix I. The member by member distribution of knowledge co-construction codes for Barriers Group is shown in table 11. This table shows that Malakai’s percentage of PH1 contributions are lower than Steven or Yoda’s, that her PH2 contributions are higher and that the PH3 contributions are equal for all three.

Table 11 - Barriers Group Member Knowledge Co-Construction

Row Labels	Grand Total	Ph1 Pct	Ph2 Pct	Ph3 Pct
Malakai	80	77.5%	16.3%	2.5%
Steven	48	93.8%	4.2%	2.1%
Yoda	81	88.9%	4.9%	2.5%
	1			
Grand Total	210	88.2%	9.4%	2.5%

Group Identity

Content analysis, field notes, interviews and reviews of participation and contribution trends within Barriers group all triangulate the finding that this group had the lowest level of group identity among all groups. Content analysis, in particular, shows a clear contrast in the communication between Barriers Group members and members of two other groups. Table 12 shows Barriers Group communicating at the group level far less frequently than the other two groups. The codebook for this analysis, found in Appendix I, was applied to the discussion board data by two interraters.

Krippendorff’s (2004, p. 227-230) alpha was calculated for the group identity codebook

for all three case study groups. This Krippendorff's alpha produced a coefficient of 92.9% for initial codes and 99.7% for codes after reliability discussions.

Table 12- Group Communication Level Using Tajfel Influenced Coding Scheme

	Barriers	Individualist	Get-Along
Small Group Communication	59.90%	85.11%	85.68%
Interpersonal Communication	39.13%	13.83%	12.24%
Interindividual Communication	0.97%	1.06%	1.30%

Barriers Group directs significantly less communication to its members than Get-Along Group and Individualist Group. Barriers Group stands out as a group whose member communication is less group focused. Another measure of the status of the group is its structural configuration, observable through social network analysis using CANS logs.

Social Network Structure

Member subgroup analysis provides a compelling measure of within group structure. If members do not consistently show up together in their a priori assigned groups, this is an indication that group members are not attending to the same material, or directly responsive to each other in the course management system. For some groups, this could indicate that most collaboration takes place outside of the course management system. In the case of Barriers Group, we know from interviews and observation that most work did, in fact, take place in Sakai. Therefore, the social network analysis subgroup measures taken from CANS logs are pertinent.

Recall from our earlier explanation of factional analysis, that consistent grouping over several data analysis runs is a more powerful indicator of subgroup formation than any single data analysis run. For our analysis, we asked UCINET to cycle through the

data 2000 times on each run in order to identify the most likely factions. Factional analysis for Barriers Group is shown in table 13.

Table 13 - Summary of Factional Subgroup Analysis of Barriers Group

Module	Members in the Same Group	Run Percentage
Three	Steven and Malakai	85%
Four	Steven, Malakai & Yoda	14%
Four	Steven & Yoda	14%
Five	Steven & Yoda	57%
Five	Steven & Malakai	14%

Factional analysis, shown in table 13, suggests that Steven and Malakai form a cohesive subgroup in module 3, that no members form a cohesive subgroup in module 4 and that a subgroup of Steven and Yoda emerges in module 5.

F-Group analysis is another subgroup focused SNA method described earlier. F-Group analysis of Barriers Group shows that Barriers Group is in a cohesive subgroup that includes all of its members and the members of Get-Along Group in Module 5. Since Get-Along Group taught Barriers Group in module five, this phenomenon is partially explained by the structure of the course. No F-Groups exist in the course in any other module during the group activities that include any of the members of Barriers Group. In module one, both Steven and Yoda are in the same group. Since no F-Groups including members of Barriers Group emerge during other parts of the course, it is also likely that Barriers Group is actually attending to more of the same discussion board posts than they did before instructor intervention; And performing more like a group in module five.

Core-periphery, betweenness and network centrality measures focus on the overall structure of the network, and the position of course members in the overall course network. While the subnetwork structural measures characterize whether or not members

of Barriers group are “in the same group”, these others measures suggest their position in the context of a larger social organization. In this case the larger social organization is an online course.

Core periphery analysis shows that members of Barriers Group are not in the core for the course in most modules, but are all there in module 5. This is depicted in table 14.

Table 14 - Barriers Group Member Core-Periphery Analysis Across Modules

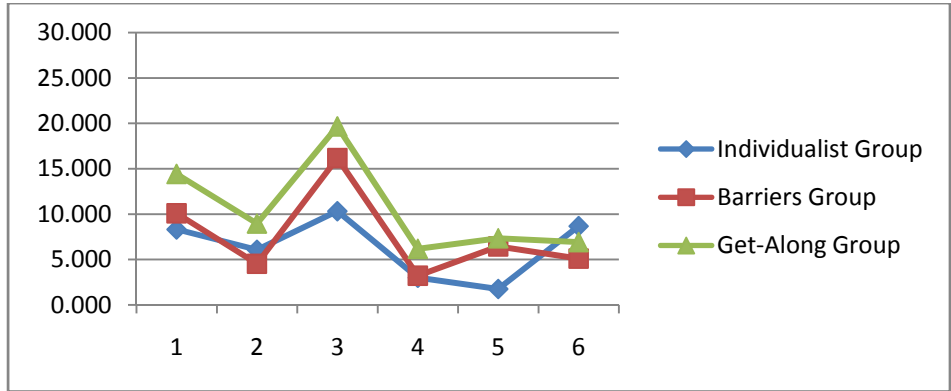
	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
Core	Yoda, Steven		Yoda		Yoda, Steven, Malakai	Malakai
Periphery	Malakai	Yoda, Steven, Malakai	Steven, Malakai	Yoda, Steven, Malakai		Yoda, Steven

This is consistent with the group coming together and participating at a higher level in the late stages of the collaboration, particularly relative to other groups in the course who declined in their participation between module four and five. It is possible that, at the same time that other groups were relaxing into a flow of collaboration, Barriers Group was emerging from severe conflict, with each member motivated to prove to the instructor that his/her behavior is now and always has been attentive, productive and contributing. Our prior analysis of CANS logs, work products and interview transcripts suggest that this re-defining of the group might, in fact, require the sort of extra effort that made Barriers Group a big contributor in module five.

Network centralization measures also corroborate the trajectory of participation by Barriers Group suggested by other data, showing them as a middle to low relative performer early, but on a sharp upward trajectory between modules five and six. Figure

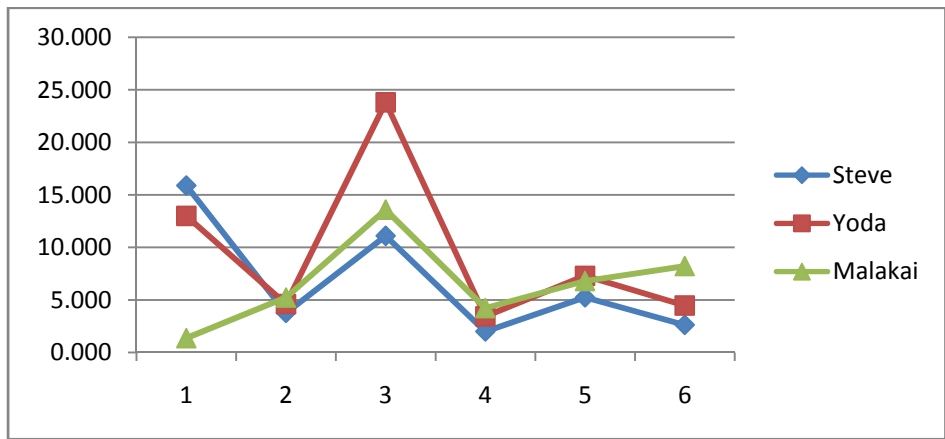
12 shows the distinct trajectory of Barriers Group’s network centralization in modules four, five and six.

Figure 12- Network Centralization for all Three Case Study Groups



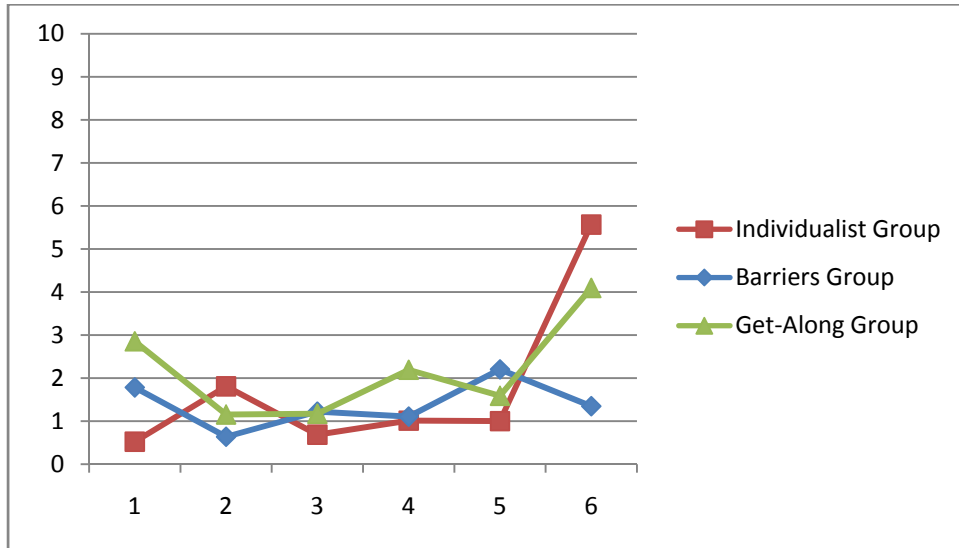
In module six course requirements were light. Barriers Group members participated at a higher rate and read more posts from other students. It is therefore not surprising to see this positive centralization trajectory for Barriers Group in Figure 12. This shows Barriers Group is more central to the network than Individualist Group or Get-Along Group for the first time in the eight week collaboration. Closer examination, in figure 13, shows that Barriers Group’s centralization is pulled up by Malakai in module six.

Figure 13 - Network Centralization Measures for Barriers Group Members



Betweenness, a measure of centrality focused on the extent to which group members make connections with others in the course, trends the opposite way as overall centralization in the three case study groups. Figure 14 shows that Barriers Group’s betweenness declines late in the collaboration.

Figure 14 - Betweenness Measures for Three Case Study Groups

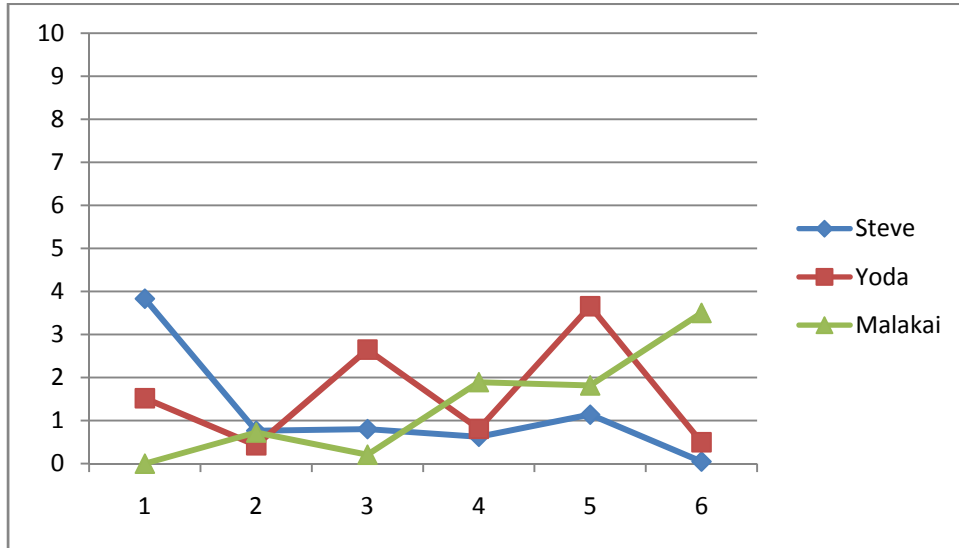


Barriers Group becomes notably more “between” nodes on the network in module five. To some extent, each of these centralization measures is confirming of the other. Since they analyze the same data for centrality differently, triangulating these SNA algorithms with each other adds a measure of validation to the conclusion that Barriers Group’s interactions in module five show marked improvement.

High betweenness is associated with a greater diversity of participation in this network data. An examination of the betweenness data at the member unit of analysis shows that Malakai’s betweenness increases in the latter part of the course, while Yoda and Steven’s decline. This is consistent with Malakai’s stated behavioral change, where she begins attending to members of other groups in order to have a rewarding experience in the course. Participating in multiple groups increases betweenness because the

connection between one member and other course members will be higher if the member participates in their own group and the larger course. Figure 15 shows that Malakai's betweenness shows a steady increase from modules three through six.

Figure 15 - Member Betweenness Measures for Barriers Group



The increase in betweenness in module five is a phenomenon lead by a single member:

Yoda. In module six, the change is attributable to another member: Malakai. This suggests the importance of attention to both small group and individual measures.

Changes to the group scores are positive in this case, but driven by a dramatic change in one individual. These increases, driven by single members, do not correspond with improvements in group development trajectories.

Social Ability for Barriers Group

Throughout the social ability data, lower numbers represent higher factor scores.

This is consistent with likert scale mapping from 1 to 7, with 1 representing “strongly agree”, and 7 representing “Strongly Disagree”. See Appendix A to review the questions.

In the next section, each of the five factors of social ability is reviewed for Barriers

Group members. Green shading indicates that the factor score moves in a pronounced way in the same general, improving trend as the overall course. Yellow shading and an underline indicate that the T2 score trends in the opposite, and a declining direction, compared with the overall course trend. This is the opposite of the overall trend in the course. Table 15 summarizes the social ability factor scores for the members of barriers group.

Table 15 - Barriers Group Social Ability Factor Scores.

	<u>Peer Social Presence</u>		<u>Written Comm. Skills</u>		<u>Instructor Social Presence</u>		<u>Comfort Sharing Personal Info</u>		<u>Social Navigation</u>	
Malakai	<u>2.82</u>	<u>3.32</u>	<u>1.00</u>	<u>2.00</u>	<u>1.00</u>	<u>2.68</u>	<u>2.07</u>	<u>2.73</u>	<u>3.27</u>	<u>3.42</u>
Steve	2.38	2.11	5.29	1.29	2.54	1.11	2.05	1.00	<u>2.62</u>	<u>1.00</u>
Yoda	<u>1.79</u>	<u>3.34</u>	4.12	3.73	<u>1.76</u>	<u>5.33</u>	<u>1.00</u>	<u>2.00</u>	1.97	2.89

Peer Social Presence

Barriers Group’s trend on the social presence factor of social ability is a decline from time one to time two. A decline in peer social presence is consistent with the difficulties encountered in the group, and Barriers Group’s general tendency, evidenced in the social network data, to not hold a central position in the course network.

Written Communication Skills

Member Malakai declined on written communication skills between time one and time 2, which only occurred for two other course members. Steven’s improvement is dramatic and Yoda’s is also substantial. Malakai’s decline is consistent with sentiments of frustration and despair expressed in the middle collaboration and post-collaboration interviews. Yoda’s increase is corroborated by her interview as well. She expressed increased confidence toward the end of the course.

Instructor Social Presence

Malakai and Yoda both declined in their sense of instructor social presence between time one and time two. The sharpness of this decline is remarkable. Malakai diminished from “1” to 2.68, while Yoda diminished from 1.76 to 5.33 on a 7 point scale. Steven’s sense of social presence of the instructor improved almost as much as Malakai’s declined, going from 2.54 to 1.11.

Malakai and Yoda were clearly frustrated with each other during interviews. They each held the other to account for the need to involve the instructor, and did not express satisfaction with the outcome of the mediation. The instructor does not have an interventionist style and clearly they each wanted the other’s behavior to change. This seems the most likely explanation for a sense of declining instructor presence. Upon looking to an authority figure to rescue their difficult situation, they were forced to address the uncomfortable challenge of completing their assigned tasks.

Comfort Sharing Personal Information

Like instructor social presence, Malakai and Yoda diminished, while Steve improved in his comfort sharing personal information. It is likely the explanation for this trajectory is the same.

Social Navigation

The course trend for the social navigation factor was diminishment. Malakai and Yoda diminished as well, while Steve’s factor score improved from 2.6 to 1. This suggests that social navigation practices generally improved in this group, while they diminished in general for participants in this online community. This appears consistent

with Barriers Group's subgrouping and centralization measures, which also suggested a general tendency of the members to look outside of their group for participation.

Information Horizons for Barriers Group

Malakai and Yoda both responded to the information horizons survey and participated in the information horizons interviews conducted in the course. As a result, we have deeper information regarding the members of Barriers Group than other groups, but we lack complete information since Steven did not respond to the survey. There is a pronounced contrast between the information resources that Malakai references and those that Yoda references. For example, Malakai is one of two people in the course who listed their spouse as one of their top five sources of information.

There is a trend in the information source differences between Malakai and Yoda, with Yoda's information sources dominated by tools, and Malakai's dominated by people. However, both Malakai and Yoda identified the instructor as one of their top five information resources. Another contrast is Malakai's listing "other people in their group" as a top resource, which is common (16 out of 20 information horizons respondents) in the course, while Yoda listed this resource as 20th out of 28. Yoda's top information resources were tool focused.

A particular oddity in Yoda's responses is her listing of the group's wiki as her third most relied upon resource when completing course work. This is worth noting because the group did not heavily utilize a wiki. This may be another example of Yoda's technology utilization not being in sync with Malakai or Steven.

The interviews for information horizons, conducted with both Yoda and Malakai, make the differences in how they use information even more striking. Figure 16 shows

Malakai's information horizons, which include references to individuals at one level, and electronic resources in general at the same level. Then, Malakai references specific electronic resources.

Figure 16 - Malakai's Information Horizons

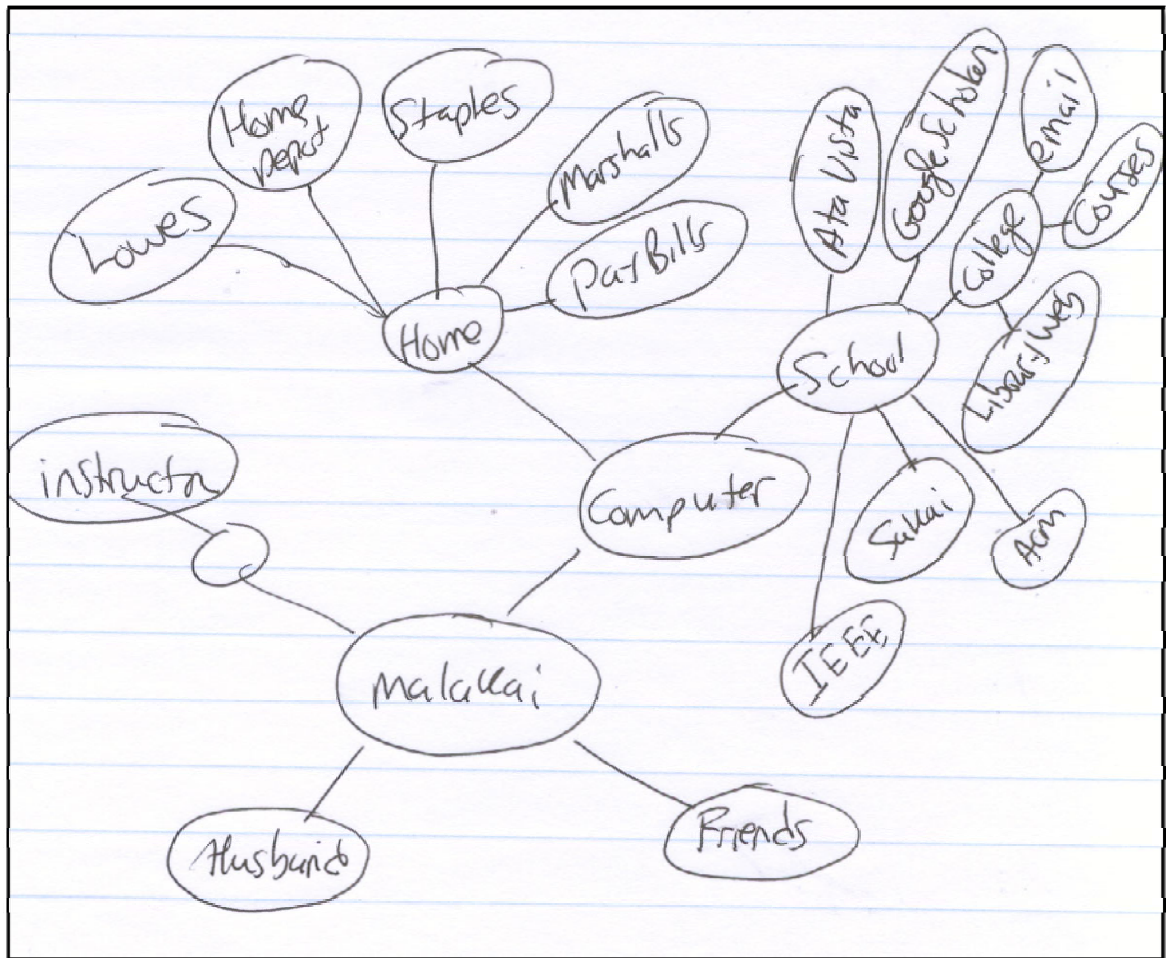


Figure 17 shows Yoda's information horizons. Yoda does not distinguish between different types of electronic or human information resources using categorization, as Malakai does. Yoda also includes more of the fine grained dimensions of the course management system than Malakai does.

Each member has different information horizons, and thinks about organizing their available information resources using a different strategy. For both Malakai and

Yoda, the distinction between course management system (Sakai) focused information resources and external resources does not appear to be central to the way they think about the information they use while participating in this course. This contrasts with the distinctions made between Sakai focused information resources and external information resources, which are referenced in separate sub questions in this study. It is possible that the different views of their information horizons, entering their collaboration, influenced the communication and interaction between Malakai and Yoda. Given their distinct information horizons, it is easy to imagine that these two members would have a difficult time agreeing on an information based premise for completing group work.

Figure 17 - Yoda's Information Horizons



Group Efficacy for Barriers Group

Rubric

Relative performance declined slightly for Barriers Group in module 4, though the overall performance of the group was highest among all groups at this stage of the course. The rubric scores for all eight groups are shown in table 16. The red and underlined squares indicate declines or low performance and the green and bold squares indicate increases or high performance. Note that the overall color code and scenario color code are based on the score, while the script color code is based on the group's trajectory from the first activity (the scenario) to the second (the script).

Table 16 - Module Four Rubric Scores

	Individualist	Canada	Adams	Police	Orange	Barriers	Catskill	Get-Along	Basis for Color Code
Scenario	24	<u>12</u>	30	<u>12</u>	24	33	18	<u>15</u>	score group
Script	4	28	<u>24</u>	20	24	<u>28</u>	22	20	trajectory
Assessment	3	6	0	3	6	3	18	3	
Total	<u>31</u>	46	54	<u>35</u>	54	64	58	<u>38</u>	score group

This relatively high performance by Barriers Group is consistent with a large body of prior work that suggests that groups who experience discord often perform at a high level. We know this was not the case in the module two debates, both from independent evaluations of other students and the members own reflections. Yet, just as clearly the group's performance rose to a high level in module four.

Reported Group Efficacy Scores

Barriers Group's survey results for Group Efficacy are lower at T1 (just after the start of the collaboration) than any other group. Then, their survey results decline.

Although the group is effective, and in pronounced interpersonal conflict, their stated beliefs about their ability to collaborate through technology trend lower. It is conceivable that Barriers Group is a special case, or that the sense of group efficacy one achieves when accomplishing something in the world is somehow muted by the experience of accomplishing it online. Perhaps the feedback or reward for doing good work is not present, the group does not recognize or celebrate their achievement, and so their sense of group efficacy becomes based more on notions of getting along than on evidence of actual efficacy.

Barriers Group Summary of Study Factors Related to Network Structure

Barriers Group diverges on several important measures of social network structure and group experience from the other groups in the course. They have lower centrality, lower betweenness centrality and fail to appear as a discernable subgroup, except in the latter part of the course, in module five. All of these factors, combined with the difficult time Barriers Group had functioning as a group suggest a correlation, at least, between the reported difficulties and the group's fringe presence in the social network analysis.

Members of Barriers group diverge from each other on social network measures, information resource usage, participation, contribution and performance. This is especially the case early on. In every measure, every story and every statistic Barriers Group's members are not pulling in the same direction until the great disruption of late module three. Following instructor intervention, the group recovers and is able to function at a high level, although they are unable to see their contributions this way. Evidence from content analysis suggests that one member, Malakai, is responsible for a

greater number of posts where knowledge is co-constructed online. This triangulates with observations in the ethnography regarding how the late stage work of Barriers Group was put together. While the group performed at a higher level on the rubric, evidence from ethnographic analysis of discussion boards and the betweenness social network data in modules five and six point to Malakai as the group member who lifted up Barriers Group's performance. Of course, that does not render Malakai an innocent in the interpersonal challenges that Barriers Group worked through, but it is important to understand that, in the Barriers Group case, one individual made a significant difference in the late stage performance of the group.

In terms of group identity, the social network measures for Barriers Group triangulate with other data about Barriers Group's identity, knowledge co-construction, information usage and performance. Together these data paint a picture of a fractured collection of individuals who are thrown in to a group, but who face a seemingly innumerable set of barriers in their efforts to function as a group.

Summary of Barriers Group

Table 17 summarizes the relationship between this case and each of the research questions, organized by patterns and themes.

Table 17 - Summary of the Barriers Group Case Framed by the Research Questions

	<u>Question One: Group Development</u>	<u>Question Two: Social Ability</u>	<u>Question Three: Information Horizons</u>	<u>Question Four: Group Efficacy</u>	<u>Question Five: Social Network Structure</u>
Pattern: Tools as Power Proxies	<p>The identity of the group is shown to be influenced by the choice of technology</p> <p>The network structures changes for this group are more well understood through the case</p>	<p>Tools are one of the aspects of social ability. In this pattern we see how the choice of tool by a member influences the social ability of the whole group</p>	<p>Tool selection acts as a constraint on the collaborative information horizons of the group's members in this case.</p>		<p>There is a nominal constraint on the view of this group's social network structure introduced by a tool that is controlled by one member, and not visible to the instructor.</p>
Pattern: Capacity and Performance	<p>Shows Knowledge Construction and Group Development may follow different trajectories</p>			<p>This pattern suggests that group efficacy and group development in this case are not related</p>	<p>Participation is greater for Malakai, who is a more advanced graduate student.</p>

	<u>Question One: Group Development</u>	<u>Question Two: Social Ability</u>	<u>Question Three: Information Horizons</u>	<u>Question Four: Group Efficacy</u>	<u>Question Five: Social Network Structure</u>
Theme: Cultural and Interpersonal Aspects of Performance	Individual identity is related to culture and graduate student standing.		Age, gender and cultural are factors contributing to information Horizon differences.	Yoda and Malakai have different standards for acceptable performance. Both suggest this is influenced by culture.	
Theme: Exaggerated Punctuated Equilibrium	This theme is visible in the story of the case, but it also emerges from the social network data	Tools, work tasks and individual participation - the three aspects of social ability - all break down within the frame of this theme.		The measurement of group efficacy declined, even though actual performance increased.	The network structure and physical distribution change for Barriers Group. This influences identity formation and information horizons
Theme: Physical Distribution Changes	Physical distribution does change the identity of the group in a number of ways, including the reduction of already low trust	The physical distribution change is accompanied by tool change, altering the social ability of members.			

The quantitative data we captured related to social ability, information horizons, group efficacy and social network structure suggest possible relationships between the experiences described in this case and quantitatively analyzed group characteristics. The

social network analysis shows that Steven and Malakai are in the same subgroup for module three. This suggests that Yoda is participating less, or with a different group. We know from her reflections and the interviews that her participation was low in this module. Real time social network analysis would have made this visible to the instructor and to group leaders earlier.

Content analysis of Barriers Group's work for group identity suggests that the group does not build an identity through their joint tasks in this case. Content analysis for knowledge co-construction shows that one member of this group led the way for the increase in the group's level of knowledge co-construction in latter modules. These findings enrich the case, and provide evidence that the distinctions between quality of work expressed by Malakai are founded in a quantifiable measure of performance.

One lasting impression of Barriers Group is the fact that their performance improved in three measurable ways following the denouement of their group difficulties: The module four rubric, knowledge co-construction analysis and raw participation & contribution. Yet, this improvement in measurable performance is not aligned with the declines in the beliefs of the members that their group could be effective. While the group's performance improved, their mutual sense of their ability to perform declined.

Case Study of Individualist Group

Individualist group started their collaboration with four members assigned to the team. One of the four members never participated in the group's work and dropped the course, though this was not known to the group until the middle of their second week working together. This caused some confusion among the team, especially after a second member, Justin, showed up and disappeared shortly thereafter. One member noted:

No, well you're talking about you know two people where the impetus was the stress of the group, we're having a conversation, the three of us, and then it's just the two, well we thought it was going to be four of us and then it was three of us and then it was two of us.

For all of module two, Individualist group was effectively composed of two members: Rabbit & Cameron. Completely online group members rely on early participation as an indication that members are trustworthy and reliable (Goggins, Laffey & Tsai, 2007), and when it does not occur there is often a negative collaboration trajectory in the group. After five weeks of collaboration, Cameron's observation about the group experience descended to these depths:

Well you asked about how I was doing with this class. It is the most miserable online learning experience I have ever had. There you have my update.

Introducing the Members of Individualist Group

Justin

Justin is in his mid '30's and lives in a major metropolitan area. During the early part of the collaboration, Justin disappears for all of module two. Subsequently, he is online and available for discussion most of the day and night. Justin is pursuing a masters degree in educational technology. His absences are later explained as family issues and taking his daughter to a camp.

Cameron

Cameron is in her early '50's. Cameron is the most consistent participator on the team, but relies on a dial up connection and is available periodically. Cameron has extensive experience using distance learning technologies in her job. She also has years of professional experience collaborating with people who are in different locations, using her dial up internet connection. Cameron is also an experienced online learner.

Rabbit

Rabbit is rarely online. She is in her early '40's. Rabbit holds three jobs, cares for young children and is married to a train engineer who travels frequently for work. Rabbit is pursuing a graduate degree in library science. During the course of the collaboration period, Rabbit's son got married and she took a trip to the Rocky Mountains. During those times Rabbit was less available to the group.

Description of Group Development

Trajectory

Individualist group's online participation patterns and observed behavior appear normal for the first few days of their collaboration. Justin makes an early post suggesting he will organize some work. There is a little confusion regarding the missing fourth member. Both the fourth member and Justin disappeared from the group by day three of the collaboration, fusing Rabbit and Cameron into a highly interdependent duo through module three.

Following module 3, the group experienced two distinct phases of dyad development. During the first phase, Rabbit and Cameron were a team and Justin was not a visible participant in any aspect of the course. During the second phase Justin and

Cameron became a team, with Rabbit participating occasionally, but expressing distraction caused by extensive travel.

The Cameron-Rabbit dyad was not perceived the same by both parties. In reflections and interviews, Cameron is concerned about maintaining a relationship with Rabbit. Rabbit does not express the same concern, or interest in a personal relationship with her team mate, though she does express bafflement at Justin's absence:

I will comment on the fact that it has been very disappointing and overwhelming that it seems that our group work isn't going to get any easier with only 2 of us completing assignments, but I feel confident in Cameron's abilities (whom I would rate as a 6 [out of 7], not only for her leadership, but for her efforts this week), and we seem to be learning a lot from each other.

In module four, there is a shift in the dyads with no discernable overlap: Rabbit becomes scarce, and Justin re-emerges. There are a number of dimensions to the group development shift that occurs as a result, but the most notable is the influence that member technology preference has on group development. Justin shows a strong preference for synchronous technology, upon his return (From the Individualist Group Discussion Board):

My skype name is [omitted here] I will be available to skype if you would like between 3 and 4. I do not know what your Skype name is Cameron? I tried to search it today, but no luck.

Cameron and Justin began Skyping routinely following that exchange, and Cameron adapted to this mode of availability very quickly (from an interview with Cameron):

I said, screw it, wait until the morning—pardon my language—and went in early, got a hold of Justin, at something like six thirty, seven in the morning, and he's on skype a lot...

The effects of this technology change are woven together with the change in active membership to alter two of the factors that comprise Social Ability: Members and

Tools. It is, in fact, following this “double shift” of social ability factors that Cameron’s message indicating that this is a very poor online experience is sent to the researcher.

The challenges faced by Individualist group through the transition from one dyadic structure to another reached a crest in the middle of module four. At that time, Cameron, who is the common member in both dyad’s, made a decision not to complete the group’s assignment without feedback from the other members. The module four assignment had six parts. Cameron completed the first three, and then asked for participation from the other members (From an Interview with Cameron):

.. these are .. the six components that we have, that we need, you know, that are part of this. I’ve done these three. And you know, this needs to be fleshed out. And we divided it up. And then, posted rapidly. Which accounts for the lack of appropriate structure for the assignment. You know, it wasn’t written in, like, you know, this is module five point five, step one, all that stuff.

The result for the group was poor performance as measured by the rubric developed for module four’s three deliverables.

Individualist group’s performance had low spots other than module four. Justin had the lowest overall grade in the course, with a final average at the “C Level”, which is not common in a graduate school course. The team’s efficacy scores were low in the survey on group efficacy, and they did not finish a group assignment in module five. While Individualist Group’s lack of cohesion is similar in its manifestations to Barriers Group, there does not appear to be a member willing, as Malakai was for Barriers Group, to lift the performance of the group up. In the case of Individualist group, it is every person for himself/herself by the end of the collaboration, and the group’s performance is inconsistent as a result.

Individualist Group Themes and Patterns

Overview

There are three patterns and three themes experienced by the Individualist Group. There were observable, qualitative patterns of change in the social ability of group members. Articulation work is recognized as critical for coordination in groups. A pattern of unraveling ensues after articulation work is abandoned by the member chiefly responsible for it in Individualist Group: Cameron. Members of Individualist group also performed redundant work, indicating abandonment of both articulation work and coordination.

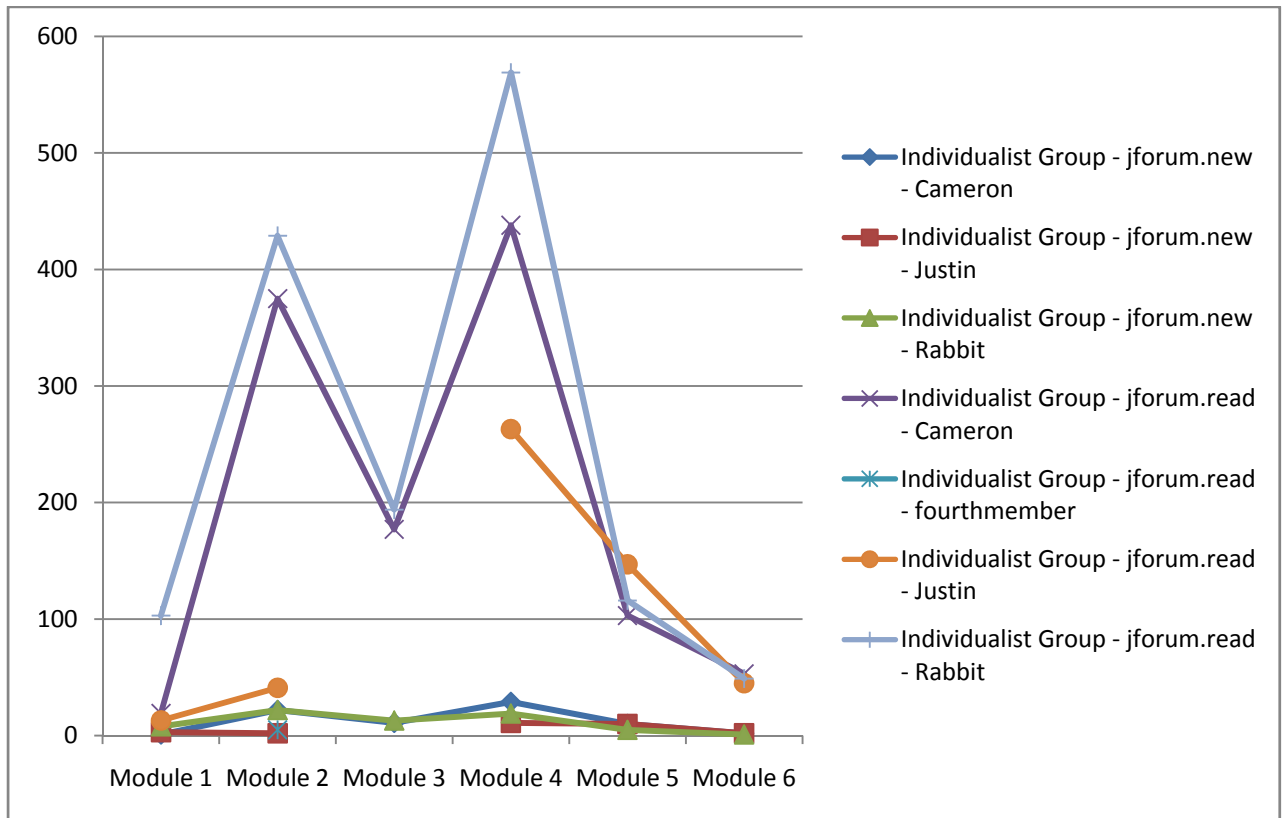
Themes in Individualist Group's experience include different member needs for structure in their work and two technology focused themes. The first technology focused theme relates to the effects of technology change on group development. The second technology theme is smaller scale, and highlights the love-hate relationship between Individualist Group members and Skype as a collaboration technology.

Pattern – Within Group Changes in Social Ability

Social ability is construed from three characteristics of an online experience: People, Tasks and Tools. Individualist group experienced volatility in people and tools. The resulting challenges illuminate how social ability might be understood at the small group unit of analysis.

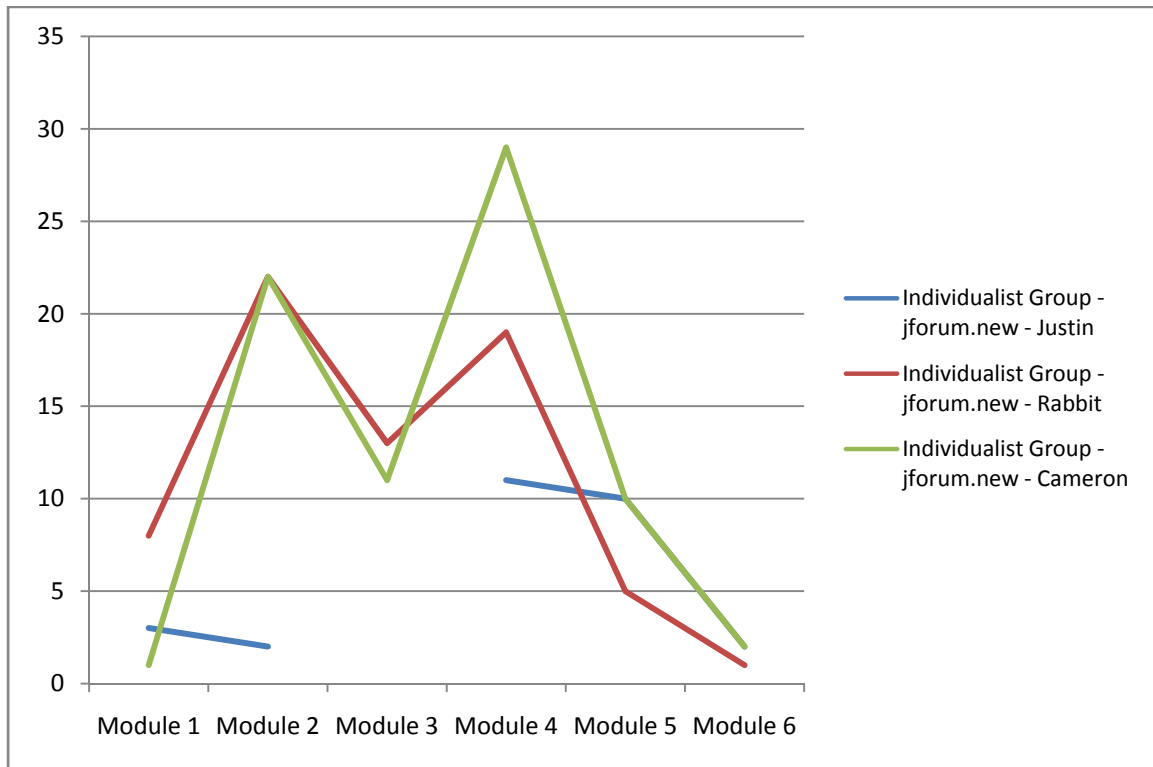
Changes in the people dimension of the Individualist Group are visible through an examination of participation and contribution changes, displayed in the Figure 18.

Figure 18 - Contribution and Participation Data for Individualist Group



Note that in module 1 and two, Justin’s participation is very low. In module 3, he does not login to Sakai at all. In module 4, Justin reappears, and in module 5 Justin replaces Rabbit as the principle communicator other than Cameron for this group. This is evidence of the dyadic change previously described. Reads naturally occur more frequently than posts, and therefore dominate the graph above. Figure 19 highlights the differences in contributions (posts) by members of Individualist Group.

Figure 19 - Contribution Data for Individualist Group



Most noteworthy is Justin’s reappearance in module 4 and equal participation with Cameron in Module 5.

Tools are another characteristic of social ability that influenced Individualist Group’s internal development. Individualist Group’s initial collaboration is discussion board focused, which is well aligned with the two members of the group with dial up internet connections. When Rabbit drops out for a time, Justin’s affinity for Skype takes over. The sense of members being able to collaborate with each other through technology and be effective is diminished through this transition, especially for Rabbit.

Tools intersected with the task for Individualist Group, and tool choices were often driven by member preferences, instead of consideration of which tool is appropriate for a particular task. Cameron knew she could always reach Justin on Skype. Often, that was not the best technology for coordinating tasks, but it did work. When Individualist

group worked to figure out how they would accomplish a task, their efforts were diffuse, the grounds where the tasks were to be completed were ambiguous and the quality of the result reflected those facts.

Pattern – Articulation Work and Performance

Articulation and coordination work usually rotates among members of an online group. Even in groups with a strong leader, different members do step in to coordinate on different tasks. We see saw this with Barriers Group, and we will see it again in Get-Along Group. Prior studies (Goggins et al, 2007) also have shown this to be the case. This did not occur for Individualist Group. Cameron performed all of the observable articulation work. Justin and Rabbit would occasionally step in to perform tasks, but relied on Cameron to coordinate those tasks in the context of an activity or module.

Justin and Rabbit exhibited characteristics of the free rider, an archetype of online non-participation where the member allows others to do the work. Rabbit's free-riding took the form of following Cameron's instructions, but contributing little to the direction of the group. Justin, in contrast, demonstrated the ability to make posts in the discussion area that appeared to represent work, but did not actually contribute to pushing the group forward. Effectively, Justin showed capacity for the dramatic presentation of participation in an online discussion, without materially participating or contributing.

Individualist Group's performance was influenced by how Cameron's articulation work was followed by either Rabbit or Justin. In module two, when Rabbit was the chief collaborator with Cameron, the work that Cameron laid out was completed by Rabbit. Justin, in contrast, when asked to take a task handoff in module four and again in module

five, did not. On these occasions, he acknowledged the task but did not complete the task.

Pattern – Individual Knowledge Construction

Groups are expected to work as groups, leading to knowledge co-construction as groups. There is some evidence in the data of members simultaneously developing independent ideas. Different thoughts, constructed through what at first glance seems to be collaboration, but upon examination is actually two people communicating with themselves in the same space. This evidence is found in chat transcripts, discussion boards and the wiki for Individualist Group.

In a chat session during module four, Cameron and Justin work together to solve a problem for the assignment, but appear to be pulling different ideas from their own views, and not adapting to each other's ideas:

Justin (Jul 3, 2008 7:14 PM CDT) What if we creates a scenario or a problem for the solve, but they have to solve it together

Justin (Jul 3, 2008 7:14 PM CDT) Yes I sent the mesage

Cameron (Jul 3, 2008 7:15 PM CDT) but it needs to contribute in a relevent way to what they do- right?

Cameron (Jul 3, 2008 7:15 PM CDT) scenario and problem solving sound good

Justin (Jul 3, 2008 7:16 PM CDT) All it has to be is relevant to collaborative learning? Right?

Cameron (Jul 3, 2008 7:16 PM CDT) you know there are othe elements to sakai that we could activate possibly and there are some web based tools that we might be able to use

Justin (Jul 3, 2008 7:17 PM CDT) Like? I am not familiar.

Cameron (Jul 3, 2008 7:18 PM CDT) Well, there is google documents, but I don;t like that one- communicator- if there is a free trail, skype can be used in a lot of different ways. I don;t think enough people will have groove or that could work

Justin (Jul 3, 2008 7:19 PM CDT) I was on a site today that was talking about groove. Can we require the people to use these?

Cameron (Jul 3, 2008 7:20 PM CDT) We can if it is free and accessible over different bandwidths. (i think)

Justin (Jul 3, 2008 7:21 PM CDT) So...say we want them to work together using skype, to solve some problem that we havent thought of yet. That might be kind of cool.

Justin (Jul 3, 2008 7:22 PM CDT) Any ideas for a problem?

Justin (Jul 3, 2008 7:22 PM CDT) That is relevant!

Cameron (Jul 3, 2008 7:22 PM CDT) I am looking up a couple of others now. Have you ever used any of the other options for netmeeting or skype - besides the voice and video?

Justin (Jul 3, 2008 7:24 PM CDT) I have never used Second Life, but I have heard that man people find it extremely interesting. I have used all of the messangers. What else might you be referring?

Cameron (Jul 3, 2008 7:25 PM CDT) maybe we give them our assignment in reverse. They design something for us :)

Justin (Jul 3, 2008 7:25 PM CDT) I don't follow.

Cameron (Jul 3, 2008 7:26 PM CDT) <http://vyew.com/site/>

In the above chat excerpt, we notice that Cameron is working to solve a collaboration problem that is directly related to the finished work product. Justin, in contrast, suggests five different technologies in response to Cameron's inquiries. Cameron is solving the task, Justin is focused on technology. At no point in their discussion is the impedance mismatch between these two points of view resolved.

There is an episode in Module 3 where Cameron sets up the work of the team. In that case, the task is to analyze and compare online stories with other members of the course. Then each group is to build consensus around which stories are similar. During this task, Justin and Rabbit do not participate or contribute for several days. When they do join in, they do not directly address the task at hand, but instead engage in a discussion regarding open source substitutes for the program Dreamweaver.

Individualist Group's wiki, which was the one available in the course management system, also demonstrates how they work on the same task, ostensibly together, while maintaining independent notions of what the work is. The five edits to

their team wiki in the early stages of Module 4 show Justin focused on methods for using a wiki, Rabbit focused on something known as “service learning” in the wiki discussion area, while Cameron makes four out of the five edits to the wiki itself. Two members are focused on concepts, and one member focused on the task completion. Two or three ships pass online.

Theme – Different Member Needs for Structure

Each of the members of Individualist Group chose to address points about the level of structure in the course when reflecting on what worked and what did not work in their collaboration. Rabbit and Cameron expressed a need for greater structure, though Cameron's views are more moderated. Justin expressed an appreciation for the lack of structure in the modules. Rabbit Comments:

The perimeters of the assignment were too broad, which allowed for too much deviation from the overall goal (collaboration skills and experience) rather than the content of what each group was asking for.

Cameron makes a more focused and time bound call for beginning the course work with highly structured activities, not necessarily ruling out activities with lower structure:

The first group assignment needs more structure, suggestions or hints on tools to use and communication guideleins. For example- initially everything on the team db then migrate to other communication options. People are going to use alternative communication methods regardless. I was just suggesting methods for condensing the amount of time it takes a group to begin to work as a group.

Contrasted with these two calls for increased structure in the work of the groups is

Justin's comment, expressing appreciation for the low level of structure:

I think what worked best for our group was that the lessons were loosely structured which allowed us to communicate in other fashions other than just the Discussion boards.

These different needs for task structuring may reflect differences in both the work and learning styles of the members. From interviews and reflections, we suggest it is possible that the increase in structure would have provided Cameron and Rabbit an indirect but effective mechanism for holding Justin accountable for participation. Justin, in contrast, may have appreciated that his absence at the beginning did not appear to hurt him – low structure met his needs, though Rabbit and Cameron’s needs were not met.

Theme – Differences Wrought by Technology and Tools

There are different perspectives that emerge from an examination of Individualist Group. Perhaps the most unique is the effect of tools on collaboration practices. Many online groups proceed through a series of tool choices early in collaboration, settle on a few and then do the work. Individualist Group changed tools throughout their collaboration, and it influenced the trajectory of the group’s development.

Early in the collaboration Rabbit and Cameron developed a rhythmic series of exchanges using asynchronous technology. Cameron started out coordinating and Rabbit followed up on her ideas. This is most apparent in the debate. Later, as rebuttals became the activity, Rabbit offered to step up and lead their efforts, and Cameron graciously accepted. These two members of what they then perceived as a dyad, figured out a way to coordinate their efforts and collaborate with each other using the course management system.

Later in the collaboration, when Rabbit dropped out and Justin came online, Cameron was no longer able to count on a response to her discussion board posts from other members of her group. Justin, however, was reliably online with his Skype account. Cameron connected the dots after a few weeks, and the way the group

developed its plans and performed its work shifted from mostly asynchronous to mostly synchronous.

Driving the technology change, Justin has a spurt of participation, during which he communicates directly with Cameron via Skype, usually using the voice technologies, on 7/15, 7/17 and 7/18. This creates a difficult tension for Cameron to manage. At the same time as the group member who has been working with her for most of the course, Rabbit, lowers her commitment level, the highly unreliable other team member, Justin, increases his. Cameron's experience at this point is quite different than her reasonable expectations for a completely online group. The result is the group experience a lack of social ability. This is reflected in Cameron's module 6 reflections, where she describes her experience as:

Being abandoned by my team members. Lack of communication from group members regarding assignments, roles and responsibilities. After delineating portions between two members or if we were lucky 3, having the responsible party for posting ignore the majority of the other members input.

Part of what happens is a function of the change in group participation, but the change in tools effects Cameron's experience as a member of her group. The change in tools demands a change in established practices. Granted, these practices had not been cemented by years of habit – something one might find at the department of motor vehicles – but online group work provides less feedback than face to face group work. A change in the tools required for participation in the group is a fundamental change to the group.

Theme – The Skype Love-Hate Transmission

The use of Skype, emerging from Individualist Group member participation changes that triggered the technology change, received mixed reviews by the members of

Individualist Group. The mix of reviews appear connected to the amount of time the members spend online.

Rabbit is not frequently online, and found the emerging use of Skype, which notably followed her sharp decline in participation, stressful. Rabbit notes:

Finding times to chat on Skype sometimes proved to be difficult (work, personal schedules) and the final assignments issued by the other groups (mod 5) caused our group a lot of confusion and stress.

Justin, as the introducer of Skype, found it to be especially useful in collaboration with his team mates:

Posting to the discussion boards was fine and all, but in order to communicate with one partner in California and one in Philadelphia, I would first have to log on...then see if they were online...then figure out how to talk with them. (Saying to myself...Should I go into the chat room and wait to see if they realize I'm in the chat room hoping they come in because I have a question. Or...should I send them a private message...hoping they check their messages to say I have a question and I am in the chat room.) WOW. Using Skype I able to see if they were online immediately, and chat with them immediately.

This excerpt from a module reflection identifies the limitations of the chat tool in the course management system. Many steps are required to reach synchronous awareness of the other students in the CMS. In contrast, there is no explicit work required to establish a feed of awareness information in Skype. If people are online and you notice it, you can instant message or call them.

Cameron's views on the use of Skype evolve through use, and her initial reticence to take advantage of Skype is transformed by the end of the collaboration. Cameron notes in the last of three interviews:

Well once we got everybody, I mean, everybody was on skype, once we got everyone's names so we could add them to our contact list on skype—cuz we all skype—um, it was a matter of, you know, waiting for someone to be on there at

the same time and saying, aha! You know, we have this part of the assignment due. Or, you know, we have this portion. And we broke things out so that, um, and divided them out so that they weren't last minute. Some things actually got posted early near the end.

Skype came about on the insistence of Justin, rejoining the collaboration at around the same time as Rabbit's participation declined. Once implemented, Cameron found that mode of collaboration preferable to the previously established asynchronous practices of the group. When Rabbit returned, the shift in technology was not supportive of her participation on a dial up line, but the practices built up by the other members in her absence were either too powerful, or too late in the collaboration to permit a shift back to prior work practices.

Quantitative Data for Individualist Group

Knowledge Construction

Content analysis of discussion board posts made by Individualist Group members in course-shared discussion boards showed that this group had the highest level of knowledge co-construction among the three case study groups, with 19% of posts at Gunawardena (1997) level Ph2 or above. Across the course, only 12.4% of posts were at level Ph2 or above. This high level of knowledge co-construction is illustrated in table 18.

Table 18 - Overall Knowledge Co-Construction For Case Study Groups

	<u>Overall</u>	<u>Mod 4</u>	<u>Mod 5</u>
Barriers Group			
ph1	88.2%	96.0%	80.2%
ph2	9.4%	4.0%	14.8%
ph3	2.5%	0.0%	5.0%
Individualist Group			
ph1	81.4%	85.1%	90.9%
ph2	10.3%	11.8%	10.1%
ph3	8.2%	3.1%	0.0%
Get-Along Group			
ph1	85.8%	84.8%	91.4%
ph2	9.1%	9.0%	5.1%
ph3	5.1%	6.2%	3.5%

The table shows that slightly less than 20 percent of all posts by Individualist group are above co-construction level PH1, which is a high, and the group also has the highest percentage of both PH2 and PH3 level posts.

The description of co-linear individual knowledge construction presented earlier contrasts with the relatively high performance of the group co-constructing knowledge online. This description from an interview with Cameron is typical of knowledge

construction within Individualist Group. These patterns of effective knowledge construction are described in reflections and observed in field notes and the discussion boards from the course:

CAMERON: *Well, yeah, so, I knew of some resources automatically. And since Justin was the only one I could get a hold of, initially, you know, he and I were discussing what we would want, you know, as consumers.*

INTERVIEWER: *Uh huh..*

CAMERON: *Well at first, you know, I had posted some stuff. But as far as, you know, really, I guess I had talked to Rabbit briefly, then...but it wasn't... it was just like a brief post on the discussion board. Then as far as you know, getting sources, that kind of thing, it was, what is it that we want of these consumers, what would help us, what do we think would be positive, how...and then, research that I was aware of and sources I knew of that were good. Um, and he had some others, and kind of built on that. And we had pulled, um, I knew of the department of energy's section we would need and you know, looked that over. So, we kind of built that way in the beginning, and then, in the end, you know, you have two people who have done a lot, and you need that other person's voice. So, Rabbit added some to it, and was, you know, putting some stuff up on the wiki, um, and was going to be in charge of the graphic.*

INTERVIEWER: *Ok. So, it sounds like you distributed the work a little bit. Um, do you, can you imagine, was there a part of that you actually felt, for example, you co-constructed, something together?*

CAMERON: *Kind of. Not...we kind of did.*

INTERVIEWER: *Ok. And was it, like, the integration of the fossil fuel research that you and Justin did?*

CAMERON: *I guess... we co-constructed in a very dysfunctional manner. Rabbit and Justin did some after Justin and I did, I think. And then, we were all together, and something else got put together. You know, it was kind of a, kind of cumulative.*

INTERVIEWER: *Asynchronous dysfunctional co-construction?*

CAMERON: *Yes!*

The discontinuity between what is observably a strained process of co-construction by members and this higher performance suggests that a closer look at the knowledge co-construction practice of members is warranted. Table 19 shows knowledge co-construction in the private discussion board area of the course management system.

Table 19 - Individualist Group Knowledge Co-Construction by Member

Row Labels	Grand			
	Total	Ph/1 Pct	Ph/2 Pct	Ph/3 Pct
Cameron	52	65.4%	13.5%	9.6%
Justin	14	92.9%	0.0%	7.1%
Instructor	1			
Rabbit	37	83.8%	5.4%	5.4%
(blank)	2			
Grand Total	106	81.4%	10.3%	8.2%

Table 19 surfaces two important concepts related to the knowledge co-construction practices of Individualist Group. First, Cameron made nearly half of all posts for the group. Second, more than 1/3 of Cameron's posts represented knowledge co-construction above the Ph1 level, while more than 9/10 of Justin's and 8/10 of Rabbit's posts were at the Ph1 level of co-construction. The overall knowledge construction statistics for Individualist Group are therefore skewed by one high performing member. In effect, it is further support for the individually focused, publicly visible knowledge construction pattern observed throughout our analysis of Individualist Group.

Group Identity

The case study presented so far suggests that Individualist Group does not have a very strong group identity. A contrast between the three case study groups illuminates how groupness is and is not communicated in the context of group discussion boards. Both Individualist Group and the not yet introduced Get-Along Group had 85% of their group discussion board posts directed at the whole group. Barriers Group, in contrast, had 59% of posts directed at the group, and the remainder directed at individuals within the group. This suggests, at least, that the manner of discussion board communication differs substantially between Barriers Group and Individualist Group, and that Individualist Group is aligned with the third case study group. The content analysis that

applies Tajfel's codes to communication may be helpful, but a high degree of group directed interaction does not necessarily indicate the group is cohesive, or has a strong identity. It may simply suggest the maintenance of civility in the face of challenges; Something Barriers Group could not sustain, but Individualist Group did.

There are significant differences in the feeling of group identity described by the members of Individualist Group in the final survey of the course. Cameron's descriptions included terms of dysfunction while both Justin and Rabbit thought of their group as successful, and high functioning at the conclusion of the course. This may be a side effect of how different members experienced the group. Just as Justin appreciated the lack of structure that permitted him to completely disappear for a time, Rabbit may appreciate that her period of lower participation ended well. She and Justin felt good about the group's work at the end. Cameron, who endured volatility without the benefits of unilateral flexibility that Rabbit and Justin afforded themselves, finished the work of the group relieved that it was over.

Social Network Structure

Member subgroup analysis provides a compelling measure of within group structure. If members of an a priori group do not consistently show up together in network groups derived from CANS logs, it is a statistical indication that the members of a group are not attending to the same material. It suggests they may not be directly responsive to each other in the course management system. For some groups, including Individualist Group, this could also indicate that most collaboration took place outside of the course management system. Individualist Group has substantial collaboration inside of the course management system, but the social network analysis centered on CANS

Logs, which are the data available, must be understood to be a partial set. Late in the course, members of Individualist Group depend on Skype in addition to the course management system. However, there is strong evidence from interviews, reflections and enumeration of the number and timing of Skype conversations that Individualist Group continued to utilize Sakai. Skype added to the group’s ability to coordinate “just in time”, but did not replace Sakai. Network statistics will, therefore, contribute to Individualist Group’s story.

One measure of network subgroups, as noted before, is Factional Analysis.

Factional analysis of subgroups for Individualist Group is shown in table 20.

Table 20 - Summary of Factional Subgroup Analysis of Individualist Group

Module	Members in the Same Group	Run Percentage
Three	Cameron and Rabbit	14%
Four	Justin, Cameron & Rabbit	14%
Four	Justin & Cameron	57%
Four	Justin & Rabbit	14%
Five	Justin, Cameron & Rabbit	43%
Five	Justin & Cameron	28%
Five	Justin & Rabbit	28%

This Factional analysis suggests that there are no cohesive subgroups visible through the activity logs in Module three, but that in Module 4 Justin & Cameron begin to form a cohesive group and there are some ties beginning between Justin & Rabbit. In module 5, at least two of three members were in a group together on every factional analysis run, and all three were together on 43% of the runs. These data show that in module five the members of Individualist group are mostly attending to the same information and responding to each other’s posts in the course management system. Factional analysis identifies their relations with each other from CANS logs.

Another measure of subgroup formation, explained previously, is F-Group analysis. F-Group analysis does not show any two of the members of Individualist Group in the same subgroup at any time in the course. In module 1, Rabbit shows up in a subgroup with other members of the course. In module 3, Cameron shows up in a subgroup with other members of the course. In module 6, a very light weight module that lasted only a few days, Justin shows up in a subgroup with other members of the course. This means, effectively, that Individualist Group is not an identifiable subgroup in the course management system at any point in the course, using F-Group analysis against the CANS logs.

Core-periphery, betweenness and network centrality measures focus on the structure of the overall network. Core-periphery analysis positions the members of Individualist Group in the larger social network structure of the course.

Table 21 shows that no members of Individualist Group are ever in the course “core” during the modules where collaboration takes place. Their presence in the core for module six is a minor anomaly of the small number of total interactions in the course for that module, and Individualist Group’s relatively active stance during it.

Table 21 - Individualist Group Core-Periphery Analysis across Modules

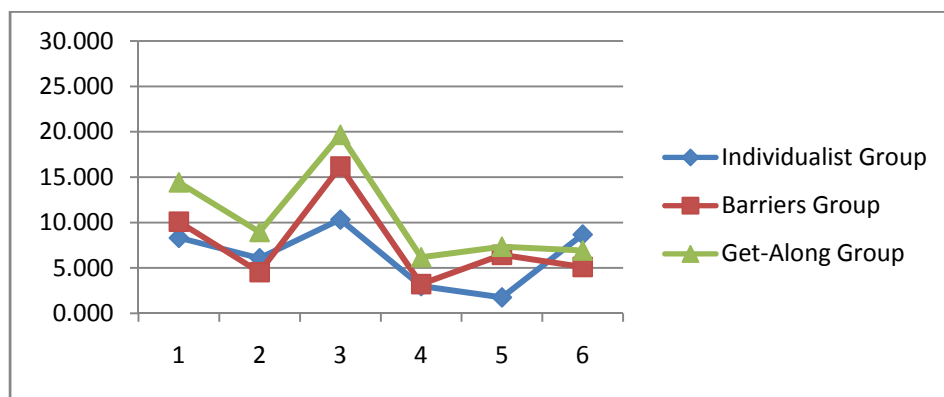
	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
Core	Justin, Rabbit					Cameron, Rabbit, Justin
Periphery	Cameron	Rabbit, Cameron	Cameron, Rabbit, Justin	Cameron, Rabbit, Justin	Cameron, Rabbit, Justin	

This is a pattern that is consistent with a membership that does not participate or contribute as actively as other members of the course. Prior work (Goggins, Laffey,

Galyen & Reid, 2009) shows that groups without members in the core of a larger online community experience difficulty. Individualist Group's experience and this core-periphery analysis reinforce that finding.

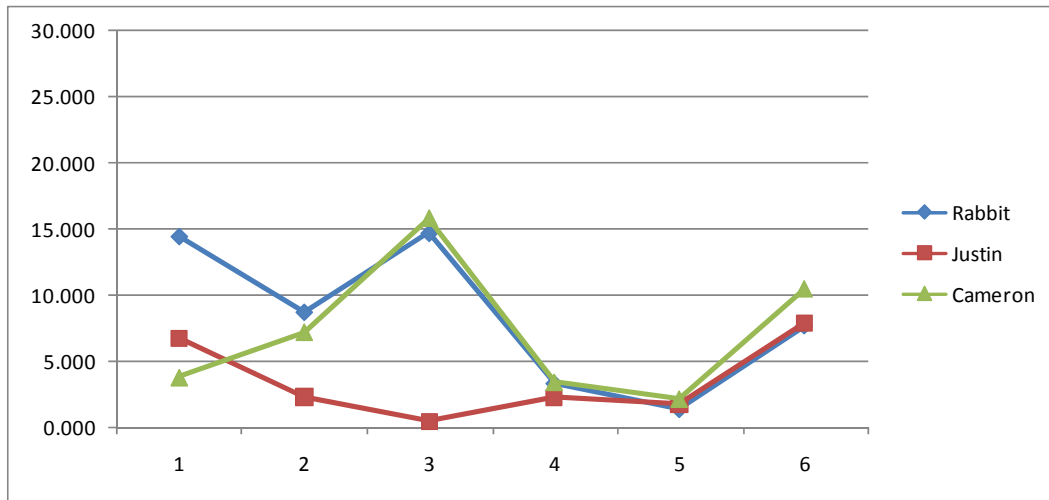
Network centralization measures further triangulate the non-central position of Individualist Group in three out of four collaborative modules when compared with the other two case study groups. This is illustrated in Figure 20.

Figure 20 - Network Centralization for all Three Case Study Groups



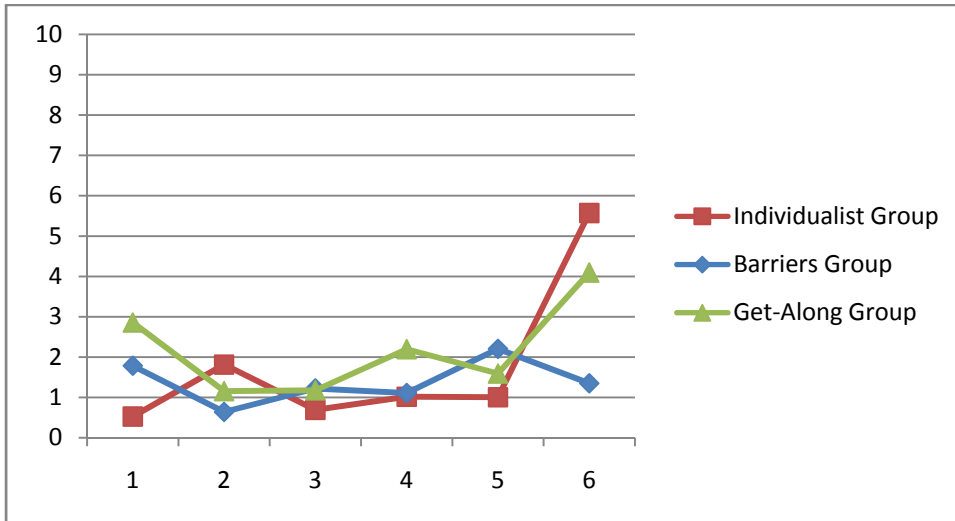
Centralization data for all of Individualist Group's members, side by side, suggests that Justin's participation was markedly more focused within the group, and did not include much participation or contribution outside the Individualist Group. Figure 21 shows that Justin's centralization is substantially lower in modules two and three, compared with the other members, and remains at the bottom for all modules except for modules one and six.

Figure 21 - Network Centralization Measures for Individualist Group Members



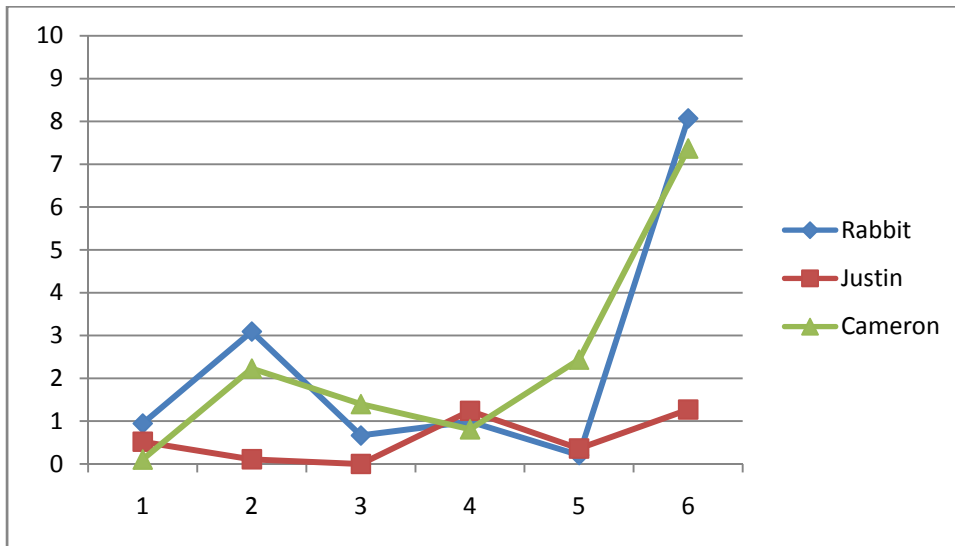
Betweenness is a measure of centrality in a social network that focuses on the extent to which members make connections with each other in the course. Though Individualist Group's overall betweenness measure is highest among the three case study groups when collaboration begins, it quickly settles to the bottom, and remains there for the duration of the course, until a spike in the small, concluding module 6. Figure 22 shows that individualist group is at the bottom of the three case study groups in modules three, four and five.

Figure 22 - Betweenness Measures for Three Case Study Groups



Like with the general centrality measure, the betweenness centrality of Rabbit and Cameron is consistently higher than Justin's, and spikes in Module 6. This is illustrated in Figure 23.

Figure 23 - Member Betweenness Centrality for Individualist Group



Social Ability for Individualist Group

Social ability factor scores for the members of Individualist group are shown in table 22. See Appendix A to review the questions.

Table 22 - Individualist Group Social Ability Factors

Member	Peer Social Presence		Written Comm. Skills		Instructor Social Presence		Comfort Sharing Personal		Social Navigation	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Justin	2.02	1.80	1.29	1.00	2.75	2.27	1.00	1.00	2.44	2.87
Rabbit	4.20	2.39	2.58	2.00	3.10	3.16	3.59	2.68	<u>2.82</u>	<u>2.43</u>
Cameron	<u>2.53</u>	<u>2.64</u>	2.00	2.00	2.70	1.77	<u>1.00</u>	<u>2.00</u>	<u>3.15</u>	<u>2.85</u>
	2.92	2.28	1.96	1.67	2.85	2.40	1.86	1.89	<u>2.81</u>	<u>2.72</u>

The Overall factor scores for all 23 members of the course who responded to the survey are shown in table 23.

Table 23 - Social Ability Factor Scores for All Course Respondents, T1 and T2

	Factor Score	
Peer Social Presence	2.73	T1
	2.32	T2
Written Communication	2.92	T1
	2.25	T2
Instructor Social Presence	2.65	T1
	2.58	T2
Comfort Sharing Personal Info	2.58	T1
	2.20	T2
Social Navigation	3.06	T1
	3.20	T2

Where the factor scores for Individualist group differ from the overall course trend, the scores are highlighted in amber and underlined in table 22. When the score shows particularly strong movement from T1 to T2 in the same direction as the course community overall trend, the score is highlighted in green. On all but one factor, Justin and Rabbit aligned with the other members of the course as a whole. On three out of five factors, Cameron diverged from the other members of the course as a whole and by implication from her mates in Individualist Group.

Peer Social Presence

The member who was active throughout the course, Cameron, showed a diminishment in perceived peer social presence. The members who were not active during substantial portions of the course, Rabbit and Justin showed improvement in this factor. Rabbit's diminished participation late in the course did not reach the status of complete absence as demonstrated by Justin in Module Two. Perhaps this helps to explain the improvement in her sense of peer social presence, which changed from a fairly weak 4.2 at T1 to a moderate 2.39 at T2. In other words, Rabbit moved from substantially below the course mean for peer social presence at T1, to effectively the same as the overall course factor score at T2.

Written Communication Skills

All members of this group indicated equivalent or improved sense of confidence in their writing skills as they pertain to the course. The factor scores for written communication skills among Individualist Group's members are consistent with the trend in the overall course community.

Instructor Social Presence

Individualist Group's members all indicated an improvement in perceived instructor social presence from T1 to T2. This is consistent with the trend in the overall course community.

Comfort Sharing Personal Information

Cameron reported declining levels of comfort sharing personal information at T2, compared with T1. This is the opposite of the overall trend in the course, which Justin and Rabbit followed. Interviews with Cameron highlighted her diminishing trust in her

other group members. Her particular experience being part of one dyad, then needing to switch to another dyad included forming two individual trust relationships instead of a single, group trust relationship. Considered from this perspective, diminished comfort sharing personal information from T1 to T2 takes shape as a side effect of the manner in which Individualist Group did their work.

Social Navigation

Cameron and Rabbit showed diminished social navigation from T1 to T2, which is consistent with the overall trend in the course. Justin's use of social navigation improved from T1 to T2. This trend is inconsistent with his persistent low rate of participation in the course management system. It may be that Justin began using social navigation to facilitate a cursory understanding of what was happening in the course.

Information Horizons for Individualist Group

Individualist Group had unusual diversity in the online habits of its members, with two members clinging to dial up connections and a third member in a metropolitan area persistently available online; if he chose to participate. Perhaps reflecting this diversity in connectivity situations, there was not one single information resource among the 28 in the information horizons survey that all three members of Individualist Group placed in their top five. This is one of two groups, out of the eight in the course, where there was no convergence of all members around at least one information resource.

Rabbit's differences in information horizons stood out among the members of Individualist Group and the course in general. Rabbit, who is seldom online and relies on a dial up connection, included a public library and google.com in her top five. Though one might expect, in the age of *the Google*, that many participants would place it in the

top five of information resources used in an online course, that was not the case. Only three of 23 respondents placed Google in their top five. Rabbit was the only person to place a public library in her top five.

Individualist Group is the only group in the course where most of the members did not place the instructor in their list of top five information resources. When the mean of member ranks is calculated, there are two information resources whose mean rank is five or higher for Individualist Group: “Other people in your small group” and “the Sakai Discussion Board for your Group”. All three members have “Sakai Private Messages” and “Sakai Assignments” ranked fifth or sixth, which indicates this resource is consistently close to the top of the list for all members. Individualist Group reports that its members and the course management system are important information resources.

Group Efficacy for Individualist Group

Rubric

Individualist Group performed lower than all other groups in the course on the module four assignments, evaluated by two raters with a rubric. Most stunning was their decline from the first part of the assignment, a scenario, to the second, a script. Analysis of interview and discussion board data clearly shows that Cameron had been actively coordinating for this group up until the midpoint of module four, and made a deliberate choice to see if other members would “pick up” on her work on the script, instead of counting on her to finish. There were six tasks for the construction of the script that she outlined. She completed three, and asked her mates to complete the final three. They did so hastily, and the result is poor quality work.

Grades are another mechanism by which performance may be assessed, though in a graduate course there is usually very little differentiation among the participants, who are typically highly motivated, aware of, able and willing to complete the necessary work to do well. Justin, a member of Individualist Group, has the distinction of being the only member of the course to receive a grade lower than “B”. This likely reflects his hasty assembly of group work products, and failure to participate in Module 2.

Group Efficacy Survey

Despite Individualist Group’s actual performance, their group efficacy survey results show that they started out believing they would be an effective group and concluded the course with the same disposition. The mean Group Efficacy Score for Individualist Group moved from 1.667 to 1.333 from T1 to T2. A score of 1 corresponds to “Strongly Agree”. See Appendix C for the survey questions.

Individualist Group Summary of Study Factors Related to Network Structure

Social network statistics for Individualist group show that all members are located outside of the core. Justin has the lowest centrality and betweenness of any course participant, and overall the group is low on these factors. Justin's non-central status, fractured participation and low level of navigation outside of his group suggest an ambivalence that would stand out to an instructor or leader of an online group. Simple measures would make a case like Justin's visible and actionable by an instructor, leader or manager.

The correspondence between lower performance and lack of a group member in the core is observed in this group as it has been observed in prior studies.

The collaboration practices of members are individually centered and sometimes characterized more as co-presence in an online environment than co-construction. The social network measures presented are consistent with individuals who are not central to a larger group. Individualist Group's network measures suggest the exploration of the relationship between low performance and individual member position in a social network analysis may be fruitful. Like Barriers Group and Get-Along Group, Individualist Group had a member who led the coordination efforts. Unlike those groups, that member, Cameron, did not compensate for group performance shortcomings. Notable here, unlike the other two more dominant members of the three case study groups, Cameron was not in the core of the overall course social network.

Summary of Individualist Group

Table 24 summarizes the relationship between this case and each of the research questions, organized by patterns and themes.

Table 24 - Summary of the Individualist Group Case Framed by the Research Questions

	<u>Question One: Group Development</u>	<u>Question Two: Social Ability</u>	<u>Question Three: Information Horizons</u>	<u>Question Four: Group Efficacy</u>	<u>Question Five: Social Network Structure</u>
Pattern: Within Group Changes in Social Ability	Tool choices are driven by member preferences instead of the needs of the group. In turn, this influences group development	All aspects of Social Ability (Tools, Tasks, and Individuals) change in the course of this group's development.			Group interactions through different tools influence how the group evolves. Tools and member participation influence group structure.
Pattern: Articulation Work and Performance	Group development appears to be stifled by a failure of the members to coordinate with each other.				
Pattern: Individual Knowledge Construction	Knowledge is constructed individually in a virtual space where members are co-present.	Social interactions occur at times that prove disruptive to task flow. Thus, membership and task interaction indicate challenges to social ability that influence performance and group development.			

	<u>Question One: Group Development</u>	<u>Question Two: Social Ability</u>	<u>Question Three: Information Horizons</u>	<u>Question Four: Group Efficacy</u>	<u>Question Five: Social Network Structure</u>
Theme: Different Member Needs for Structure	Aspects of member identity related to the preference for structure in tasks impedes group development				
Theme: Differences Wrought by Technology and Tools	The two distinct dyads that form indicate an observable change in network structure	Tool changes influence and are influenced by member changes, but not tasks.	The rapid change of tools alter the information horizons of members, particularly related to their use of the group.		The changes in technology and structure reflect the group development challenges experienced by this group.
Theme: The Skype Love-Hate Transmission	Group development is harmed by the choice of a tool one member lacks the infrastructure to use.	Tool choice drives behavioral change in the group that has positive implications for Justin and Cameron and negative implications for Rabbit	Social and collaborative information practices of the group changed dramatically with the introduction of Skype. The group information space was altered by this choice.		

Examination of knowledge co-construction trends for Individualist Group show that one member, Cameron, makes the strongest contributions in discussion board posts.

The strength of this one member's performance raises the overall knowledge co-construction rates for the group. This shows that, like in the case of physically co-located groups, completely online groups may have their performance influenced heavily by individual members who perform significantly above the norm.

Individualist Group goes through two distinct phases of development: First, in the Cameron-Rabbit dyad, and second in the Cameron-Justin dyad. Despite this evolution in structure, the members of the group develop a practice of addressing each other as a group, indicating the emergence of a group identity not seen in the Barriers Group. The structure of the group, though in this case volatile, does not influence the communication practices and observable group identity of Individualist Group.

Network subgroup analysis using F-Groups and Factions confirm what is observed and reported in the case study: That this group does not behave online as a group. We have the conflicting information of communication that reflects a group identity combined with network information that shows, structurally, that the group is not a group. The structural report is consistent with the case study of Individualist Group. This suggests the possibility that group member communication practices that address the group are formed as habits through practice in other online groups, and that these habits may persist even in the face of a group that is not functioning well. Members' identifying with a group is observed here, even though the group's performance as a group is fractured and performance is lowest of the eight groups on our module four rubric.

Individualist group is characterized by a group identity on par with other groups, combined with a volatile group structure and declining performance. The most active

member, who also performed at a high level and was the common thread in the two dyads showed a decline in social ability from T1 to T2. Group efficacy scores remain flat in spite of this decline in performance.

Case Study of Get-Along Group

The activity in module 2 of the course draws participants in to an online situation where they are compelled to disagree with one another. Members of one group take a position – one they are assigned, though do not necessarily believe – and are given the task of defending this position. Get-Along Group is assigned “position B”, which is:

Having students collaborate and cooperate are ways of supporting learning, but the primary goal of instruction is to have students experience the subject matter at hand. When students interact during the course of their assignments they learn with and from each other but this social nature of learning is incidental to the primary tasks of examining and making sense of the subject matter. Designers of CSCL should focus on making sure that students interact effectively with the subject matter and use social interaction as a way to reinforce the direct learning that students do in the subject matter. The social nature of learning will prove to be an asset in building new knowledge and competencies, but the primary mechanisms of learning are the students’ direct cognitive experience of the subject matter.

Other groups initiated their collaboration by agreeing or disagreeing amongst themselves about whether or not the position they were assigned was one they agree with personally. Get-Along Group got straight to work partitioning the components of the module into sections, researching ways to defend the position and drafting versions of their argument. Tommy started things out by agreeing to do research on the subject, and creating the first draft. Joplin edited the draft for grammar. Sally made changes to the structure of Tommy’s argument, presenting it with sheepish assertions and questioning of the changes to the rest of the group.

Defense of the group’s argument evolved with reliance on Tommy’s coordination and Sally’s online writing skills. Tommy presented himself throughout this opening group task as a person who did not do well with “big words”, but understood how to

organize work. Sally, initially timid, proved to be a good writer who helped the team make its' points in the debate.

Joplin made several attempts to contribute, but did not ever seem to find her place in the construction of the argument. Her contributions were short, timid and around the periphery of constructing the argument. Her biggest initial contributions were grammar, spelling and sentence structure corrections.

Get-Along Group was judged by the team rating their argument against an opponent as the winner – 7 to 3. Like Barriers Group, the margin of victory in the debate was wide, except in this instance Get-Along Group emerged the victor.

Introducing the Members of Get-Along Group

Joplin

Joplin is a teacher in her early '50's, taking the course as part of the requirements to complete a masters degree in educational technology. She has taken several online courses at the same university in the past. Joplin is sometimes overwhelmed by the pace of collaboration in Get-Along Group, and self identifies as a lower contributor and follower early in the group's work together. As the Get-Along Group collaborates, Joplin's view of her effectiveness and contributions rise.

Tommy

Tommy is a prolific online group participant. He is active in a number of virtual industry discussion groups and regular meetings, collaborates at work through technology and completed his Bachelors degree online. Tommy is in his mid '50's. Tommy describes himself as not a very good writer, and of average intellectual ability. He enjoys helping out students who are new to online collaboration. Tommy participated and

contributed at a higher rate than any other member of the class. Tommy is an information technology professional. Tommy is a leader within Get-Along Group.

Sally

Sally is in her '40's, and is somewhat skeptical about online group work at the beginning of the course. Sally contributes consistently to the work of the group and is influenced by the effectiveness of the group. Her skepticism about online group work softens as her contribution and participation rates rise within Get-Along Group.

Description of Group Development

Trajectory

Get-Along Group begins their work together with high participation and contribution levels, and sustains those levels throughout the course. Tommy is among the most active members in the course, and Sally and Joplin's participation rates, while not as high as Tommy's are above the course mean.

Interviews with Tommy and survey data from all three members suggest that the group formed a very strong group identity during their collaboration. At the beginning the members were pleased with Tommy's "take charge" approach. The positive nature of this initial experience helped to solidify a positive group identity. When one of the members, Joplin, had a brief absence from the group, the collaboration continued among Tommy and Sally, and Joplin was welcomed back by her fellows when she returned. Getting off to a good start helped Get-Along Group stay cohesive through a brief rough patch.

Patterns of Technology Use

Get-Along Group develops discrete work practices connected to specific collaboration technologies that all of the members adopt and come to rely on. This begins with Tommy breaking the work down in to discrete units and creating a discussion board topic for each activity in each module. When Get-Along Group adopted a team wiki, the members collaborated around it using a turn taking strategy that is apparent from reviews of the edit logs. The wiki is subsequently used for knowledge co-construction and creative work. Get-Along Group uses the Sakai database for coordinating activities, arranging schedules and putting together pieces of independently developed work. Synchronous tools like skype and text chat are used for ideation by Get-Along Group.

Adaptation Issues in Module Four

The well developed and atypically reified work practices for Get-Along Group created challenges for them in module four. It appears that Get-Along Group had a difficult time adjusting their practices to the difference in the task structure for Module four. The technology practices that they developed in Modules two and three embodied a systemized approach that served them well there, but broke down early in Module four.

The task in Module four was different. Module two and three called for coordination on large, structured tasks, while module four required coordination between members on tasks that were not listed in the syllabus. The group had no practices to figure out what to do when the work was not predefined.

Get-Along Group was forced to adapt, and change their work practices. The effects of this adaptation were most pronounced in the processes the group followed to

develop their scenario, which principally served as a proving ground for the renegotiation of their work practices. Get-Along Group is the only group of the three case study groups whose performance improved from the scenario to the development of the script in module three, suggesting they struggled at first, but restored a rhythm on these new types of tasks.

A notable dimension of Get-Along Group's adaptation to the changes in module four is that the group is aware of why they are effective. Tommy notes:

What I have done is taken the information that we have for this week and put my spin on it saying, "Ok guys this is what I think we are supposed to do, and if I am wrong tell me." So I am either going to be right or I am going to be wrong, or whether it is the right way or the wrong way I don't know

Recognition of the success up to a point did not diminish the group's belief in their ability to be effective when faced with a challenge. The struggle did not redefine the group or alter the member's identity. Sally reflects:

...as a team, we found ways to communicate and share information. Once we establish this routine, we stuck with our game plan. We have found using wiki-spaces and the discussion board an excellent method of sharing information. Another thing apparent about our team is no one harps about having done more work than the other has. In the end, our final product is a team effort by a group of individuals and not an individual effort

Sally's observation about the incorporation of wikis alludes to a mechanism Get-Along Group eventually used to meet the challenges of module four. Sally's reflection also focuses on the importance of maintaining civil communication within the group. It is conceivable that this peaceful communication value expressed by each member at different times is also a contributing factor to Get-Along Group's low performance in module four, however.

One contributing factor in Get-Along Group's ultimate adaptation to the changes required in module four may be the frequent comparisons they make between themselves and other groups in the course. This frequent practice of looking at other groups in the discussion board is one of the themes discussed in the next section.

Get-Along Group Themes and Patterns

Overview of Themes and Patterns

There are three patterns and two themes reflected in Get-Along Groups experience. The patterns are:

1. Sense Making and Social Comparison – There is an interaction between these two group acts
2. Making tasks visible to the group – This practice is consistent throughout the collaboration
3. Group self awareness – Get-Along Group is aware of their groupness

The themes are:

1. Changes in individual identity and group identity are interleaved
2. The negotiation of place and space in an “open tool” online collaboration

Pattern – Sense Making and Social Comparison

Sense making and social comparison are two unrelated constructs from two different literatures. Sense making as meant here is a concept from the information science literature (Tidline, 2005), while social comparison is a construct found in social psychology (Festinger, 1954, Buckingham & Alicke, 2002, Turner, Brown & Tajfel, 1979). Get-Along Group utilized technology to make sense of the group and its tasks,

utilized those technologies for social comparison, and then fed those comparisons back through the sense making practices they developed.

When Get-Along group initially came together, they swiftly went to work making sense of their group and its purpose. Tommy's practice of creating discussion boards for each activity was a significant part of this. This led to the more general practice of making sense of each activity before starting work on it, which occurred for most of Get-Along Group's work. This making sense of the activity occurred through discussion board posts and instant messenger chats.

Making sense of the work of other groups that is connected to their activities sometimes posed a challenge for Get-Along Group. Joplin begins with a question in the Get-Along Group discussion board:

I assumed the partner team was the other team they are teaching. So are we suppose to do the assingment with them? If not then why should we care about the partner team. Skimming over the assignment I have not figured out where the partner team comes into play. Did I mention I like to ask a lot of questions, however I am not being difficult..

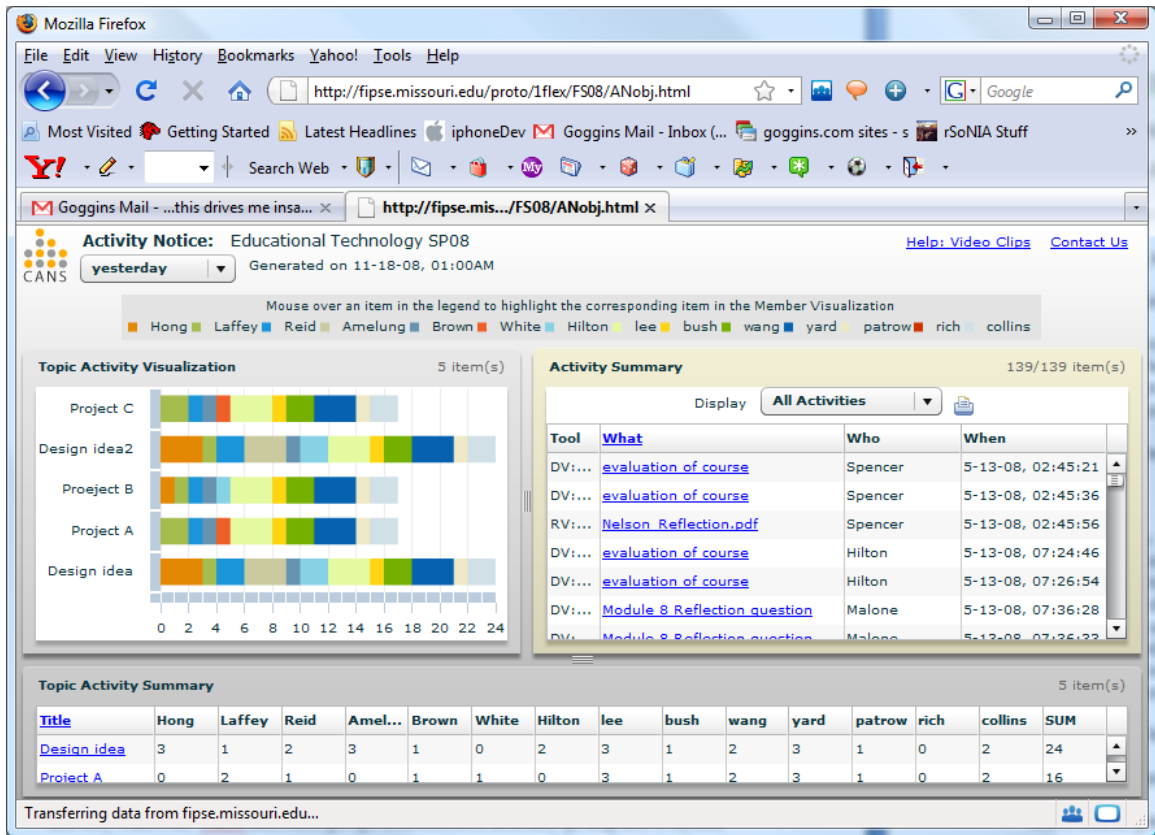
Further examination of the task assigned to them by Barriers Group in Module five leaves Get-Along group continuing to struggle:

I am having a problem here. What are we supposed to do for this mod? I really think the author was an art major who got tired of playing ole maid and came up with a new card game. First, you cannot use the words task planning and fun in the same sentence. As I read the article, I expected some new idea and found what companies have been doing for years. Companies have been planning using large white boards for years and CUTA is nothing more that putting ideas on a small white board. All we are doing is putting our ideas in writing, which is nothing new. Flowcharts with boxes and circles come after the ideas are put down on paper. I have a problem taking an idea serious that involves gender and drawing pictures.

This is the same assignment that scored very high on our rubric for Barriers Group. It is easy to follow, but requires a work style, again, that is outside of Get-Along Groups normal mode of operation.

Sense making and social comparison experiences of Get-Along Group are manifested in two ways. First, Get-Along Group members examine the work of other groups through analysis and discussion about their posts. Second, Get-Along Group made active use of a new aspect of the course management system, an activity reporter, during their work. Tommy is the only informant in the study who made note of the activity monitor. Get-Along Group used it actively to see how active other groups were. A screen shot of the activity monitor is shown in figure 24. You can see that the activity monitor shows who is reading what topic, in a particular time frame on the right, and overall member participation in specific topics on the left. Figure 24 is taken from an online group in the same toolset, but not the group in this course.

Figure 24 - Activity Monitor



An exemplar comparison of Get-Along Group members with other people in the course, taken from an interview with Tommy, is below:

...what's being asked of us is really just common sense. But some of them you know are really just getting confused... I just, it's interesting to read their posts though, and when they come out with that. You have to wonder, it's like ok, their idea of what, how things should be done, and they're coming back with a question, it's like, I don't even read that in the statement, I'm not sure how they're writing it like that.... I've seen people really struggle on instructions and requirements in this particular course really more than any other.

Tommy's social comparison with other groups places himself, and members of his group in a special place; Membership is privileged.

Later, Get-Along Group's comparisons of themselves with other groups interacted with their activities making sense of their work and their groupness. In some cases, sense

making is short circuited by this comparison. This is similar to playground imitation in some ways, but unfolds online differently. For example:

You didn't see the cohesion you would expect. Some of the activities that I looked at there wasn't the coherence in the activities, there was some confusion about which direction. For example, the moodle of course. Is it supposed to be a course about moodle or any topic? Because there was disagreement within the group that they were unable to resolve that discord. If you take a look at the [SKRBL], they were also confusion about how this should be done. I think some of the confusion in the activities, in the posting that I didn't see the camaraderie that I would have expected.

This critical analysis short circuited Get-Along Group's participation in an online course module designed by another team. They made judgments, based on their own emergently rigid style of work, and used those judgments as rationale for not participating fully in the activities designed by other groups.

Poor first impressions by other groups do not have a lasting impact on Get-Along Group's interactions with those groups, however. In one case, when a group had difficulty getting started with Get-Along Group, Tommy and Sally suggested that the group had been doing good work all along, and that this incident was an exception; The group should not worry. In this way, the permanent digital record acted to overcome an initial challenge one group faced when working with Get-Along Group.

Get-Along Group is sometimes intimidated by groups whose members use big words. This is especially the case for Tommy and Joplin. For example:

There is one thing about this class, I consider myself somewhat intelligent, but I am not a rocket scientist by any means. I find that with the material we have been covering, there are some pretty intelligent people around here, and there are a lot of big words being thrown around, and sometimes I feel a little bit uncomfortable or a little bit out of place. I am probably not as likely to respond to someone that starts throwing around five dollar words as I am to reply to someone that is probably speaking a little bit more on my level, so I might actually understand what there point is and what they are saying. My answer is that I would probably

be more likely to reply to somebody that is thinking more in terms that I can understand

The absence of visual cues changes the nature of comparison and stereotyping takes on a distinctly literate form.

Pattern – Making Tasks Visible to the Group

Practices supporting fluid collaboration and cooperation online were developed on a wide spectrum among the groups. Some groups built a simple rhythm that they followed. Barriers and Individualist groups demonstrated difficulty getting into a rhythm, struggling more with developing common ground than common practices. Get-Along Group's reified practice of structuring their work using discussion boards focused on the major activities of a module endured from beginning to end. This practice proved central to the work that Get-Along Group did, and the way that they interacted. The members viewed it as a successful strategy, although this practice sometimes impeded the groups' task accomplishment, particularly when adapting to new task types.

This accepted group practice was the driver behind Get-Along Group's struggle at the beginning of module four, noted previously. The strength of the established practice within the group forced change for module four, because the module required more unstructured collaboration. The members eventually developed a new practice, the use of the wiki, to work on these kinds of open ended design tasks. A researcher's field notes reflect this quick adaptation to wikis:

This wiki goes through 57 different iterations... which is the most I've seen so far.... The work represents mostly Tommy and Sally; Joplin's contributions seem less significant in this activity, and mostly confined to the correction of grammatical errors and things like that.

Tommy described the group's practices around the wiki in greater detail:

Well we kind of actually, what we did is we went to, obviously went to the discussion board just to kind of post the assignment and in general just saying ok this is what we have to do, and the majority of our work was done through the wiki for that process. We updated things, we each, when we make a change to the wiki we select a color, so I may do green and somebody else may do blue and somebody else may use orange, so what we'll do is if we make a change to the wiki or something like that we will do it in our assigned, or chosen colors not so much assigned as, it's a chosen thing

The discussion board practice is noted, but the use of the wiki and the integration of the discussion board with the wiki becomes a defining characteristic of Get-Along Group's collaboration practices after module four. Making the work of the members visible is accomplished through this theme of structured work practices that incorporate discrete awareness, coordination and leadership practices.

Pattern – Group Metacognition (Self Awareness)

There are a number of characteristics of Get-Along Group that were analyzed consistently across modules and reported consistently by all members. Members expressed a consistent understanding of the group practices. Further, the group demonstrated and the members expressed an awareness of how their group identity is defined.

Member practices that were identified consistently in the data include:

1. Rotation of leadership. Each member took a turn as the coordinator of tasks, though Tommy was always responsible for module setup
2. Members expected this group experience to be like other, positive completely online group experiences they had in the past
3. Members participated in a sometimes obsessive manner. This is particularly in evidence with Tommy, though all members showed above average participation and contribution rates in the course

Equally compelling is the consistent reflections by the members of Get-Along Group, who identified a core set of practices as substantially responsible for their cohesive and successful completely online work:

1. Enthusiasm by all group members
2. Good communication practices
3. Breaking group work into chunks
4. Members who are attentive to demonstrating that they are responsible
5. Common language
6. Checking messages daily
7. Rely on other group members. Do not try to do it all yourself.

Perhaps surprising is the notation of a common language. The members each had an experience in a past course where communication with a member who did not have English as a first language impeded collaboration. Although the members were able to identify these rather specific factors that lead to satisfying collaboration, they appear to appreciate that some of success is directed by chance. Sally reflects:

*Pray to the *group gods* to get a group of like-minded individuals in your group who you can interact with easily without language issues or slacker issues!*

Theme – Completely Online Identity Interchange: Individuals and Groups

Individual and Group identity are visibly influenced by the experience of collaboration in this group. Tommy's sense of urgency about providing structure is increasingly complemented by a trust that members will accomplish the necessary tasks. Sally's skepticism about online groups is softened by the experience of participating in Get-Along Group and having positive, responsible members to work with. Joplin's low

confidence, evident in her early participation in the group, diminishes as the collaboration goes on. At the end of the course, Joplin is a confident, satisfied member of the group.

Get-Along Group's identity emerges from the positive interactions of its members. While the group is task focused early on, the stopping and starting dimension of module four leads the members to adopt new and more effective practices. These practices, primarily characterized by the use of the wiki and coordination of tasks using the discussion board, raise the trust level among the members and support a more fluid type of interaction. The members of Get-Along Group are able to divide the load in module five and check back with each other with very limited communication. This could be contrasted with the experience of Barriers Group, whose communication increased dramatically in module five, counter to the trend among the other seven groups in the course.

The emergence of a group identity through practices that are focused on thoughtful application of technology suggests a distinct trajectory for member social ability in Get-Along Group. The member practices, combined with tools forge group identity. The members are aware of why the get-along, and share a common view of success, which encompasses completion of the work to a level of excellence they have learned will be satisfactory. In the cases where the task types change, the group goes through adjustments and a reengineering of their practices for the new task type. The group identity remains constant, and the adjustments made to their practices may be viewed as a manifestation of evolving social ability.

Theme – Creation of Multiple Places and Spaces

The adaptation and evolution of the tools Get-Along Group used for collaboration is a component of their experience, and incorporated in the other themes and patterns discussed thus far. This adaptation of work places and the sometimes creation of a common work space that the team uses to collaborate and evolve their identity is also a distinct and identifiable theme in itself. Thematically, Get-Along Group likes to build collaboration spaces to suit the needs of a particular task, and is more confident in their pursuit of additional, complementary tools than Barriers Group or Individualist Group.

First and foremost Get-Along Group views tools as vital for the completion of group tasks. Through experimentation, they ultimately build habits of using Skype for ideation, discussion boards for coordination and wiki's for building group work products. The completely online place that Get-Along Group references in their relations with each other is an interwoven amalgamation of these specific places. Though not connected in cyberspace, these disparate tools are merged together in minds of the group as their place.

Other groups, like Barriers Group and Individualist Group spend time discussing tool use conceptually before engaging in the use of a new tool. Get-Along Group has a practice of just getting started when they think a new tool will support their collaboration more effectively. For example, the introduction of the wiki and the practices for using it introduced earlier emerged in a single discussion board post:

Hey guys! I copied and pasted team 7's position into our wikipage. I typed up some paragraphs in response to some of their ideas. I put those in blue font. I copied Joplin's thoughts and placed them right after the paragraph to which they pertain, and I put Joplin's thoughts in red font. Tommy, how about you choose a different color when you add thoughts? Here is the link to the page. <http://anonymized.wikispaces.com/CSCL+GET-ALONGGROUP+Page> We'll see how this works!

The choices of tool are a pragmatic means to the end of completing their work, and members quickly adapt to the strategies of other members. While groups like Barriers Group used tools as a proxy for power, and Individualist Group struggled with members whose online preferences drove them to prefer different tools, Get-Along Group rolled easily with tool changes. Get-Along Group's online experience of groupness is encumbered by fewer obstacles as a result of their fluid adaptation of technology.

Quantitative Data for Get-Along Group

Knowledge Construction

Get-Along Group's Knowledge Construction rates in public discussion boards shows that they have the lowest knowledge construction rates in module five, which is the module where they are working with other teams. This information is displayed in table 25.

Table 25 - Overall Knowledge Co-Construction for Case Study Groups

	<u>Overall</u>	<u>Mod 4</u>	<u>Mod 5</u>
Barriers Group			
ph1	<u>88.2%</u>	<u>96.0%</u>	80.2%
ph2	9.4%	4.0%	14.8%
ph3	2.5%	0.0%	5.0%
Individualist Group			
ph1	81.4%	85.1%	<u>90.9%</u>
ph2	10.3%	11.8%	10.1%
ph3	8.2%	3.1%	0.0%
Get-Along Group			
ph1	85.8%	84.8%	<u>91.4%</u>
ph2	9.1%	9.0%	5.1%
ph3	5.1%	6.2%	3.5%

The overall knowledge construction data puts them in between Barriers Group, with the overall lowest rates of knowledge construction, and Individualist Group, with the overall highest rates of knowledge construction in the course.

The members of Get-Along group participated at significantly different rates, and with different levels of knowledge co-construction. Joplin’s participation and contribution rates were the lowest, however the knowledge co-construction represented in her posts were the highest among Get-Along Group members. Table 26 shows that Joplin had more than twice as many PH2 posts as Sally or Tommy.

Table 26 - Get-Along Group Knowledge Co-Construction by Member

Row Labels	Grand			
	Total	Ph1 Pct	Ph2 Pct	Ph3 Pct
Joplin	94	78.7%	16.0%	5.3%
Sally	119	85.7%	7.6%	5.9%
Tommy	186	87.6%	6.5%	4.3%
	26			
Grand Total	425	85.8%	9.1%	5.1%

Group Identity

Most of the posts between members of Get-Along Group were directed at the group itself. The rate was 86%, very similar to the rate for Individualist Group’s posts and a notably higher rate than Barriers Group’s 59%. Get-Along Group’s quantitatively measured group identity is supported by the statements made in the closing course survey. Tommy described the group as “Working well together” and Joplin described the group as “EXCELLENT”.

Social Network Structure

Member subgroup analysis provides a compelling measure of within group structure. If members of an a priori group do not consistently show up together in

network groups derived from CANS logs, it is a statistical indication that the members of a group are not attending to the same material. Get-Along Group did have a wiki that they used for creating documents, but their practice was to combine the act of wiki editing with a corresponding post about the update in the discussion board. Get-Along Group's social network statistics, based on CANS logs, should therefore paint a reasonably accurate picture of their social network status and practices.

Factional Analysis for Get-Along Group is shown in table 27.

Table 27 - Factional Analysis Results for Get-Along Group

Module	Members in the Same Group	Run Percentage
Three	Joplin & Sally	25%
Three	Sally & Tommy	25%
Four	Sally & Tommy	84%
Four	Joplin & Sally	16%
Five	Joplin, Sally & Tommy	14%
Five	Sally & Tommy	14%

The lower rate of subgroup formation in modules three and five, compared with Barriers Group and Individualist Group is suggestive of a more coordinative approach to group work processes. Get-Along Group possibly felt little need to coordinate with each other, except in module four, where the task explicitly required the groups to work closely with each other and not with outside group members.

F-Group analysis for Get-Along Group shows Tommy, Sally and Joplin all in the same F-Group for both modules four and five. For module four they are alone in their own F-Group, the only group in the course to be represented that way for a module. In module five Get-Along Group and Barriers Group are in the same F-Group. This is likely a side effect of those groups teaching each other as part of module five. The F-

Group statistic reinforces the strong evidence from our qualitative analysis that Get-Along Group is a cohesive group with structural evidence.

Core-periphery analysis shows that all members of Get-Along Group are in the course core during the most critical parts of the course for collaboration: Module's four and five. At least one member is in the core for all Modules, with Tommy being in the core for modules one through five. Sally is in the periphery in the first few modules, which is consistent with her early skepticism about online learning. Table 28 shows all members of Get-Along group in the core for the principal collaborative modules of four and five.

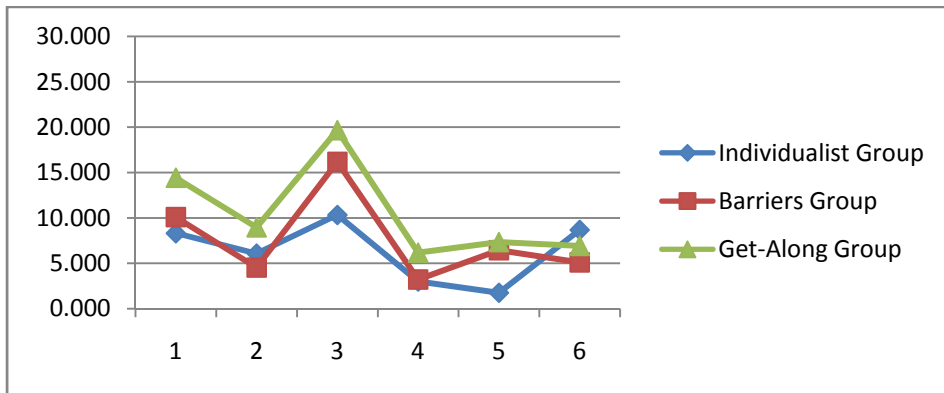
Table 28 - Get-Along Group Member Core-Periphery Analysis across Modules

	Module 1	Module 2	Module 3	Module 4	Module 5	Module 6
Core	Tommy, Joplin	Tommy	Sally, Tommy	Joplin, Sally, Tommy	Joplin, Sally, Tommy	Joplin
Periphery	Sally	Sally, Joplin	Joplin			Sally, Tommy

Members in the social network core have been associated with higher performing groups in past studies (Goggins et al, 2007). In this case, Get-Along Group is not a high performing group, but is a cohesive group. Understanding the implications of core-periphery membership on group development in a completely online setting warrants further research.

Network Centralization measures corroborate the notion that Get-Along Group is more toward the center of the total course social network than the other case study groups. Figure 25 shows Get-Along Group's centralization consistently above the other two case study groups.

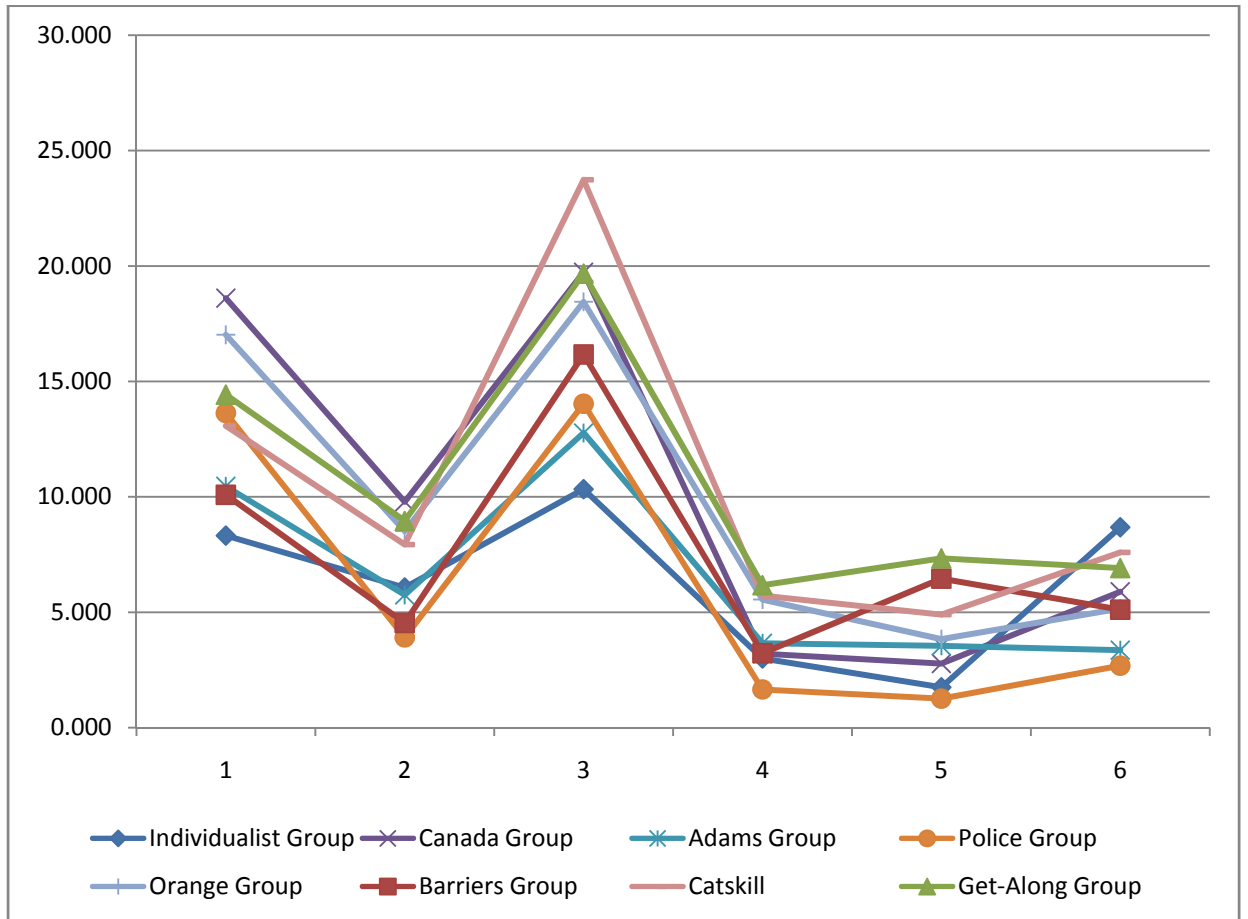
Figure 25 - Network Centralization for all Case Study Groups



Get-Along Group's network centralization position is also near the top in all modules, and at the top in modules four and five, in the context of all eight groups in the course.

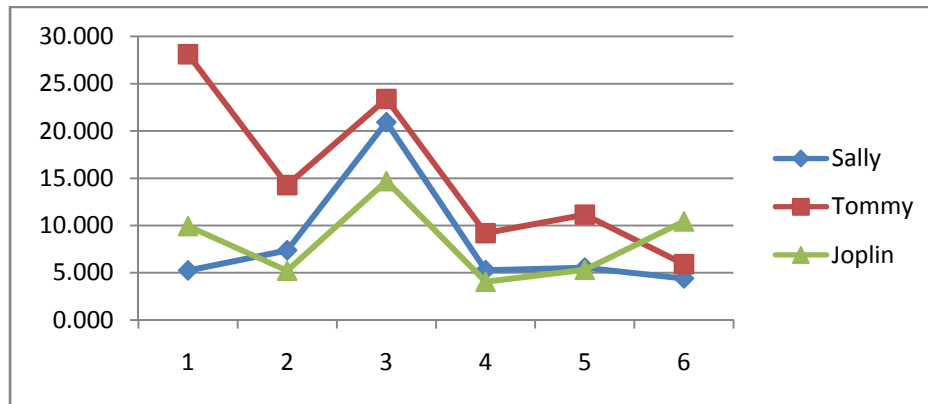
Figure 26 shows that Get-Along Group is more central than every group except Catskill Group in module three, and the most central group in the core of the collaborative part of the course – Modules four and five.

Figure 26 - Network Centralization for all Eight Groups (Get-Along Group is Team 8)



The trajectory of individual members of Get-Along Group suggests that Tommy is highly central to the overall network in the course. Figure 27 shows Tommy’s centralization considerably higher than Sally’s or Joplin’s in modules one and two. Tommy remains most central in the overall course network among Get-Along group members until module six, when Joplin’s centralization makes a sharp rise while other members decline.

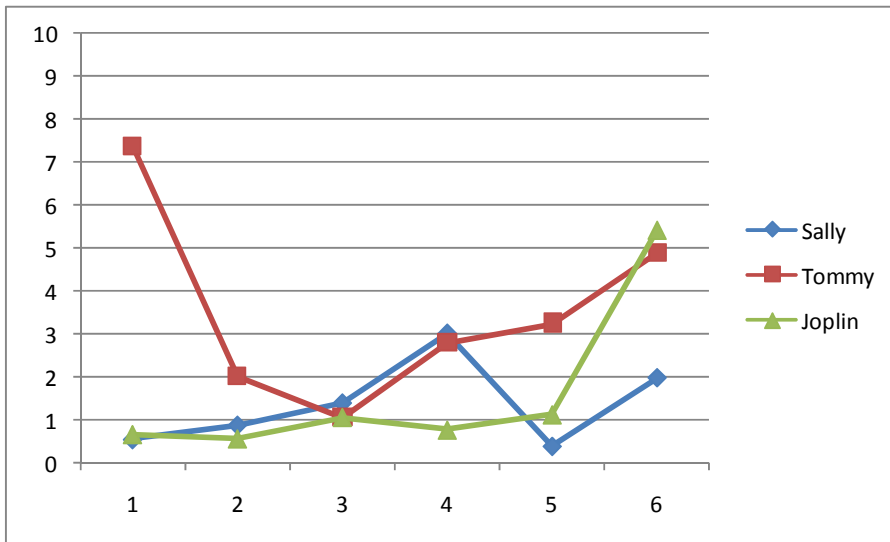
Figure 27 - Network Centralization of Get-Along Group Members



Tommy has the highest degree centrality of any member in the network.

The graph of member betweenness for Get-Along Group members, in figure 28, shows Tommy consistently high, but reveals Sally to have higher betweenness in modules three and four. When betweenness differs from centralization, the explanation for this network data set is that the member whose betweenness is comparatively higher is reading and posting the work of more members of the course. In this case, although Tommy's rate of participation leads to a highly centralized network position, Sally's diversity of participation is shown through slightly higher betweenness numbers in figure 28.

Figure 28 - Member Betweenness Measures for Get-Along Group



Tommy's high degree of betweenness in the network early in the course, before teams were assigned, indicates a group agnostic personal behavior – Tommy is an active participant in online courses. This finding is triangulated in interviews with Tommy, where he characterizes his participation in this course as “*obsessive.. possibly I spent a bit too much time online*”. Sally, whose participation began with some skepticism about online group work rises in her betweenness centrality with Tommy in modules two, three and four. Then, in module five the difference among members suggests that Sally and Joplin have focused on their isolated responsibilities for teaching and participation, while Tommy's interactions return to a broader, large course network mode of participation. When in the group, performing group tasks, Tommy's betweenness is moderated by the group participation. When the course activity is not focused on the small group, Tommy's place in the larger course network is more central.

Social Ability for Get-Along Group

Get-Along group members had higher social ability scores and greater positive development on each of the five factors than any other group in the course. The summary of their factor scores are shown in table 29.

Table 29 - Get-Along Group Social Ability Factor Scores

Member	Peer Social Presence		Written Comm. Skills		Instructor Social Presence		Comfort Sharing Personal		Social Navigation	
	T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Joplin	4.70	1.44	6.63	1.00	5.56	1.81	7.00	1.00	<u>3.77</u>	<u>3.49</u>
Sally	4.29	2.27	1.00	1.00	2.70	2.68	1.64	1.32	3.74	5.90
Tommy	1.41	1.83	6.00	5.71	<u>2.40</u>	<u>2.53</u>	2.27	2.32	<u>3.45</u>	<u>3.26</u>
	3.47	1.85	4.55	2.57	3.55	2.34	3.64	1.55	3.65	4.22

The Get-Along Group scores are green when they are especially positive and in the same direction as the complete course community. They are beige and underlined when the move with significance in the opposite direction as the whole course community. These scores for Get-Along Group may be placed in context with the overall scores for all 23 survey respondents, shown in table 30.

Table 30 - Overall Course Social Ability Factor Scores

	Factor Score	
Peer Social Presence	2.73	T1
	2.32	T2
Written Communication	2.92	T1
	2.25	T2
Instructor Social Presence	2.65	T1
	2.58	T2
Comfort Sharing Personal Info	2.58	T1
	2.20	T2
Social Navigation	3.06	T1
	3.20	T2

Peer Social Presence

Joplin and Sally had notable improvements in peer social presence from T1 to T2. Tommy had a nominal diminishment, but given his prolific, early participation, this may be understood as a highly present individual experiencing a nominal decline.

Written Communication Skills

Joplin experienced a large improvement in perceived written communication skills. Tommy's written communication skills factor started low and remained low throughout the course. This is consistent with Tommy's self-defacing communication about his vocabulary and intellectual capacity in interviews.

Instructor Social Presence

Joplin's sense of instructor social presence improves dramatically from T1 to T2. Tommy's diminished slightly. Sally's improved almost as slightly as Tommy's diminished. As a group, Joplin feels a greater sense of instructor social presence at the end than at the beginning, while Tommy and Sally are fundamentally unchanged. It is not known if specific events or the experience working successfully with an online group influenced Joplin's sense of instructor social presence.

Comfort Sharing Personal Information

Joplin and Sally experience significant improvements in their comfort sharing personal information from T1 to T2. Joplin, especially, moves from a position of strong disagreement toward a position of strong agreement with her comfort sharing personal information. This, combined with Joplin's other improved social ability factor scores suggests that Joplin's comfort working with completely online groups is improved by her experience with Get-Along Group.

Social Navigation

Social navigation improved for Tommy and Joplin, but diminished for Sally. Social navigation diminished for the course overall. Diminishing social navigation suggests that members are relying less on observing the actions of others in the course management system in order to direct their own activities, which occurred in the course overall. The fact that Tommy and Joplin both bucked that trend in the course and increased social navigation points to a difference in their experiences compared with Sally's. We know that Tommy is curious, and likes to participate in the course both broadly and extensively. Joplin started the course with timid participation. Her experience in Get-Along Group likely changed her perspective on how to follow the participation of diverse members in an online group setting.

Information Horizons for Get-Along Group

Get-Along group had the highest level of commonality among their top five for all groups. The instructor, other people in their group, the Sakai discussion board for their group and the team wiki were in the top five for all three members. Joplin & Tommy both rated other people in the course highly, but Sally did not. Joplin and Sally both had email in their top five, but Tommy did not.

Get-Along group rated Sakai announcements consistently lower than members of other groups did, very close to the bottom in the case of all members. This view may exist because Tommy would take the activities in a module and create a discussion board specifically for each activity. He included due date and other organizing information. This practice may have limited the team's reliance on instructor issued messages during their work together.

Group Efficacy for Get-Along Group

Rubric

For all of their close connections, organization and nominal knowledge construction, Get-Along Group's performance was subpar. Their total score on the module 4 rubric was third lowest in the course, higher than Individualist Group's, but more consistently low. Get-Along Group showed low scores on both the scenario and the script, while Individualist Group, you may recall, performed at an average level on the Scenario and then extremely low on the script. Get-Along Group's score did improve from the first task to the second task, which is unique among the three case study groups. The practices that led to a positive group development trajectory likely contributed to their adaptation to the new type of task.

Group Efficacy Survey

Get-Along Group's Group Efficacy survey scores were slightly better at T2 than they were at T1, with Tommy raising his score on a single question from a 3 to a 1 (out of 7, with 1 being the highest) on the second survey. All other questions were rated at the "1" level at both points when the survey was requested. The questions are available in appendix C. The question that Tommy increased his score on at T2 was "I believe my group has the ability to use communications software to collaborate with remote group members". It is likely that, early in the collaboration, Tommy was simply withholding judgment about the tools at his disposal, the tasks in front of him and the at that point unknown and unproven members of his group.

Get-Along Group Summary of Study Factors Related to Network Structure

Get-Along group has a high degree of centrality in the course social network, participation and contribution rates that are several times higher than any other group, solid group identity, a good sense of group efficacy and no events that lead to a concern about performance. All of the members of Get-Along group received an “A” in the course.

Two areas of performance concern emerge for Get-Along group. First, their score on the Rubric for module 4 points to low performance (relative to other groups) on the most critical assignment in the course. Second their nominal level of knowledge construction in course discussion boards points to prolific but sometimes less productive group communication.

The social network data suggests two areas for investigation to aid in the identification of groups that get along well, but complete work and construct knowledge at rates lower than similar groups in the same context. First, the volume of transactions stand out, and suggest a possibly social instead of task focused motive from Tommy, who expressed a desire to be a helper in the course during interviews. Second, the participation of a member like Tommy changes dramatically when he is participating in group activities, compared with when he is participating in activities that involve all course members. This is evident from his betweenness and network centralization measures for modules one through six. Tommy is also near the center of the social network overall in the course, which identifies him as a diverse, as well as prolific participator and communicator.

Summary of Get-Along Group

Table 31 summarizes the relationship between this case and each of the research questions, organized by patterns and themes.

Table 31 - Summary of the Individualist Group Case Framed by the Research Questions

	<u>Question One: Group Development</u>	<u>Question Two: Social Ability</u>	<u>Question Three: Information Horizons</u>	<u>Question Four: Group Efficacy</u>	<u>Question Five: Social Network Structure</u>
Pattern: Sense Making and Social Comparison	Group development is positively influenced by reifying practices based on sense making and social comparison activities of the group.			Reified work practices of the group impair performance when the type of task changes. The group does adapt, but after evidence of poor performance.	
Pattern: Making Tasks Visible to the Group	Group identity emerges through the practice of making the work at hand visible.		The use of the wiki and discussion board constrains and focuses the information horizons of this group and it's members		

	<u>Question One: Group Development</u>	<u>Question Two: Social Ability</u>	<u>Question Three: Information Horizons</u>	<u>Question Four: Group Efficacy</u>	<u>Question Five: Social Network Structure</u>
Pattern: Group Metacognition (Self awareness)	Group development is directed in a specific way by the practices and awareness of members.			This group implicitly shares a common definition of what effective looks like.	The network structure of the group reflects the observed and articulated practices of the members and cohesiveness of the group.
Theme: Completely Online Identity Interchange: Individuals and Groups	Group identity is forged from the individual identities of members, and their expressed intentions to contribute to the group.	Member interactions through technology are driven by tasks. The dominance of task focus within this group constitutes a particular trajectory for the development of group social ability.			
Theme: Creation of Multiple Places and Spaces	The group's identity incorporates these constructed group places and is shaped by them.	This group explicitly understands the relationship between tasks and tools in a completely online environment and manages each in the context of			

	<u>Question One: Group Development</u>	<u>Question Two: Social Ability</u>	<u>Question Three: Information Horizons</u>	<u>Question Four: Group Efficacy</u>	<u>Question Five: Social Network Structure</u>
		the other.			

Get-Along group is defined by its cohesive group identity, the molding of technology to meet the needs of the group, the common expectations of its members regarding performance and the mid-level relative quality of their performance. Centrality in the course social network derived from CANS logs corresponds with this group's experience. Also noteworthy was that the variation in the group's centrality was tied directly to the types of tasks, with tasks requiring large amounts of group work

It is notable that Get-Along Group also shared a uniquely high number of common information resources. This suggests that the correspondence of information resources with group cohesion in a completely online environment may warrant future investigation. Since our survey took place at the conclusion of activities, it is impossible to know whether the common information resources emerged from the group experience, or contributed to its cohesiveness. Barriers Group had two members interviewed for their information horizons, and they were different at the beginning and end of the collaborative activity, providing an example of a non-cohesive group that does not evolve

toward common resources. Future work should examine the role of information horizons and group development in a more focused manner.

Comparisons of All Eight Groups

The research questions for this dissertation have been answered in the case studies by triangulating:

1. Interviews,
2. Top down and bottom up ethnography of course discussion boards,
3. Content analysis of over 1600 discussion board posts on two rubrics,
4. Social network analysis of CANS logs,
5. Pre and post collaboration Group Efficacy survey results,
6. Pre and post collaboration social ability survey results and
7. Information horizons survey results

Together, these data were used to paint a picture of the experiences of three completely online groups. At the end of each case study, the patterns and themes that emerged were connected to the five core research questions. Together, these three case studies represent an opening collection of online group development archetypes framed within the research questions for this dissertation.

The case studies already presented are a deep analysis of the research questions. The remainder of chapter four reflects a wide analysis of the research questions. In this section, we move fluidly between the individual, small group and community (course) units of analysis to answer the research questions in the frame of all eight groups.

Each of the following sections begins with an overview of the data analysis related to the general research question, followed by the findings associated with each sub question. The top level research questions are numbered the same as they are in Chapter three. Research questions one through four include sub questions, which are

presented as sub headings. Question five does not have a sub question, but that section is organized in the same way as the sections for the other questions: With an overview of the data analysis, followed by findings organized as answers to the research questions.

One: How do Completely Online Groups Develop?

Throughout this dissertation, we frame completely online group development as knowledge construction, group identity and social network structure. Knowledge construction and group identity are addressed within each of the case study groups in the earlier sections. In this section we first compare knowledge construction and group identity formation across all three case study groups. Then we address the final two sub questions for research question one with social network analysis that incorporates the action from all eight groups.

In What Ways and to What Extent is Knowledge Developed Within Groups?

Each case study group selected a different combination of technologies for knowledge co-construction, and developed knowledge both together and individually along a unique trajectory. Table 32 shows the overall rates of knowledge co-construction for the three case study groups across all modules and specifically in modules four and five. The extent of knowledge construction in each case study group and by each case study group member for module four is shown in figure 29. Figure 30 shows the same analysis for module five.

To richly describe each group, the case studies presented contribution and participation data separately from knowledge co-construction data. In this section, our objective is to compare the groups, so we show these two data sets together. Figures 29 and 30 integrate within group post statistics (contributions) with knowledge co-

construction data. In these figures, we see raw participation analysis of each group’s discussion boards combined with the results of coding knowledge co-construction levels for each group. This sheds additional light on the extent to which each of the three case study groups co-constructed knowledge. Table 32 shows Individualist Group has the highest overall rate of knowledge co-construction, and that Barriers Group has the lowest. Rates are part of the knowledge co-construction story.

Table 32 - Overall Knowledge Co-Construction rates for Case Study Groups

	<u>Overall</u>	<u>Mod 4</u>	<u>Mod 5</u>
Barriers Group			
ph1	<u>88.2%</u>	<u>96.0%</u>	80.2%
ph2	9.4%	4.0%	14.8%
ph3	2.5%	0.0%	5.0%
Individualist Group			
ph1	81.4%	85.1%	<u>90.9%</u>
ph2	10.3%	11.8%	10.1%
ph3	8.2%	3.1%	0.0%
Get-Along Group			
ph1	85.8%	84.8%	<u>91.4%</u>
ph2	9.1%	9.0%	5.1%
ph3	5.1%	6.2%	3.5%

Figure 29 shows gross number of posts for each of the case study groups, and the level of knowledge co-construction for each category of post. It also shows the post levels for each member of each case study group in a stacked line. Table 32 shows that Get-Along Group has the highest rate of knowledge co-construction in it’s posts in module four. Figure 29 show that Get-Along Group also has the highest total number of posts, and a visibly higher number of posts at the Ph2 level. Get-Along Group also has the highest number of Ph3 level posts in module four. In this module, the group with the

most Ph3 posts also has the highest percentage of Ph3 posts. There is a consistent view of which group co-constructed knowledge to the greatest extent.

Figure 29 - Module Four Gross Knowledge Construction Across Groups and Members

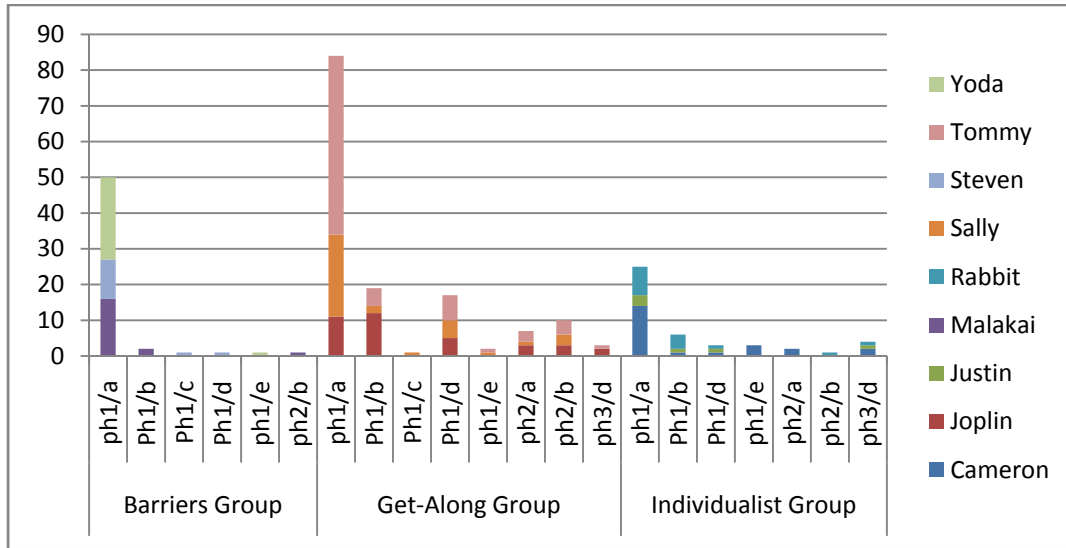
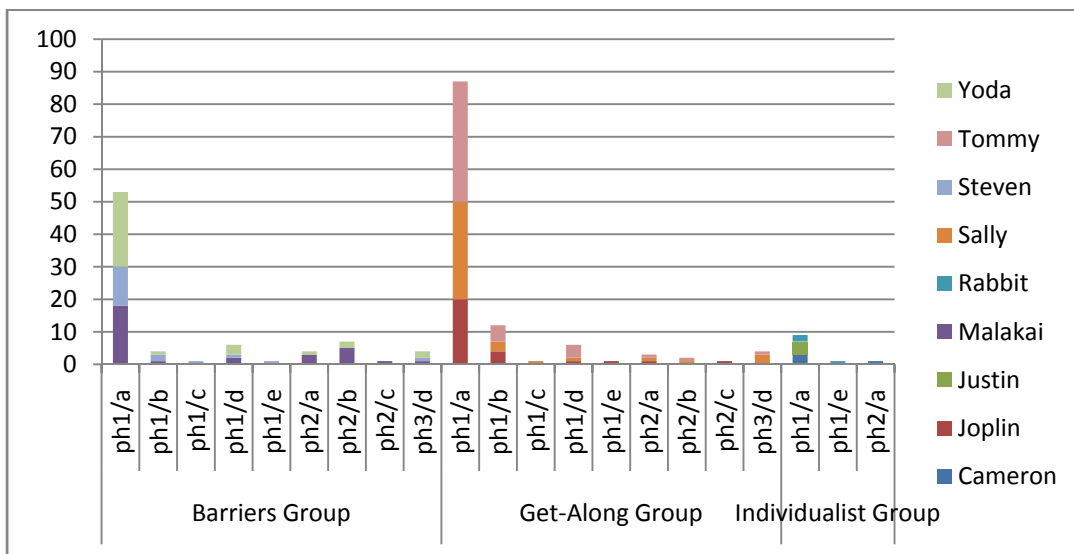


Figure 29 also shows that Barriers Group and Individualist Group have notable differences in the level of knowledge co-construction within the Ph/1 level during module four. Recall that Gunawardena’s (1997) instrument for evaluating knowledge co-construction in discussion boards includes the lowest level at Ph/1 and the highest level at Ph/5. The full instrument is presented in Appendix E. Individualist Group members have Ph1/A, Ph1/B, Ph1/D and Ph1/E levels of knowledge co-construction to go along with Ph3/D contributions. Barriers Group is visibly concentrated in the Ph1/A type of knowledge co-construction in module four. This is evident in table 32, but more emphasized in Figure 29.

Figure 30 shows that the gross contribution levels of Get-Along Group still exceed those for Barriers Group and Individualist Group in module five, but their level of knowledge co-construction is concentrated more totally in the Ph1 range, and Barriers

Group shows knowledge co-construction in the higher, Ph2 and Ph3 range. Individualist Group's knowledge co-construction and participation rates are also visibly lower in module five. Unlike module four, in module five Barriers Group has the highest percentage of knowledge co-construction at the Ph3 level, but Get-Along Group has the same number of Ph3 posts.

Figure 30 - Module Five Gross Knowledge Construction Across Groups and Members



Together, table 32 and Figures 29 and 30 show that knowledge co-construction rates and contribution rates provide a partial answer to our question about the extent of knowledge co-construction in these completely online groups. By combining contribution rates and knowledge co-construction in the same diagram, we see interesting contrasts in the total extent of knowledge co-construction and contribution across the case study groups. A highly participative group like Get-Along Group will sometimes have the same total number of high knowledge constructing posts as a group with a higher percentage of such posts, simply by virtue of their participation. At other times, the same

group will have the highest rate of knowledge co-construction and the highest total number of high co-constructing posts.

What Identities Do Group Members Develop, to What Extent Does Group Identity Form, and How is Identity Shaped During Online Group Work.

The specific identities of each case study group and its members, along with the practices which shaped those identities are explicated in each group case study. Each group’s identity is influenced by the identities of the members, and those member identities in turn influence the development of the group. The three distinct trajectories experienced by each of the three case study groups speak most directly to this question.

In the case studies, we also separately note the extent of group identity formation observable through coding of discussion board posts, noting interesting contrasts between the groups where they exist. These differences are presented more visually, comparing all three case study groups, in table 33.

Table 33 - Discussion Board Communication Coded for Group and Individual Identity for all Three Case Study Groups

	Barriers Group	Individualist Group	Get-Along Group
Small Group Communication	59.9%	85.1%	85.7%
Interpersonal Communication	39.1%	13.8%	12.2%
Interindividual Communication	1.0%	1.1%	1.3%

Although Barriers Group and Individualist Group both faced challenges in their collaboration, only Barriers Group had a significantly lower percentage of communication directed at the group level and a significantly higher percentage of communication directed at the interpersonal level. This is our quantitative measure of group identity formation across groups. The small group case studies suggest that there are at least two distinct categories of group identity rate discernable from discussion

board posts. The lower rate is associated with a group who broke down completely. The higher rates are associated with groups who functioned with discord in one case, and lack of discord in another as described in the case studies. In other words, completely online group identity formation may have more to do with the extent of breakdown than performance or member described experiences of groupness.

What Social Network Structures are Formed Within Online Small Groups and Across Online Small Groups During Group Work?

Social network measures were presented to describe the comparative structure of case study groups using statistics. SNA may also be applied to the course community. Diagrams provide the most straightforward analysis method for understanding the relative position of group members to each other, and to other students in the course. The calculation of tie strength, discussed earlier, is visually represented in each of the social network diagrams in this report. The location of the nodes, relative to each other, is based on the distance between those nodes, calculated from the relative strength of ties between a node and the network of nodes around it, using Netdraw, version 2.083.

An Overview of the Diagram Color Schemes and Analysis Techniques

Three options within Netdraw were used to represent social network data in this course. First, the layout of the social network was adjusted using Netdraw's multi-dimensional scaling algorithm, found under the "Layout" menu. Second, line size was adjusted to reflect tie strength. The effect of these two choices is to place the nodes in space in a manner that reflects similarity, and to emphasize connections that are stronger, based on calculated distance measures. A third analysis technique from Netdraw is used

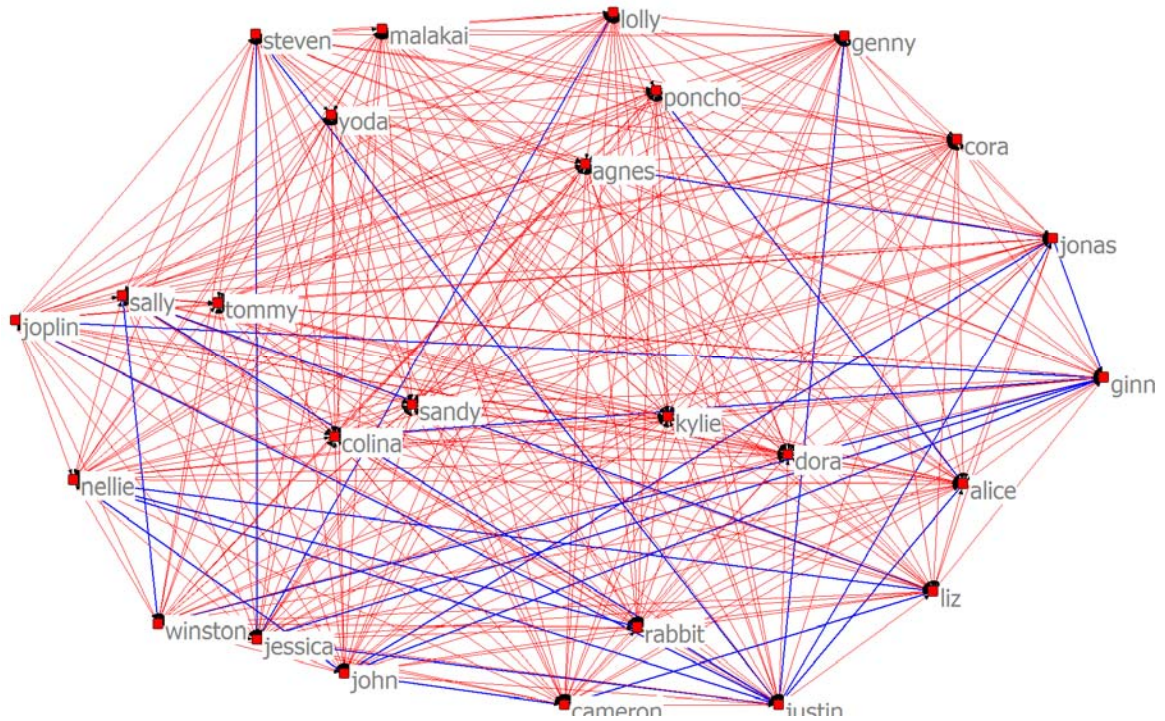
in some cases to color non-reciprocal ties differently than reciprocal ties. Those are explained in context.

Analysis of Social Network Structures Formed During Group Work

The first network diagram is of all interactions between all nodes (people) in the network that occurred during the entire eight week course. Several aspects of the social network, calculated using CANS logs emerge from this diagram. First, the members of the three groups from our case studies are clustered in those same groups. We find Barriers Group in the north, Get-Along Group in the west and Individualist Group in the southeast. The clustering suggests that the distances between nodes, calculated based on CANS log reads and posts between specific individuals, results in social network data that reflects the a priori structure of the groups in total. Using data from the entire course as a starting point has a smoothing, “big picture” effect on our view of the data.

Knowing that the big picture reflects a structure we know a priori establishes trust that using the same data to build social network diagrams for narrower windows in the course will consistently and usefully reflect variations in the actual network structure. Figure 31 shows the overall social network structure for the eight week course.

Figure 31- Social Network Diagram of All Members based on Euclidean Distance, for entire eight weeks (blue lines are non-reciprocal ties)



Kylie, Dora, Alice and Liz from Canada group are clustered near each other, as are Winston, Jessica and John from Adams Group. Sandy and Colina from Catskill Group are close to each other and close the center of the network, while Nellie (the third member of Catskill Group) is at a greater distance and on the periphery. Given the proximity of members of other a priori groups to each other in the network visualization, we suspect there are interesting causes for this network position worthy of future investigation.

For seven out of the eight a priori assigned groups the members are clustered near each other. Members who are known to be more active, including Tommy, are closer to the center of the network. Members who are known to be less active, including Justin, are close to the periphery. The visualization of the eight week network structure is

puzzling in some ways. For example, Rabbit is nearer the center of the diagram than Cameron; if we recall the case of Individualist Group, the qualitative descriptions and other measures of participation confirm Cameron as more central to that group than Rabbit. The visualization of the course network in Figure 31 suggests that there is an aspect of Rabbit's participation in the overall course not visible from her interactions with her group.

A few additional social network statistics help to shed additional light on questions that arise from figure 31, such as Rabbit's position. Table 34 describes the overall degree centrality for all of the members of the course over the life of the course (8 weeks). This table includes reflexive/diagonal ties – those between a member and themselves, which occur naturally in our data set when a member reads or responds to their own post. Rabbit's position closer to the center of the overall course network is explained by an examination of degree centrality. We can see that Rabbit's normalized in degree and out degree centrality is higher than her group mates Cameron and Justin. Higher in degree and out degree centrality will push a member toward the center of a visualization like the one in figure 31, while lower centrality will push members toward the periphery. While the case of Rabbit's participation in the Individualist Group would suggest a more peripheral position for her in the social network, a review of her overall participation in the course places her closer to the center. In Rabbit's instance, she is participating more in the overall course over eight weeks than she does in her group for the latter modules.

Table 34 - Degree Centrality for all Members in All Modules, Including Reflexive / Diagonal Ties

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
tommy	649.612	531.791	11.426	9.354
kylie	466.752	375.785	8.21	6.61
agnes	448.962	252.592	7.897	4.443
colina	446.118	416.108	7.847	7.319
sandy	368.692	263.572	6.485	4.636
dora	367.079	165.715	6.457	2.915
sally	318.128	315.461	5.596	5.549
poncho	291.367	314.189	5.125	5.526
john	259.829	210.136	4.57	3.696
joplin	250.899	286.284	4.413	5.035
malakai	244.921	280.384	4.308	4.932
yoda	234.386	337.672	4.123	5.939
jessica	216.139	243.678	3.802	4.286
rabbit	215.614	217.99	3.792	3.834
steven	193.872	194.744	3.41	3.425
lolly	178.201	278.211	3.134	4.894
nellie	171.039	289.402	3.008	5.09
alice	164.296	209.25	2.89	3.681
cameron	161.133	238.725	2.834	4.199
winston	160.12	226.406	2.816	3.982
genny	155.48	129.238	2.735	2.273
liz	138.464	121.067	2.435	2.129
cora	126.767	157.474	2.23	2.77
instructor	123.168	308.495	2.166	5.426
researcher	87.929	1.019	1.547	0.018
jonas	75.397	115.969	1.326	2.04
justin	73.859	123.469	1.299	2.172
ginny	61.309	44.705	1.078	0.786

The social network data we generated is valued data, meaning that the existence of a tie between two actors has a weight, or distance. To review how this weight is calculated, return to chapter three. For this type of value network data, the raw out degree and in degree scores are calculated by UCINet using tie strength as an input instead of the

simple existence or non-existence of a binary tie. For example, in a binary network, in degree and out degree would be 100% for any actor who was read at least once by every other actor and read every other actor at least once.

In an online collaboration like this, the simple existence of a tie does not provide enough data. Most actors would be near 100%. This is evidenced in the social network diagram in figure 31, which shows a small number of one directional (blue) ties. Therefore, the degree, both in and out, is normalized. While data for the whole course reflect higher raw scores than module one because the tie strength is greater if every connection over eight weeks is counted, normalized degree centrality is a consistent statistic for comparing data between time periods or modules in this study.

Degree centrality social network data also include descriptive statistics, which are useful for interpreting the variability in the actor level comparisons. The descriptive statistics for table 34 are in table 35. From this table we can see that Rabbit's degree centrality (3.792 out, 3.834 in), while highest for her group, is still below the course mean (4.177 out, 4.177 in), but well within the standard deviation (2.422 out, 1.926 in) of the mean. Justin, in contrast, has out degree (1.299) and in degree (2.172) centrality more than one standard deviation below the course mean. This is consistent with his overall low performance as a group member. In Justin's case, this low performance extended out to the course.

Table 35 - Descriptive Statistics for Degree Centrality Data Across All Modules, Including Reflexive Ties

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
Mean	237.483	237.483	4.177	4.177
Std Dev	137.72	109.506	2.422	1.926
Sum	6649.533	6649.532	116.96	116.96
Variance	18966.707	11991.471	5.868	3.71
SSQ	2110220.75	1914914	652.857	592.434
MCSSQ	531067.813	335761.188	164.301	103.877
Euclidean Norm	1452.66	1383.804	25.551	24.34
Minimum	61.309	1.019	1.078	0.018
Maximum	649.612	531.791	11.426	9.354

Reflexive / Diagonal Tie Semantics and Interpretation

One final aspect of the degree centrality data in this study is that some is presented with diagonal ties, and other tables without. The presence of diagonal ties is a counting of connections a person makes with themselves. In our data, reading your own post or responding to your own post will result in a reflexive or diagonal tie. In some cases the two tables are contrasted in order to underscore different possible interpretations of the network data. The data has the same structure, just different strength measures for the same time period. For example, overall network centralization will generally be greater if reflexive ties are removed. Table 36 shows the overall network centralization for the eight week collaboration with reflexive ties removed.

Table 36 - Overall Network Centralization across All Modules, With and Without Reflexive Ties

	With Reflexive Ties	Without Reflexive Ties
Network Centralization (Outdegree)	7.80%	10.95%
Network Centralization (Indegree)	5.57%	6.03%

To this point we have clearly shown that Tommy is the most active member of the course network. This is reflected in a number of measures and case study dimensions already discussed. If we remove the reflexive ties from the degree centrality measure of socio-centric density, the result will show lower overall density levels. This is illustrated in table 37.

Table 37 - Centrality for all Actors in All Modules, NOT Including Diagonal Ties

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
tommy	446.565	328.744	17.969	13.228
kylie	383.186	292.219	15.418	11.758
agnes	379.281	182.91	15.261	7.36
dora	337.165	135.8	13.567	5.464
colina	309.324	279.315	12.446	11.239
sandy	300.496	195.375	12.091	7.861
sally	235.543	232.876	9.478	9.37
john	207.498	157.805	8.349	6.35
poncho	196.917	219.739	7.923	8.842
joplin	179.51	214.895	7.223	8.647
malakai	173.094	208.558	6.965	8.392
yoda	171.051	274.337	6.883	11.039
rabbit	165.948	168.324	6.677	6.773
steven	160.719	161.591	6.467	6.502
jessica	154.491	182.03	6.216	7.324
genny	141.51	115.268	5.694	4.638
lolly	138.409	238.419	5.569	9.593
liz	125.653	108.256	5.056	4.356

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
alice	119.553	164.508	4.81	6.619
cameron	118.957	196.549	4.787	7.909
nellie	118.461	236.824	4.767	9.529
winston	116.078	182.364	4.671	7.338
instructor	109.028	294.355	4.387	11.844
cora	108.509	139.215	4.366	5.602
researcher	87.929	1.019	3.538	0.041
jonas	59.538	100.11	2.396	4.028
justin	57.444	107.054	2.311	4.308
ginny	53.948	37.344	2.171	1.503

Comparing table 37 with table 34 shows that Dora jumps ahead of Sally and Colina, while Tommy, Kylie and Agnes remain the top three participants, using out degree as a measure. The normalized measures of centrality for this online network indicate higher centralization. This is also visible upon reviewing the descriptive statistics for table 37, shown below in table 38.

Table 38 - Descriptive Statistics for Degree Centrality Data Across All Modules, NOT Including Reflexive Ties

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
Mean	184.136	184.136	7.409	7.409
Std Dev	103.244	75.097	4.154	3.022
Sum	5155.803	5155.803	207.455	207.455
Variance	10659.232	5639.575	17.258	9.131
SSQ	1247826.625	1107276.13	2020.268	1792.713
MCSSQ	298458.531	157908.094	483.213	255.658
Euc Dist	1117.062	1052.272	44.947	42.34
Minimum	53.948	1.019	2.171	0.041
Maximum	446.565	328.744	17.969	13.228

One measure of the differences in these two networks (one including the reflexive ties, the other not) is the measure of variability of degree. Variability of degree describes whether the population is homogenous or heterogeneous in structural positions. In other

words, are more people mathematically similar in their position relative to others (Homogeneous) or mathematically different (Heterogeneous). The coefficient of variation will tell us whether the variability in this network is relatively high or relatively low compared to typical scores (Hanneman, 2007). The coefficient of variation is calculated by dividing the standard deviation by the mean and multiplying by 100. A higher number indicates a more heterogeneous network. In the case of the data with reflexive ties, the calculation for the in degree coefficient of variation is:

$$\left(\frac{1.926}{4.177}\right) \times 100 = 46.11$$

The calculation for the out degree coefficient of variation for the data with reflexive ties is:

$$\left(\frac{2.422}{4.177}\right) \times 100 = 57.98$$

The in degree coefficient of variation for data without reflexive ties is:

$$\left(\frac{3.022}{7.409}\right) \times 100 = 40.79$$

The out degree coefficient of variation for data without reflexive ties is:

$$\left(\frac{4.154}{7.409}\right) \times 100 = 56.07$$

These statistics show that the in degree coefficient of variation is much greater when the reflexive ties are present. The out degree coefficient of variation is almost the same in both cases. The greater in degree heterogeneity when the reflexive ties are present suggests that not all participants read and respond to their own work to the same extent.

In a completely online setting using the types of logs we have, the semantics of a reflexive tie is meaningful. If a person is reading and responding to themselves, they will

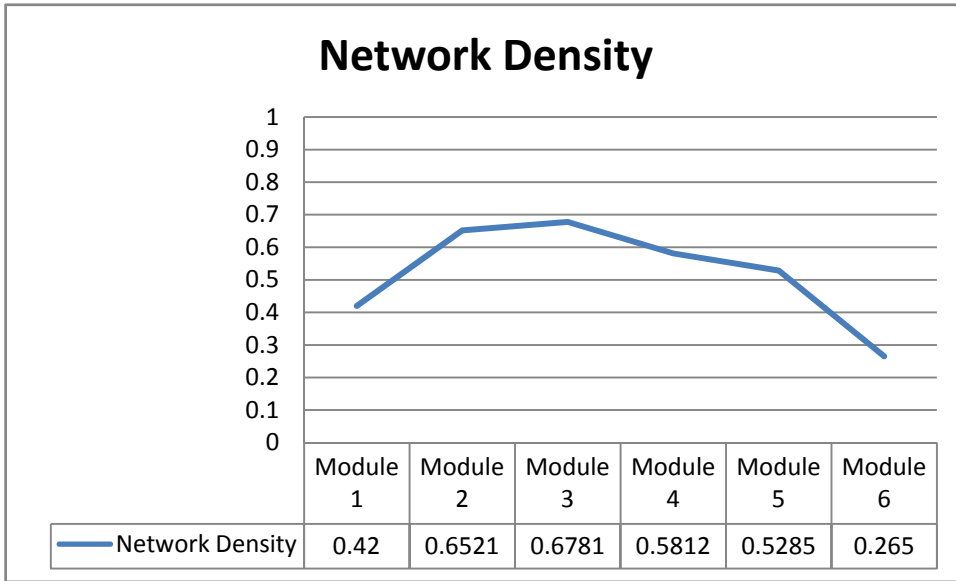
become more central to the network. This notion follows the simple Hollywood axiom that there is no such thing as bad publicity. On the other hand, the specific semantics of these semi-narcissistic online behaviors are not well known. Within a small group, reading and responding to one's own work may simply be an indication that one has made two posts in a row in order to further their group's efforts. Showing such an individual as more central in the network may be appropriate. However, the purpose of this study is to understand completely online group development. Including self-responses and self-reads in the module by module comparison of actor degree centrality would not be a measure of group development, but a measure of group non development that we have shown, in our data set, mutes the diversity and in degree centrality of other members. In addition, by excluding reflexive ties from the data that follows, we will have a sharper contrast between in degree and out degree centrality. Using Hanneman's (2007) guidelines, in degree centrality is moderately homogeneous in this network, while out degree centrality leans more toward heterogeneity. Therefore, the presentation of data comparing modules will not include reflexive or diagonal ties (two terms for the same thing). This point is particularly important for the next sub question, which examines changes to network structure over the life of the course. The comparison between network centrality in adjacent modules is a contrast of the changing behavior of groups, and not individuals, because the reflexive ties are removed.

To What Extent do Social Network Structures Change Over the Course of Group Work?

There are a number of additional social network statistics, not examined in the case studies that will help us understand the changing structure of the course network. One example is the measure of overall network density, which provides a picture of the

percentage of the total number of ties in a network compared with the total number of potential ties. For each module, the social network density for all the members of the course varies as shown in figure 32.

Figure 32 - Overall Social Network Density trends by Module

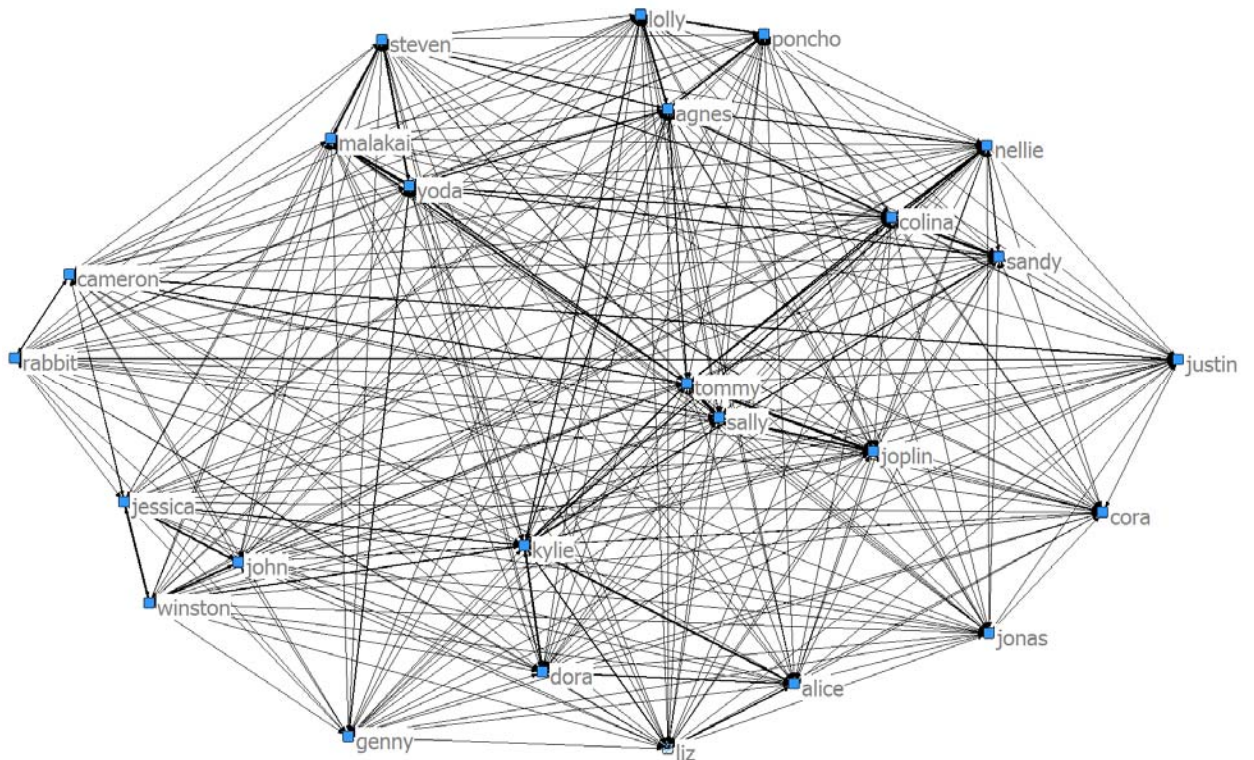


The maximum value of one would occur if every member of the course read or responded to every post from every other member of the course. While this does not occur in any module, it is clear that the activities in modules two and three lead to the highest overall network density. A slightly narrower view of the groups, focused on the time of

collaboration that occurred during modules three through five shows the evolving nature of the social network in this course. In this time window, we can see a tight grouping of Malakai, Steven and Yoda – Barriers Group, as well as a tight grouping of Tommy, Sally and Joplin – Get-Along Group. We also see two members of Individualist Group close together, but on the periphery. Justin, the third member of Individualist group is also on the periphery, but on the opposite side of the network from his peers. There are two phenomena in the experience of the groups and in this social network diagram that

warrant discussion. First, the centrality of Get-Along Group in the module three, four, five diagram compared with the whole course diagram. Second, the dispersion of Justin to the opposite side of the network from the rest of his group is of interest.

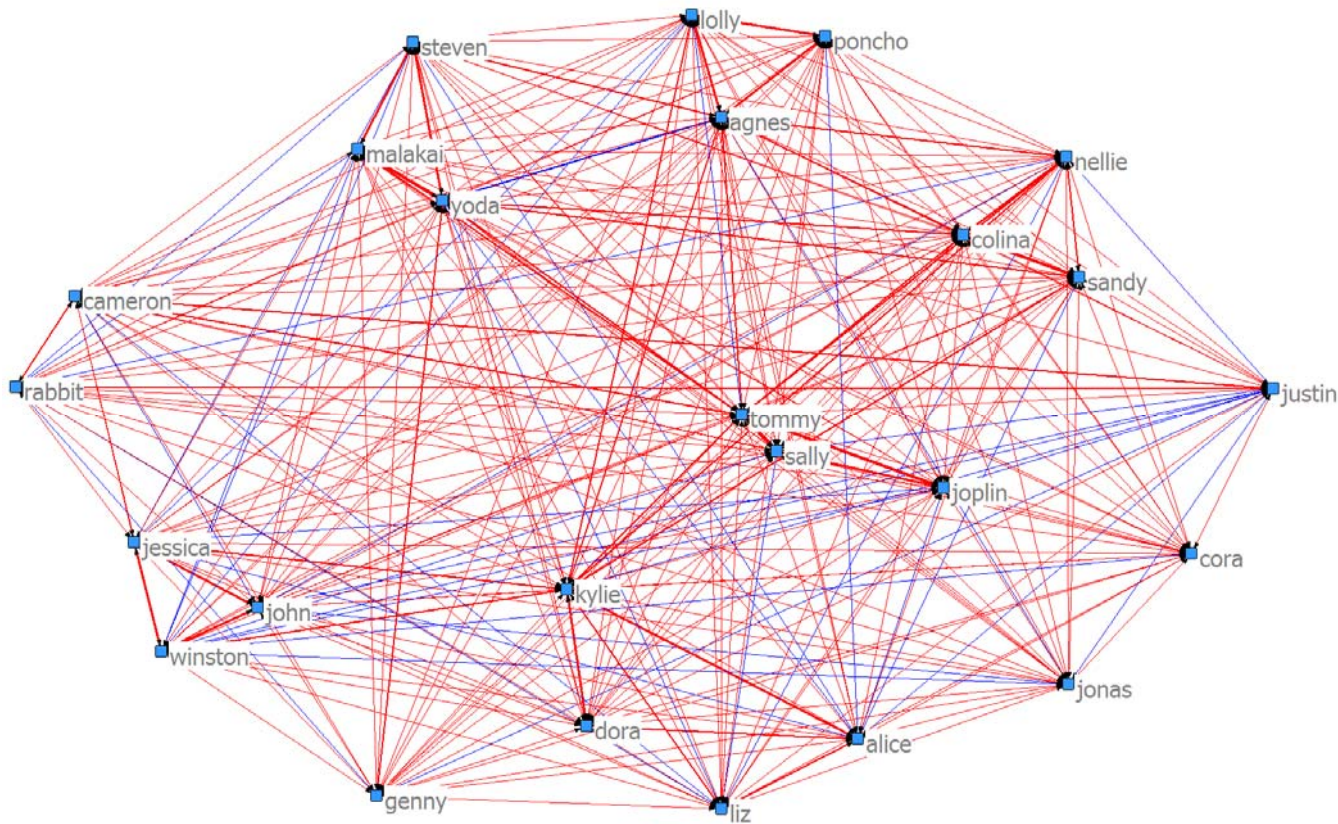
Figure 33 - Social Network Diagram of all Members Based on Euclidean Distance for Modules three through five (Darker lines are stronger ties)



The social network diagram for all course members for all modules, shown in figure 31, places Get-Along Group farther from the center of the diagram for modules three, four and five than figure 33. Since modules three, four and five are the modules of most intense small group collaboration, removing the ties from activities like the debate in module two and the non-grouped module one should tighten the small networks known a priori. This is what is represented in figure 33, where Get-Along Group is nearer the center. Get-Along Group is logically more central in figure 33 because their overall participation in the course is much greater, and they therefore recorded interactions not

only with themselves, but with more of their fellows. This active, wide reach of Get-Along Group members makes them, by definition, central to the social network. The social network diagram for module's three through five confirms this. Get-Along Group member Tommy is the most active participator and contributor in the course, and is individually central in the visualization. Figure 34 is the same social network with non-reciprocal ties in blue like figure 31, but with line thickness continuing to reflect strength of ties, as in figure 33.

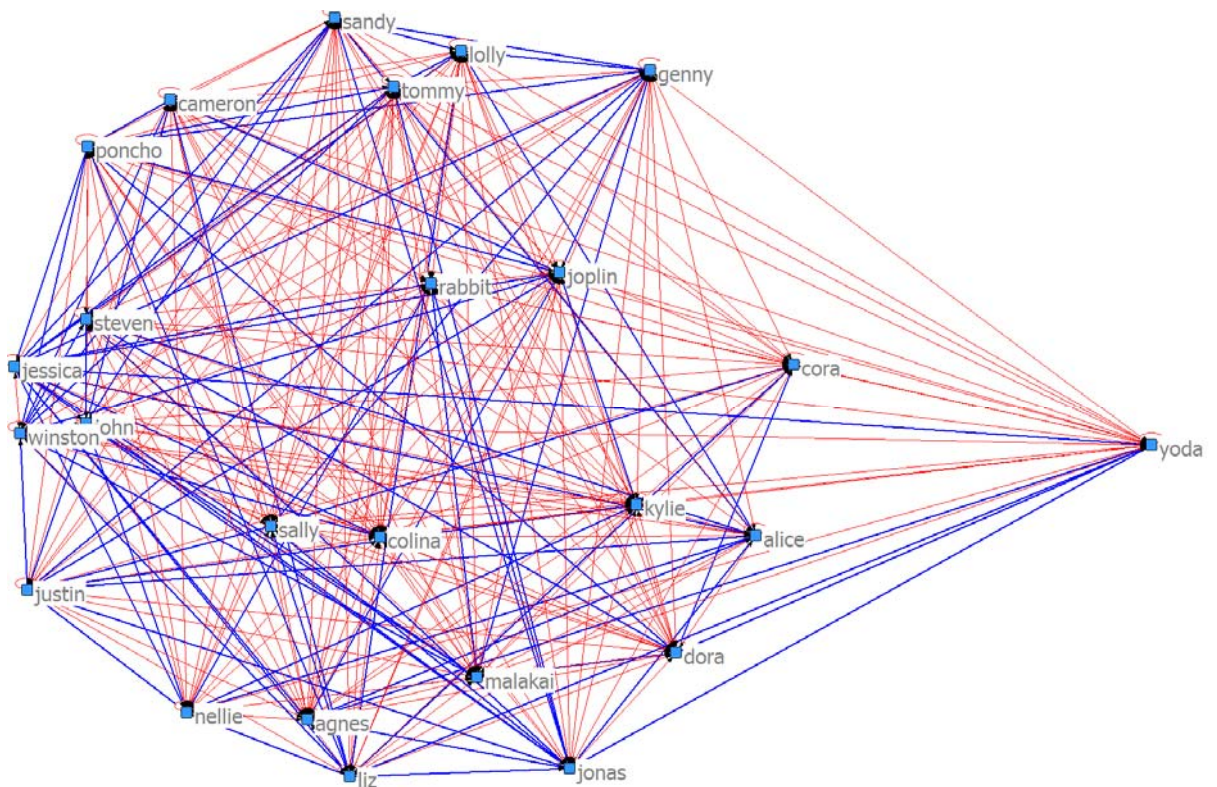
Figure 34 - Modules three, four and five with weighted ties and non-reciprocal ties in blue



Different time frames produce similar, but evolving social network diagrams.

Figure 35 looks at just modules four and five. Module four, you will remember, is the module when the small groups each designed a scenario, a lesson script and an evaluation plan. Module five is when those plans were taught. Each group participated in two modules taught by another group, and taught one module to two other groups. This task design would suggest that there will be three groups in the course that each group does not interact with. The diagram below reflects this in the number of non-reciprocal ties. Module three, which is what we removed in this diagram, compared with the previous one, asked participants to review everyone's stories, and choose those most like their own. That activity naturally resulted in a denser set of reciprocal ties.

Figure 35 - Social Network Diagram for Modules Four and Five Combined (blue lines represent non-reciprocal ties)



These last two diagrams demonstrate that this type of social network analysis provides semantically different visualizations of the same social network, when viewed in different time boxes. The structure of the network is dynamic to the task the group is working on, and the participatory traits of the group. This is not that different from a weather report. Six days of sunshine is a great week, but if the weather report is viewed from the perspective of that one day with a tornado outbreak, the picture is different. A wide, course long view will paint an overall picture, but data from one or two modules will identify important shifts in those networks.

The difference in the views is evident in a comparison of the first two social network visualizations and the last two. The locations of individuals and groups in the network evolve, as we described with Individualist Group and Get-Along Group. The final social network visualization in figure 35 also provides insight into a change we know occurred in Barriers Group in module four and five. While the group became much more active, with participation and contribution rising among all three members during the same time period when all other course participants declined in those measures, we also see that they have become dispersed from one another. Just as the case study for Barriers Group described the events of module four and five as tumultuous and redefining, the social network diagram reflects a change. Barriers Group member divergence in information resource use, decline in measured performance and decline in group efficacy further triangulates the social network diagram that shows them far apart from each other, but with stronger ties to members of the larger course community.

Social network measures also help to refine our understanding of how social network structures change over the course of group work. We return to degree centrality,

a socio-centric density measure devised by Freeman (citation) to measure the centrality of each actor and to relate the actors to the overall centralization of the network. Like with the micro level social network analysis we did with the case study groups, this macro level analysis was performed using UCINet. Recall that there are two types of density: In Degree and Out Degree. In degree density characterizes the extent to which an actor is prominent in a network. Actors with high in degree centrality in this study's context are those whose work is read more frequently. Out degree centrality is a measure of influence in social network analysis. In our study, actors with higher out degree centrality are posting items in the course to a greater degree than others. In traditional social network analysis, out degree centrality is equated with power because an actor is communicating directly with another individual, ostensibly exercising power. In our study out degree centrality will be higher for those who post more, and in degree centrality will be higher for those who are read more. This is a consequence of the way the strength of tie measure was calculated.

If every actor were reading the work of a single other actor, such as the instructor, the in degree and out degree centrality of each actor who is not the instructor would be low. This is an example of a highly centralized network. If everyone reads and posts to each other individual equally, the network will have very low centralization measures. Centralization at the network level, then, is a measure of the presence of an influence and prestige elite. Low centralization overall logically leads to the interpretation that the network is not reliant on a small subset of actors.

Degree Centrality Social Network Data

In this section we describe the degree centrality social network data, descriptive statistics and coefficient of variation for particularly interesting parts of the eight week collaboration. Complete statistics for modules two through six are available in Appendix I. The data for the entire course were presented in the answer to the previous sub question.

Module One

The degree centrality social network data for module one is shown in table 39.

Table 39- Module 1 Degree Centrality

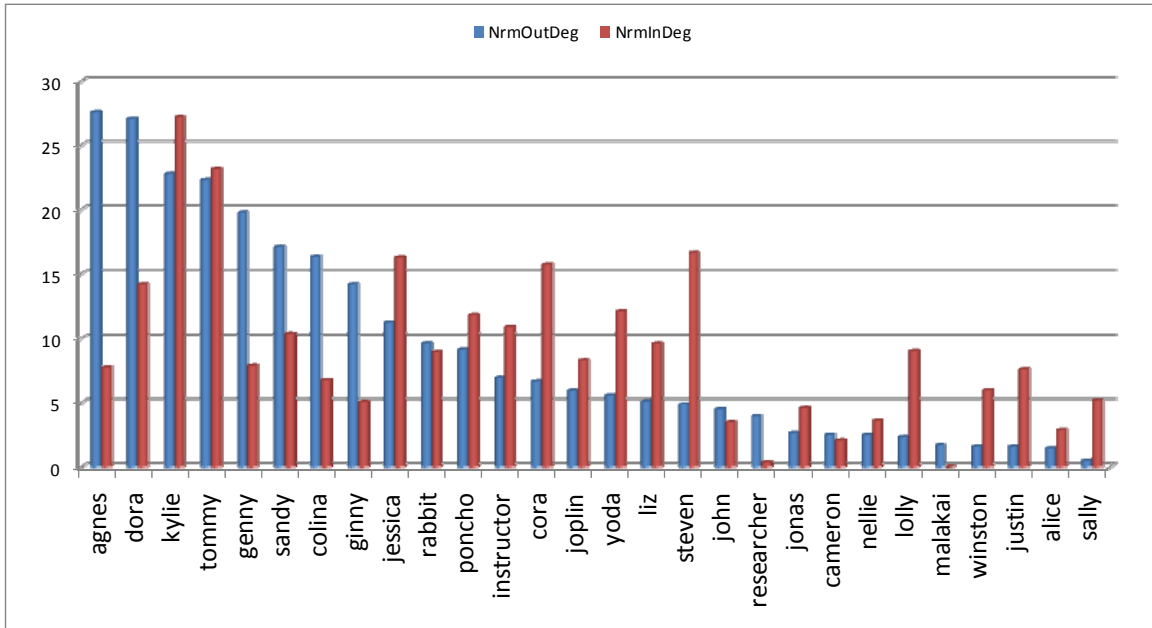
	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
agnes	196.576	54.742	27.61	7.689
dora	192.95	100.682	27.101	14.141
kylie	162.313	194.024	22.797	27.251
tommy	159.023	164.909	22.335	23.162
genny	140.552	55.813	19.741	7.839
sandy	121.845	73.768	17.114	10.361
colina	116.455	47.938	16.357	6.733
ginny	100.72	35.969	14.147	5.052
jessica	79.98	116.075	11.234	16.303
rabbit	67.8	63.167	9.523	8.872
poncho	64.51	84.061	9.061	11.807
instructor	49.2	77.607	6.91	10.9
cora	47.2	112.26	6.629	15.767
joplin	42.186	58.542	5.925	8.222
yoda	39.563	86.026	5.557	12.083
liz	36.228	67.732	5.088	9.513
steven	34.431	118.589	4.836	16.656
john	31.354	24.25	4.404	3.406
researcher	27.542	2.5	3.868	0.351
jonas	18.375	32	2.581	4.495
cameron	17.375	14.375	2.44	2.019
nellie	17.292	25.188	2.429	3.538

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
lolly	16.188	63.69	2.274	8.946
malakai	11.875	0	1.668	0
winston	11.063	42.438	1.554	5.961
justin	11	53.794	1.545	7.556
alice	10	20	1.405	2.809
sally	3.375	36.833	0.474	5.173

Out degree centrality data shows that Agnes, Dora, Kylie, Tommy and Genny are each a standard deviation more central to the network in module one than other members of the course. Agnes and Genny have in degree centralization that is close to the mean, suggesting that they are actively reading other members posts, but much less likely to create a post, or respond to the posts of others than Dora, Kylie or Tommy. There are three members – Steven, Yoda and Cora – in module one who have significantly higher in degree centralization than out degree centralization. This means that in module 1, these participants posted information to a larger number of individuals than they read.

What the data in figure 36 data tells us about module one, which is not discernable from the activity logs or raw participation and contribution counts, is the variety of individuals in the course read by the different individuals. Since module one is the only module in the course where members are not participating in their small groups, these data provide insights into habits of some of the members, brought with them to the class. Steven, Cora and Yoda post a lot more than they read. Agnes and Genny read a lot more than they post. Dora, Kylie and Tommie are very active in this module, in both directions.

Figure 36 - Module 1 In and Out Degree Centrality Visualization



This visualization of the network normalized out degree centralization for module one shows the high degree of centrality that Agnes has. This is contrasted in the same figure, which visualizes how much lower Agnes' in degree centralization is, compared to her out degree centralization. Table 40 shows the descriptive statistics for figure 36.

Table 40 - Module 1 Degree Centrality Descriptive Statistics

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
Mean	65.249	65.249	9.164	9.164
Std Dev	58.459	44.927	8.211	6.31
Sum	1826.97	1826.97	256.605	256.605
Variance	3417.495	2018.407	67.418	39.818
SSQ	214897.64	175723.2	4239.34	3466.536
MCSSQ	95689.859	56515.41	1887.698	1114.894
Euc Dist	463.571	419.194	65.11	58.877
Minimum	3.375	0	0.474	0
Maximum	196.576	194.024	27.61	27.251

In module 1, we notice that the members of Barriers Group have low measures of in degree centrality. Tommy, a member of Get-Along Group, is the only of our case study group participants who has high degree centrality in module one. This triangulates with Tommy's expressed desire to be helpful to other students, and his observed practice of being extremely active posting and responding to other members of the course from the beginning. Cameron, Malakai and Justin show very low activity in module one.

Table 41 - Module 1 Network Centralization

Network Centralization (Outdegree)	19.129%
Network Centralization (Indegree)	18.757%

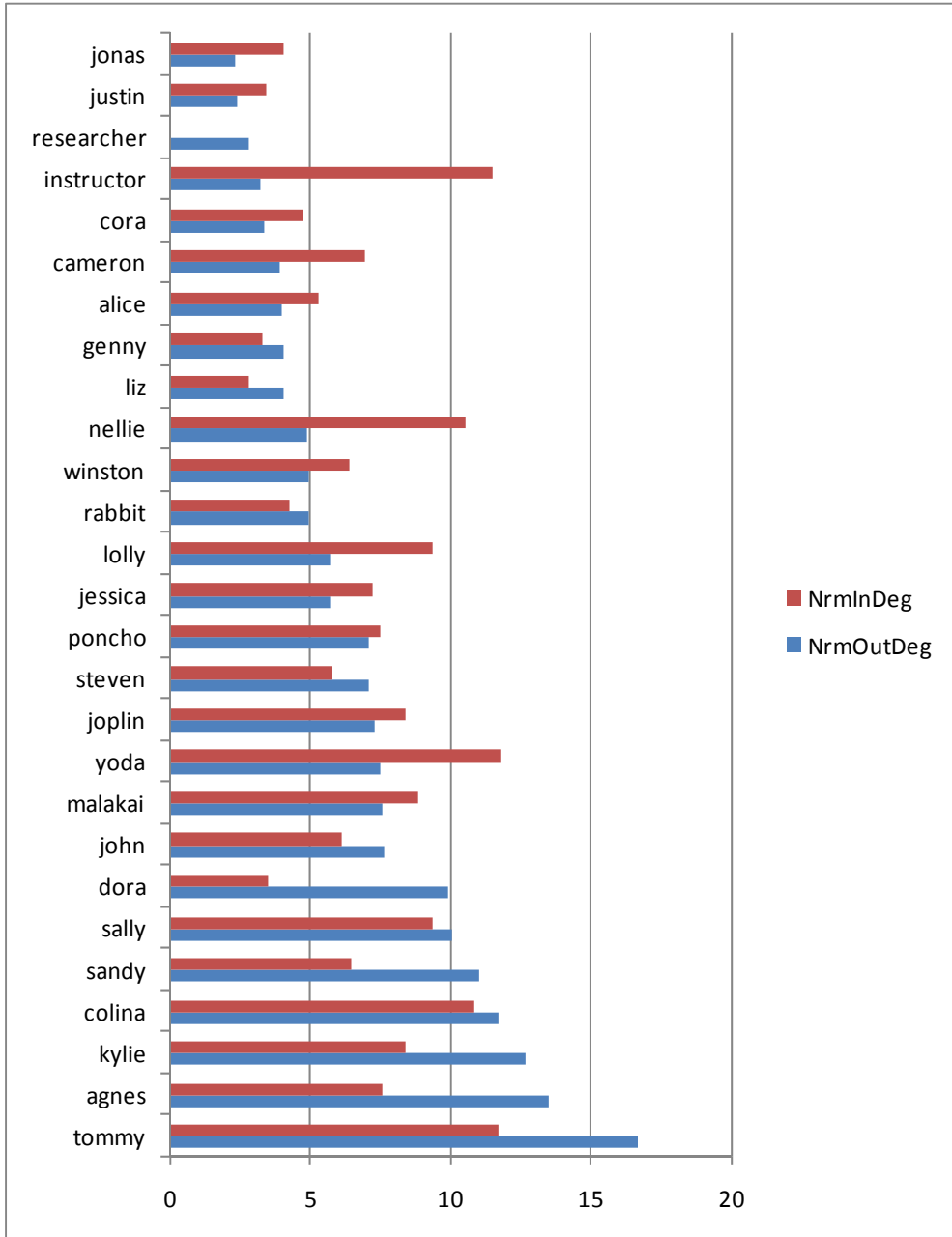
Table 41 shows overall network centralization is highest in module one. High network centralization suggests a small number of group members are in positions of high influence and prestige. Though the centralization of the network is highest for this course in module one, it still reflects a network without a centralized power structure. Highly centralized social networks show network centralization values above 60% (Wasserman & Faust, 1994).

Module by module degree centrality is available in Appendix I. In the next section, findings from these data are presented according to analytically interesting module sets.

Degree Centrality across Modules Three Through Five

Social network data for modules three through five were presented in the last sub question. This provided a sense of the proximity of each course participant to each other participant. Degree centralization data for the same period provide another view of the social network data. Figure 37 shows the normalized in degree and out degree centralization for each course member for modules three through five.

Figure 37 – Normalized In and Out Degree Centrality in Modules Three through Five



As in module one, Agnes, Tommy, Kylie and Dora have high out degree centrality in the central collaborative modules of the course, suggesting that they have the most diverse habits for reading and responding to the work of others in the course. Again, high out degree centrality indicates that they have strong “read ties” and “reply ties” with many

more other members of the course than the mean. This behavior could be considered “lurking” if they do not respond, but more likely it suggests that these members are actively comparing the work of their group with other groups in the course. Reading many discussion boards that are not required for you to read (i.e., discussions from other groups) would have this effect. Tommy, who is also a very active reader in the course, is farther from center in this visualization. The implication is that while Tommy’s participation is active, he is focused on a narrower range of individuals than Yoda in modules three through five.

High in degree centrality indicates a member’s work is more widely read. Not surprisingly in these core modules, the instructor’s in degree centrality is high. Yoda, Nelly, Lolly, Joplin, Colina and Sally also have noticeably high in degree centrality during this part of the course. This suggests that whatever they post is read by a wider variety of course members than the others. This could be a result of their role in one of the modules, or something compelling they have contributed that others are attending to. Our prior examination of specific members in each of the case study groups demonstrates that the centrality data can be expected to relate to some semantically identifiable event in the course of an online group’s development. In this case we do not know the specific event(s), but we have built confidence that we will find them if we go looking.

In degree centrality and out degree centrality data differ from the core participation metrics. High levels of participation and contribution are measures of activity. Degree centrality is a measure of variety in participation and contribution. Degree centrality answers the question: “Is a member viewing and contributing to the work of a few, or many?”.

Question Two: What is the Role of Social Ability in Online Group Development?

Overall, there were 25 online course participants, and 23 of them (92%) completed the pre and post test for social ability. There were two factors of the five that showed both significance and moderate power, even for a sample size this small. The social ability factors of peer social presence and written communication skills showed a statistically significant improvement from T1 (before collaboration began) to T2 (Shortly before the conclusion of small group collaboration). Table 42 shows the social ability of 23 of the 25 course members for T1 and T2.

Table 42 - Social Ability for 23 of 25 Course Participants who Responded to Both Surveys

Factor	Paired Differences					t	df	Sig. (1-Tailed)	Power
	Mean	Std. Deviation	Std. Error Mean	95%					
				Upper	Lower				
Pair 1 Peer social Presence	2.81	7.54	1.57	-0.45	6.07	1.79	22	0.04	0.36
Pair 2 Written Communication Skills	-1.62	4.17	0.87	-3.43	0.18	-1.87	22	0.04	0.37
Pair 3 Instructor Social Presence	0.40	8.53	1.78	-3.30	4.09	0.22	22	0.41	0.05
Pair 4 Comfort Sharing Personal Information	-0.91	3.60	0.75	-2.47	0.65	-1.21	22	0.12	0.25
Pair 5 Social Navigation	-0.53	3.19	0.66	-1.91	0.84	-0.80	22	0.22	0.17

Understanding social ability broken down by group and member across the entire course provides additional perspective on how components of this construct had different trajectories and different tendencies in each group and for each course member. The complete Social Ability data are in table 43.

Table 43 - Social Ability Factor Scores for All Respondents by Group

Member	Group	Peer Social Presence		Written Comm. Skills		Instructor Social Presence		Comfort Sharing Personal Info		Social Navigation	
		T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
Justin	Individualist	2.02	1.80	1.29	1.00	2.75	2.27	1.00	1.00	2.44	2.87
Rabbit	Individualist	4.20	2.39	2.58	2.00	3.10	3.16	3.59	2.68	2.82	2.43
Cameron	Individualist	2.53	2.64	2.00	2.00	2.70	1.77	1.00	2.00	3.15	2.85
		2.92	2.28	1.96	1.67	2.85	2.40	1.86	1.89	2.81	2.72
Alice	Canada	3.24	2.00	2.00	2.00	2.67	3.29	2.00	3.00	2.00	3.00
Dora	Canada	2.32	1.59	2.00	1.00	3.13	2.38	2.00	2.00	2.15	2.75
Kylie	Canada	2.10	1.82	5.00	2.00	1.89	2.13	2.53	2.53	2.39	2.49
Liz	Canada	3.69	2.44	1.00	1.00	3.77	3.41	2.73	2.64	5.30	5.23
		2.84	1.96	2.50	1.50	2.87	2.80	2.32	2.54	2.96	3.37
Jessica	Adams	3.08	3.00	2.00	4.00	2.54	4.54	3.00	3.02	4.18	3.84
Winston	Adams	2.13	1.84	2.00	2.00	2.54	2.09	1.00	1.00	1.79	2.64
		2.61	2.42	2.00	3.00	2.54	3.32	2.00	2.01	2.99	3.24
Cora	Police	3.04	3.75	1.00	1.00	2.30	1.88	4.00	2.66	3.44	4.46
Genny	Police	1.83	2.16	2.29	3.00	2.85	3.08	1.27	3.00	3.41	3.70
		2.43	2.96	1.65	2.00	2.57	2.48	2.63	2.83	3.42	4.08
Agnes	Orange	3.07	2.94	5.00	2.00	2.09	1.83	4.27	4.00	3.21	2.72
Ginny	Orange	2.07	3.01	2.36	2.00	2.00	3.84	3.00	2.00	3.02	3.90
Lolly	Orange	1.53	2.00	1.00	1.00	1.42	2.00	3.28	1.00	1.72	2.00
Poncho	Orange	2.97	2.97	1.00	1.00	2.35	2.35	1.00	1.00	3.13	3.13
		2.41	3.64	2.34	1.67	1.97	2.56	2.89	2.33	2.77	2.87
Malakai	Barriers	2.82	3.32	1.00	2.00	1.00	2.68	2.07	2.73	3.27	3.42
Steven	Barriers	2.38	2.11	5.29	1.29	2.54	1.11	2.05	1.00	2.62	1.00
Yoda	Barriers	1.79	3.34	4.12	3.73	1.76	5.33	1.00	2.00	1.97	2.89
		2.33	2.92	3.47	2.34	1.77	3.04	1.71	1.91	2.62	2.44
Colina	Catskill	2.55	1.00	2.00	1.00	3.55	1.00	2.00	1.00	3.38	1.75
Nellie	Catskill	2.32	2.21	6.00	5.00	2.03	2.10	3.73	3.73	3.41	2.90
Sandy	Catskill	3.65	2.42	3.69	5.00	3.77	2.55	3.00	3.00	3.72	4.13
		2.84	1.88	3.90	3.67	3.12	1.88	2.91	2.58	3.51	2.93
Joplin	Get-Along	4.70	1.44	6.63	1.00	5.56	1.81	7.00	1.00	3.77	3.49
Sally	Get-Along	4.29	2.27	1.00	1.00	2.70	2.68	1.64	1.32	3.74	5.90
Tommy	Get-Along	1.41	1.83	6.00	5.71	2.40	2.53	2.27	2.32	3.45	3.26
		3.47	1.85	4.55	2.57	3.55	2.34	3.64	1.55	3.65	4.22

The green color with bold text indicates that factor score at that time is above the score of the overall course, and a red color with an underline indicates that the factor score is lower than the overall course. The overall course factor scores are presented in table 44.

Table 44 - Overall Social Ability Factor Scores for the Course

	Factor Score	
Peer Social Presence	2.73	T1
	2.32	T2
Written Comm. Skills	2.92	T1
	2.25	T2
Instructor Social Presence	2.65	T1
	2.58	T2
Comfort Sharing Personal Info	2.58	T1
	2.20	T2
Social Navigation	3.06	T1
	3.20	T2

Looking across all eight groups social ability factor scores, it is notable that some groups experienced a trajectory of increased social ability relative to the larger community, and other groups and individuals experienced a trajectory of decreased social ability relative to the larger community. Individualist Group and Orange Group trended higher in their social ability factor scores. Canada and Police Group trended lower. Adams Group and Barriers Group were mixed. Catskill Group and Get-Along Group had diminished social ability factor scores at the beginning and the end of the collaboration, compared with the larger community.

For the answers to the sub questions, the reader is advised that this is a mixed methods examination of group development in a completely online context. The data

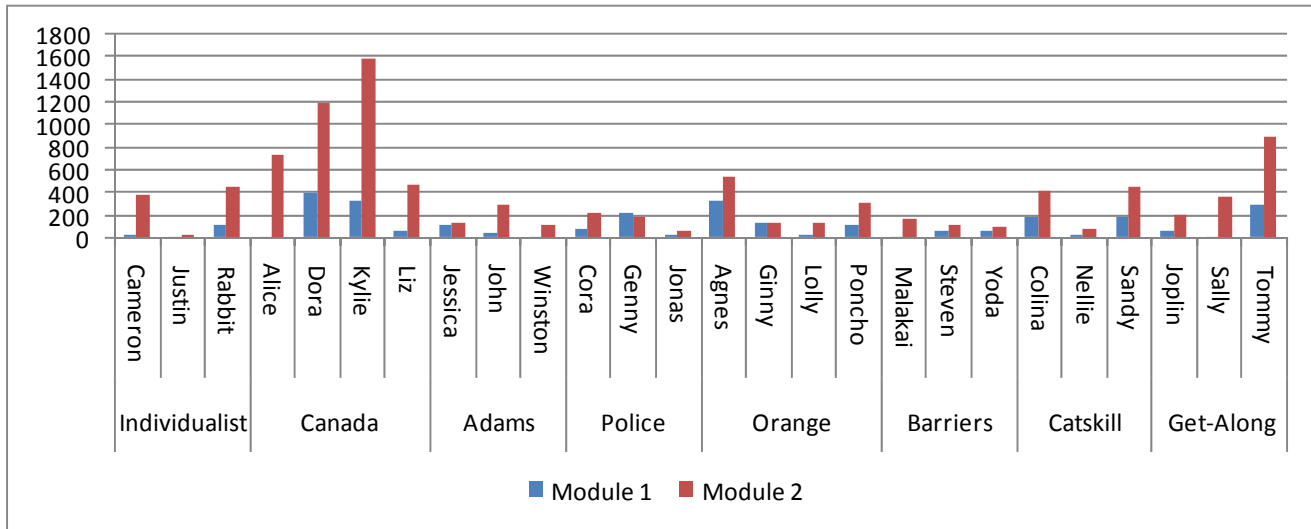
reported below do not suggest experimentally derived causal inference, but instead note a few trends that may warrant further examination in future studies.

How Does the Social Ability of a Member Influence Their Participation in a Group?

Comparison of the three case study groups provides a descriptive answer. In each case study the social ability factors for the members that can be related to group development are described. The purpose of this section is to revisit that analysis for all three case study groups and all eight groups in the course to discern possible relationships between social ability of a member and participation of that member in a group. This analysis will focus on the two social ability factors with power and significance for the overall course and all its members between T1 and T2: Peer Social Presence and Written Communication Skills.

For T1, the relationship between participation and social ability would relate the participation of members in modules one and two to their social ability scores. Figure 38 shows the combined total participation and contribution of each member of each group in modules one and two.

Figure 38 - Total Participation (reads and posts) by members in Modules One and Two



Participation is visibly greater for all members in module two. It is also noteworthy that Canada Group’s participation stands out in module two, suggesting very active collaboration by that group. Table 45 shows the combined participation and contribution counts for each member in modules one and two, along with a plus or minus symbol indicating if they are above or below the course mean for the two social ability constructs with significant changes from T1 to T2.

Table 45 - Module One and Two Combined Participation and Contribution Counts With Social Ability Factors (Above [+] or Below [-] Mean)

Row Labels	Module 1	Module 2	Grand Total	Peer Social Presence		Written Communication Skills	
				T1	T2	T1	T2
Individualist	147	891	1038				
Cameron	20	397	417	+	-	+	+
Justin	16	43	59	+	+	+	+
Rabbit	111	451	562	-	-	+	+
Canada	802	4005	4807				
Alice	13	748	761	-	+	+	+
Dora	401	1197	1598	+	+	+	+
Kylie	323	1592	1915	+	+	-	+

				Peer Social Presence		Written Communication Skills	
Row Labels	Module 1	Module 2	Grand Total	T1	T2	T1	T2
Liz	65	468	533	-	-	+	+
Adams	181	562	743				
Jessica	123	147	270	-	-	+	-
John	43	295	338				
Winston	15	120	135	+	+	+	+
Police	331	478	809				
Cora	83	224	307	-	-	+	+
Genny	220	191	411	+	+	+	-
Jonas	28	63	91				
Orange	610	1140	1750				
Agnes	329	548	877	-	-	-	+
Ginny	140	133	273	+	-	+	+
Lolly	32	141	173	+	+	+	+
Poncho	109	318	427	-	-	+	+
Barriers	125	396	521				
Malakai	10	169	179	-	-	+	+
Steven	56	121	177	+	+	-	+
Yoda	59	106	165	+	-	-	-
Catskill	406	966	1372				
Colina	191	418	609	+	+	+	+
Nellie	27	97	124	+	+	-	-
Sandy	188	451	639	-	-	-	-
Get-Along	358	1475	1833				
Joplin	60	211	271	-	+	-	+
Sally	8	372	380	-	+	+	+
Tommy	290	892	1182	+	+	-	-
Grand Total	2960	9913	12873				

Table 45 shows that there is not a discernable relationship between social ability factor scores for peer social presence or written communication skills at the outset of collaboration. The two social ability factors with significance and power between T1 and T2 do not seem to have predictive utility for levels of participation and contribution at the beginning of group collaboration.

Social Navigation at T1 does appear to be nominally associated with higher combined initial participation and contribution, however. This is particularly true for the extreme cases with the very highest and very lowest combined total participation and contribution counts in modules one and two. Table 46 shows that Canada Group has the highest total participation and contribution rates in modules one and two, and has three out of four members above the mean in social navigation. At the high end of participation and contribution, we can see that the social navigation factor in social ability may be correlated with higher levels of initial participation. The results are mixed for groups at the low end in social navigation. Catskill Group and Get-Along Group are each composed entirely of members with below the mean social navigation factor scores, but participate toward the high end in modules one and two. The very lowest group in module 2 is Barriers Group, which we described in a case study. Some of their causes for low participation are understood not as measures of any individual or group factor, but of the circumstances of the members. The two lowest groups in participation and contribution other than Barriers Group are Adams Group and Police Group. Each of those groups had only two of three members complete the social ability survey, but three out of those four were below the mean on social navigation.

Table 46 - Module One and Two Combined Participation and Contribution Counts With Social Navigation Social Ability Factor Score (Above [+] or Below [-] Mean)

Row Labels	Module 1	Module 2	Grand Total	Social Navigation	
				T1	T2
Individualist	147	891	1038		
Cameron	20	397	417	-	+
Justin	16	43	59	+	+
Rabbit	111	451	562	+	+
Canada	802	4005	4807		
Alice	13	748	761	+	+

Row Labels	Module 1	Module 2	Grand Total	Social Navigation	
				T1	T2
Dora	401	1197	1598	+	+
Kylie	323	1592	1915	+	+
Liz	65	468	533	-	-
Adams	181	562	743		
Jessica	123	147	270	-	-
John	43	295	338		
Winston	15	120	135	+	+
Police	331	478	809		
Cora	83	224	307	-	-
Genny	220	191	411	-	-
Jonas	28	63	91		
Orange	610	1140	1750		
Agnes	329	548	877	-	+
Ginny	140	133	273	+	-
Lolly	32	141	173	+	+
Poncho	109	318	427	-	-
Barriers	125	396	521		
Malakai	10	169	179	-	-
Steven	56	121	177	+	+
Yoda	59	106	165	+	+
Catskill	406	966	1372		
Colina	191	418	609	-	+
Nellie	27	97	124	-	+
Sandy	188	451	639	-	-
Get-Along	358	1475	1833		
Joplin	60	211	271	-	-
Sally	8	372	380	-	-
Tommy	290	892	1182	-	-
Grand Total	2960	9913	12873		

The relationship between Social Ability and participation in these completely online groups is inconclusive. There appears to be a nominal relationship between social navigation factor scores at the beginning of a collaborative period that may warrant future investigation, but the association is not clear and not conclusive. The design of an experiment to control for this factor could prove challenging. In the next question, we

examine how social ability changes through the experience of completely online group work.

How does Group Development Influence the Social Ability of Group Members?

This next question focuses on the changes in social ability wrought by different types of group development. In contrast to the first question, the best place to look for these relationships is toward the end of collaboration, and by comparing the trajectory of T1 social ability factors scores to T2 social ability factor scores for the two factors that showed statistical significance and power between T1 and T2. Table 47 shows the module four and five combined participation and contribution counts for the members of all groups along with the same two factors of social ability.

Table 47 - Module Four and Five Combined Participation and Contribution Counts With Social Ability Factor Scores (Above [+] or Below [-] Mean)

Row Labels	Module 4	Module 5	Grand Total	Peer Social Presence		Written Communication Skills	
				T1	T2	T1	T2
Individualist	1329	391	1720				
Cameron	467	113	580	+	-	+	+
Justin	274	157	431	+	+	+	+
Rabbit	588	121	709	-	-	+	+
Canada	1139	876	2015				
Alice	170	96	266	-	+	+	+
Dora	354	203	557	+	+	+	+
Kylie	495	446	941	+	+	-	+
Liz	120	131	251	-	-	+	+
Adams	693	478	1171				
Jessica	199	158	357	-	-	+	-
John	305	195	500				
Winston	189	125	314	+	+	+	+
Police	303	201	504				
Cora	112	42	154	-	-	+	+
Genny	99	130	229	+	+	+	-

				Peer Social Presence		Written Communication Skills	
Row Labels	Module 4	Module 5	Grand Total	T1	T2	T1	T2
Jonas	92	29	121				
Orange	1200	679	1879				
Agnes	524	430	954	-	-	-	+
Lolly	299	108	407	+	+	+	+
Poncho	377	141	518	-	-	+	+
Barriers	466	1156	1622				
Malakai	182	380	562	-	-	+	+
Steven	142	376	518	+	+	-	+
Yoda	142	400	542	+	-	-	-
Catskill	1101	835	1936				
Colina	560	361	921	+	+	+	+
Nellie	149	215	364	+	+	-	-
Sandy	392	259	651	-	-	-	-
Get-Along	5373	3925	9298				
Joplin	1429	883	2312	-	+	-	+
Sally	1310	1008	2318	-	+	+	+
Tommy	2634	2034	4668	+	+	-	-

In table 47 there is a visible trend of groups with the highest combined total participation and contribution in modules four and five also having a majority of members with high Peer Social Presence at T2. This is the case Get-Along Group, Canada Group and Catskill Group. It is most pronounced for Get-Along Group, whose participation and contribution levels are four times those of the next closest group, and have all members with above the mean peer social presence. This group is particularly notable because peer social presence was below the mean for two members at T1 and moved above the mean at T2. The association is less conclusive, again, at the low end. Though one might have hypothesized (we did not) that higher levels of participation during a collaborative team project (this course) would result in higher levels of peer social presence, here we have data that triangulates such a hypothesis. It is noteworthy that similar hypotheses

could be made for other components of social ability, but we did not find correlations between participation levels in latter modules and other social ability factor scores.

How Does Social Ability of All Members Influence Group Development?

The answer to this question is the substance of the social ability discussion for each of the five factors of social ability in each of the three case studies. From the answers to the questions above, we see a nominal indication that groups with members who have higher social navigation factor scores at the start of collaboration tend to participate more at the beginning. We can also see that peer social presence factor scores are higher at T2 for groups with higher levels of participation in the later periods of collaboration in small groups.

These descriptions of the relationship between social ability, its constituent factors and group development are exploratory and not intended to result in causal inferences. Yet, through these data there is the suggestion that some social ability factors are related to the early participation and contribution of members, and other factors are associated with the levels of participation and contribution at the end of collaboration. The role of social ability in completely online group development is not brought into focus through this study, but more specific questions to inform future studies are brought to light. For example, what dimensions of social ability are more valuable for predicting group interactions and structuring groups, and what dimensions of social ability are helpful for measuring the progress of completely online groups? This past section suggests a place to initiate further experimental work with the construct of Social Ability.

Question Three: What is the Role of The Members Information Horizon in Online Group Development?

The first two sub questions sought to capture distinctions between information horizons of members inside the course management system and outside the course management system. These two sub questions are below:

1. How does a group member's information horizon within the course management system context influence group development online?
2. How does a group member's global information horizon – the course management system and all other components identified – influence group development online.

Through the information horizons interviews, conducted with three course members, and the subsequent survey, completed by 21 members of the course toward the end of the eight weeks we learned that no distinction between the course management system (Sakai) as an information resource, and other information resources is consistently understood by the participants in this course. The members we interviewed did not make the sharp distinctions between these information spaces that we implied with our research questions. In fact, the most frequent descriptions were of the movement between them and among them, without reference to whether or not a particular information resource was in or out of Sakai (The course management system) Our answer to these questions will be integrated, then, and our discussion of the role of information horizons in group development will be centered on a holistic integration of all of the horizons described as important by the members of the course.

The information resources used by group members showed some variability across the eight groups and individuals. Overall, the following are the mean ranks of the information resources used by members of the course. Members were asked to rank the information resources from 1, the most used resource, to 28, the least used resource. Each information resource in the list of 28 was derived from information horizons interviews with three members of the course. Table 48 shows the overall course ranking of information resources, based on the survey responses of 21 members.

Table 48 - Mean Rank of Information Resources by 21 Members Who Completed Information Horizons Survey, Organized by Group

<u>Mean Rank</u>	<u>Information Resource</u>
5	Other people in your small group
5.7	Sakai Discussion Board for Your Group
6	Instructor
8.4	Other people in the course
8.6	Sakai Discussion Board for Everyone
8.9	Sakai Assignments
9.2	Your Group's Wiki
9.5	Course
10.3	Sakai Private Messages
10.8	Sakai Announcements
11.7	Sakai Discussion Board for Another Group
12.6	Google
13.1	Email
15	University Libraries Web Site
16.4	Other Library
16.9	Spouse or significant other
17.3	Friends
17.7	People at Work
17.8	University Libraries
18.1	Google Docs
18.3	Scholar.google.com
18.8	Another Group's Wiki
18.9	ISLS

<u>Mean Rank</u>	<u>Information Resource</u>
20.1	IEEE.org
20.7	ACM.org
20.8	Children
21.2	University Intranet
22.5	Alta Vista

The top two resources across all respondents are related directly to the member's assigned small groups.

Given the focus of the top information resources on group information, it would be interesting to see how information horizons are perceived differently in a setting that is not centered on small groups work, but we reserve that question for future study. The information resources used by members of different groups often centered on the sources the groups used to coordinate with their members. The information resources that were most used by members of the course, and by the groups those members were in are shown in table 49. We see a diversity of information resources, and differences in information resource use by the members of different groups. Canada Group, for example, is concentrated on the use of other people in their group, the instructor and the group wiki. Orange Group members show some contrast, with two members concentrating the information resources on the group centric resources like discussion boards and other people in their group, while a third member, Agnes, has very different information horizons that include children, and rate the use of group information resources at the bottom. Each of the case study groups also displayed divergence in their information resource utilization, as previously discussed. In the case studies, we observed that groups with information resource alignment had fewer group development

difficulties than those groups with divergence among member information resource preferences. A future contrast between the experience of Canada Group and Orange Group may reveal new and interesting contrasts in group development along information horizons lines.

Table 49 - Most Used Information Resources by Course Members, by Group

Member	Group	Spouse or Significant 'other'	Children	The Instructor	Other people in your small group	Other people in the course	Sakai Discussion Board for your group	Sakai Discussion Board for another group	Sakai Discussion Board for everyone	course	Google.com	email	Your group's wiki	Sakai Private Messages	Sakai Assignments	Sakai Announcements
Cameron	Individualist	15	28	2	13	12	3	14	11	1	10	7	21	6	5	4
Justin	Individualist	10	25	6	1	11	2	13	12	9	8	4	7	3	5	15
Rabbit	Individualist	16	15	8	1	9	10	11	12	13	4	18	3	5	6	7
Alice	Canada	27	28	6	1	7	5	14	8	9	10	17	2	11	20	13
Dora	Canada	16	25	2	1	11	5	14	13	6	17	8	4	15	7	9
Kylie	Canada	21	28	3	5	6	2	4	1	17	18	20	7	10	9	16
Liz	Canada	0	0	12	1	15	3	0	11	6	17	0	5	13	14	16
John	Adams	1	2	4	3	8	5	17	9	7	15	19	6	10	12	11
Jessica	Adams	0	0	5	0	7	1	0	6	0	0	13	2	12	3	4
Winston	Adams	26	27	20	1	8	3	11	4	5	7	9	6	10	2	22
Genny	Police	14	3	4	2	11	20	26	9	12	5	7	1	16	8	6
Agnes	Orange	14	1	26	28	5	27	13	24	25	17	20	8	22	23	15
Lolly	Orange	10	25	2	1	3	5	7	6	4	9	8	11	12	14	13
Poncho	Orange	27	28	2	1	3	4	13	6	5	24	17	18	10	9	11
Malakai	Barriers	4	28	1	20	14	9	10	8	2	16	22	27	7	5	6
Yoda	Barriers	12	28	5	1	6	2	4	13	15	16	10	3	11	8	9

Member	Group	Spouse or Significant 'other'	Children	The Instructor	Other people in your small group	Other people in the course	Sakai Discussion Board for your group	Sakai Discussion Board for another group	Sakai Discussion Board for everyone	course	Google.com	email	Your group's wiki	Sakai Private Messages	Sakai Assignments	Sakai Announcements
Colina	Catskill	19	20	5	1	3	2	14	4	21	7	17	26	9	8	10
Sandy	Catskill	16	11	2	13	14	4	5	6	7	3	24	25	8	1	9
Joplin	Get-Along	28	27	3	1	5	2	10	6	11	23	4	2	8	7	9
Sally	Get-Along	19	20	5	3	16	1	17	6	7	11	4	2	8	9	10
Tommy	Get-Along	26	27	2	1	3	4	6	5	7	14	13	8	10	11	12
Mean		16.9	20.8	6.0	5.0	8.4	5.7	11.7	8.6	9.5	12.6	13.1	9.2	10.3	8.9	10.8
Standard Deviation		8.9	11.1	6.3	7.5	4.2	6.5	6.2	4.8	6.4	6.5	6.9	8.7	4.1	5.5	4.4

How information horizons influences group development is most explicitly described in the case study for Barriers Group. Two of Barriers Group's members participated in Information Horizons Interviews near the beginning of their collaboration as a group. Barriers Group's case is one where Yoda and Malakai did not have close alignment on the information horizons that were most important at the beginning of their collaborative work together.

How Does Group Development Influence the Information Horizons of Members?

The groups we examined closely in the case studies showed a pattern that may warrant future investigation. Barriers Group and Individualist Group members had little alignment of preferred information resources, while Get-Along Group's members shared

many of the same information resources. This finding suggests that information horizons may play a role in the development of group identity and especially group cohesion or, that information horizons diversity may play a role in more interpersonally challenging group development trajectories in completely online settings. The investigation of this pattern in future studies is suggested.

Question Four: What is the Role of Group Efficacy in Online Group Development?

Group efficacy, as measured using the survey instrument in Appendix C, showed statistically significant changes in the total course on two questions, the use of communications software and the ability to work with people who cannot physically meet. Like with the social ability survey, a decreasing score indicates improving performance. The t-test performed on responses taken before groups were assigned, and toward the end of the collaboration is shown in table 50.

Table 50 - Group Efficacy T-Test for the Entire Course Community for 24 of 25 course participants who responded to both surveys

	Paired Differences					t	df	Sig. (1-Tailed)	Power
	Mean	Std. Deviation	Error Mean	95% Confidence					
				Upper	Lower				
Pair 1 Ability to Use Communications Software to collaborate with remote team members	-0.292	1.083	0.221	-0.749	0.165	-1.320	23	0.100	0.265
Pair 2 Ability to do teamwork in a distributed environment if appropriate technology is available	-0.417	1.100	0.225	-0.881	0.048	-1.856	23	0.038	0.361
Pair 3 Ability to share information using technology with remote group members	-0.125	0.741	0.151	-0.438	0.188	-0.827	23	0.208	0.170
Pair 4 Ability to work with people who cannot physically meet	-0.333	0.816	0.167	-0.678	0.011	-2.000	23	0.029	0.385

Sharing information and communicating with technology did not improve to a statistically significant degree within the course community. The ability to do teamwork through technology and work with people who could not get together physically did show statistically significant gains from T1 to T2. The common characteristic for these two

factors that showed statistically significant gains is that they speak to members feeling able to be part of a successful completely online group. The two questions without gains address specific types of tasks – communicating and sharing information. This thematic contrast between the measures that show gains from T1 to T2 and those which do not show gains points to the possibility that members who are generally comfortable with each other following this type of remote collaboration become convinced of the feasibility of distributed work in general. Yet, these same members do not gain confidence in the specific tools they are using or believe them to possess special features that contributed to the success. The efficacy change for the members of this course is about changes in beliefs about successful completely online group work, and not changes in beliefs about the effectiveness of or member competence using particular tools.

Showing the trajectories of each of the eight groups from T1 to T2 sheds additional light on the relationship between group efficacy and the online development of each of the eight groups. This is shown in table 51.

Table 51 Group Efficacy Survey Responses by Team and Member. (1 = "Strongly Agree", 7 = "Strongly Disagree")

		Name	Ability to use Communication Software to Collaborate, T1	Ability to use Communication Software to Collaborate, T2	Ability to do Distributed Teamwork through technology, T1	Ability to do Distributed Teamwork through technology, T2	Ability to Share Information with Distributed Team Members Through Technology, T1	Ability to Share Information with Distributed Team Members Through Technology, T2	Ability to use Communications Technology to Work With People Who Cannot Physically Meet, T1	Ability to use Communications Technology to Work With People Who Cannot Physically Meet, T2	
Individualist Group	1	Justin	1	1	1	1	1	1	1	1	
	2	Rabbit	2	2	2	2	2	2	2	2	
	3	Cameron	2	1	2	2	2	1	2	2	
	Total	N	3	3	3	3	3	3	3	3	3
		Mean		1.67	1.33	1.67	1.67	1.67	1.33	1.67	1.67
	Grouped Median		1.67	1.33	1.67	1.67	1.67	1.33	1.67	1.67	
Canada Group	1	Alice	2	2	2	2	2	2	2	2	
	2	Dora	2	1	2	1	2	1	2	1	
	3	Kylie	1	1	1	2	1	1	1	1	
	4	Liz	2	1	1	1	1	1	1	1	
	Total	N	4	4	4	4	4	4	4	4	4
Mean			1.75	1.25	1.50	1.50	1.50	1.25	1.50	1.25	
Grouped Median			1.75	1.25	1.50	1.50	1.50	1.25	1.50	1.25	
Adams Group	1	Jessica	1	1	1	1	1	1	1	1	
	2	John	1	1	1	1	1	1	1	1	
	3	Winston	1	1	1	1	1	1	1	1	
	Total	N	3	3	3	3	3	3	3	3	3
Mean			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Grouped Median			1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Police Group	1	Cora	1	5	1	5	1	3	1	3	
	2	Genny	1	2	1	2	1	1	1	1	
	Total	N	2	2	2	2	2	2	2	2	
		Mean		1.00	3.50	1.00	3.50	1.00	2.00	1.00	2.00
	Grouped Median		1.00	3.50	1.00	3.50	1.00	2.00	1.00	2.00	

Orange Group	1	Agnes	1	2	1	2	1	2	1	2	
	2	Ginny	1	.	6	.	1	.	1	.	
	3	Lolly	1	1	1	1	1	1	1	1	
	4	Poncho	1	2	1	2	1	2	1	2	
	Total	N	4	4	3	4	3	4	3	4	3
		Mean		1.00	1.67	2.25	1.67	1.00	1.67	1.00	1.67
Grouped Median			1.00	1.67	2.25	1.67	1.00	1.67	1.00	1.67	
Barriers Group	1	Malakai	3	2	3	6	3	2	3	6	
	2	Steven	1	1	1	1	1	1	1	1	
	3	Yoda	2	3	2	3	1	3	2	3	
	Total	N	3	3	3	3	3	3	3	3	3
		Mean		2.00	2.00	2.00	3.33	1.67	2.00	2.00	3.33
		Grouped Median		2.00	2.00	2.00	3.00	1.67	2.00	2.00	3.00
Catskill Group	1	Colina	1	2	1	1	1	1	1	1	
	2	Nellie	1	1	2	1	1	1	1	2	
	3	Sandy	2	2	2	2	2	2	2	2	
	Total	N	3	3	3	3	3	3	3	3	3
		Mean		1.33	1.67	1.67	1.33	1.33	1.33	1.33	1.67
		Grouped Median		1.33	1.67	1.67	1.33	1.33	1.33	1.33	1.67
Get-Along Group	1	Joplin	1	1	1	1	1	1	1	1	
	2	Sally	1	1	1	1	1	1	1	1	
	3	Tommy	1	3	1	1	1	1	1	1	
	Total	N	3	3	3	3	3	3	3	3	3
		Mean		1.00	1.67	1.00	1.00	1.00	1.00	1.00	1.00
		Grouped Median		1.00	1.67	1.00	1.00	1.00	1.00	1.00	1.00
Total	N	25	25	24	25	24	25	24	25	24	
	Mean		1.36	1.67	1.56	1.79	1.28	1.42	1.32	1.67	
	Grouped Median		1.33	1.52	1.39	1.52	1.25	1.36	1.29	1.48	

While most groups had mixed results, or improved nominally on a number of group efficacy measures, Police Group, Orange Group and Barriers Group all showed members with significant declines on group efficacy measures from T1 to T2. We have an understanding of the drivers behind Barriers Group members declining sense of group efficacy from our case study. Police Group and Orange Group's cases were not explicated. Next, we explore the relationship between group efficacy and actual effectiveness, measured using a rubric.

Actual performance across the eight groups was assessed by two raters in module four, as noted in the case studies. Each rater graded the participants using the same rubric, found in Appendix G. The agreed to scores for each group are found in Table 52.

Table 52 - Rubric Scoring Summary for All Eight Groups

	Individualist	Canada	Adams	Police	Orange	Barriers	Catskill	Get-Along	Basis for Color Code
Scenario	24	12	30	12	24	33	18	15	score group
Script	4	28	24	20	24	28	22	20	trajectory
Assessment	3	6	0	3	6	3	18	3	
Total	31	46	54	35	54	64	58	38	score group

While Police, Orange and Barriers Group have the common characteristic of at least one member whose belief in the efficacy of technology mediated group work diminished, the relative performance of these groups are different. Police Group is a low performer, while Orange Group is middle of the road and Barriers Group, as previously discussed, performs at a high level in module 4. As we learned from the three case studies, actual performance and a sense of group efficacy do not always align with each other.

Question Five: To What Extent Does Social Network Structure, Observed Through Online Communication Patterns, Reflect the Observed Knowledge Construction, Identity Formation and Information Horizons of Group Members?

We experimented extensively with the data to identify connections between social network structure and knowledge construction, identity formation and information horizons of group members. This is distinct from the first research question in this study, which focused on social network structure as a component of group development. For the first research question we examined the relationship between social network structures and their potential for identifying relationships between individual course

members and revealing network structure within and across groups. We also showed that these structures change over the course of an online collaboration, and that these changes in the network structure related to the experiences described in the three case study groups. Question one addressed the utility of social network analysis for providing insight into completely online group development.

This final research question focuses attention on the direct relationship between social network structure and group identity, knowledge construction and information behavior across all eight groups. The result of this exploration is the conclusion that for this course, and for these small groups and individuals there is no discernable relationship between network structure and knowledge construction, identity formation or information horizons. We did, however, discern relationships between some of the social network statistics and other constructs in this study.

Degree Centrality and Group Performance

This research was not designed as an experiment for deriving causal inference, of course, but our exploration has resulted in some observations about potential relationships that exist between social network position, particularly degree centrality, and group performance in completely online settings. For example, table 53 shows the mean degree centrality for group members in each of the eight groups in the course, as well as the group's performance on module four's scored collaborative assignments. The cells are red/underlined where the value falls below the mean, and green/bold where the value falls above the mean.

Table 53 - Group Module Four Performance and Degree Centrality Means

Group	Out Degree Centrality	In Degree Centrality	Mod 4 Rubric Score
Barriers Mean	7.39	8.78	64.00
Catskill Mean	9.20	9.26	58.00
Adams Mean	6.09	6.58	54.00
Orange Mean	6.55	6.09	54.00
Canada Mean	7.64	5.01	46.00
Get-Along Mean	11.32	9.80	38.00
Police Mean	3.26	4.03	35.00
Individualist Mean	3.77	4.88	31.00

Four out of the five teams who score below the mean on the rubric are also below the mean on degree centrality, meaning the work they produce is not read by an audience as wide as other groups.

A correspondence between social navigation and high scores on the module four rubric is observable, although there does not appear to be a relationship with group efficacy reported by the groups and in degree centrality. This is illustrated in table 54.

Table 54 - Rubric Scores Compared to Other Factors in the Study

Group	Out Degree Centrality	In Degree Centrality	Mod 4 Rubric Score	T2 Social Navigation Factor Score	Group Efficacy
Barriers Mean	7.39	8.78	64.00	2.44	2.67
Catskill Mean	9.20	9.26	58.00	2.93	1.50
Adams Mean	6.09	6.58	54.00	3.24	1.00
Orange Mean	6.55	6.09	54.00	2.87	1.67
Canada Mean	7.64	5.01	46.00	3.37	1.31
Get-Along Mean	11.32	9.80	38.00	4.22	1.17
Police Mean	3.26	4.03	35.00	4.08	2.75
Individualist Mean	3.77	4.88	31.00	2.72	1.50

Note that Orange Group and Individualist Group also had social navigation scores that were higher than the course mean, but did not perform well on the module four rubric overall. Table 55 shows the observed relationship between high out degree centrality and group efficacy scores.

Table 55 - Out Degree Centrality and Group Efficacy

Group	Out Degree Centrality	In Degree Centrality	Group Efficacy
Get-Along Mean	11.32	9.80	1.17
Catskill Mean	9.20	9.26	1.50
Canada Mean	7.64	5.01	1.31
Barriers Mean	7.39	8.78	2.67
Orange Mean	6.55	6.09	1.67
Adams Mean	6.09	6.58	1.00
Individualist Mean	3.77	4.88	1.50
Police Mean	3.26	4.03	2.75

Again in this case, there are groups whose efficacy scores are above the mean, but whose centrality is below the mean. There is not an observable correspondence between the group means on the group efficacy factor, though the highest performing groups in this particular course also had the highest out degree centrality. A future experiment should explore this relationship further.

Social Network Measures and Activity Type

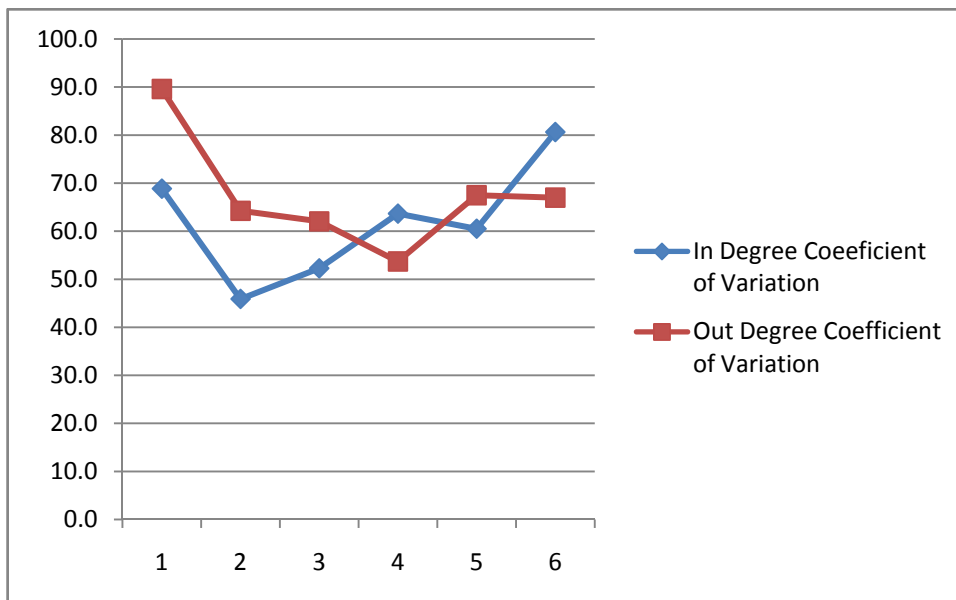
One measure of diversity of degree centrality in a network presented earlier is the measure of coefficient of variation. Table 56 shows the coefficient of variation measures for each module in the course.

Table 56 - Coefficient of Variation Measures for All Six Modules

	Standard Deviation	Mean	Coefficient of Variation in The Network
Module 1 In Degree	6.31	9.164	68.9
Module 1 Out Degree	8.211	9.164	89.6
Module 2 In Degree	3.345	7.289	45.9
Module 2 Out Degree	4.683	7.289	64.2
Module 3 In Degree	5.439	10.406	52.3
Module 3 Out Degree	6.457	10.406	62.1
Module 4 In Degree	3.442	5.407	63.7
Module 4 Out Degree	2.904	5.407	53.7
Module 5 In Degree	2.788	4.608	60.5
Module 5 Out Degree	3.11	4.608	67.5
Module 6 In Degree	2.545	3.156	80.6
Module 6 Out Degree	2.114	3.156	67.0

The coefficient of variation highlights the differences between in degree and out degree coefficients. This contrast is more easily seen in figure 39.

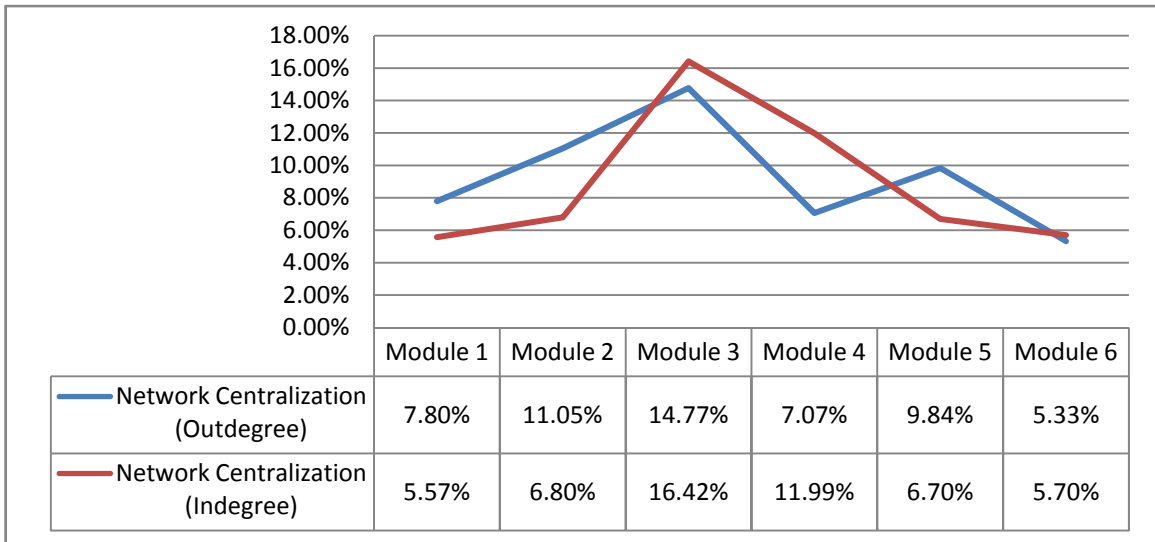
Figure 39 - Graph of Coefficient of Variation across All Six Modules



Lower values suggest a more homogeneous set of network positions among the members, while higher values suggest a more heterogeneous set of network positions among the members. All values in this network are moderate to high, suggesting that there is general variability of network positions in the course. The low point for out degree variation in position is in module four. This could be the result of members being focused inward on their group's activities, and only leaving their group's cave to address questions and feedback from the instructor. All members view posts from the instructor, do not venture outside their own group's posts as much, possibly because of the intensity and inward focus of the module four tasks. In module five, when the groups are teaching two groups and being taught by two other groups, the out degree coefficient of variation goes up. One possible explanation for this is that the group members interact across a far more diverse population of course members than in module four. The decline of the in degree coefficient of variation in module five suggests that members are being viewed by a more common set of folks than was the case in module four. One possible explanation is the activity type of module five, where most groups had a single member responsible for posting activities to the other groups. This single member then had their work accessed by many people, while the other members of the group were interacted with less. The result would be what we see in the graph, which is less variability in the set of people whose posts are viewed in the network during module five.

Another indication of module by module network structure is the overall network centralization. A high degree of network centralization reflects a consolidation of influence and prestige among a small set of people. Figure 40 shows the in degree and out degree network centralization in the modules of this course:

Figure 40 - Network Centralization Over Course Modules



Comparing figures 39 and 40 it is visually apparent that the coefficient of variation and network centralization trend in opposite directions, although not linearly, and not in each case. For the first two modules, out degree centralization was greater than in degree centralization, suggesting a slightly more dominant behavior by active posters than a concentration of people whose work is widely read in these two modules. This flips in modules three and four, when small group activity is greatest, suggesting that the structure of small group activities leads to more concentration of people whose work is read by others than people posting responses. In other words, more posting resulted in more centrality (out degree) than being read (in degree) during the early part of the course, and in modules three and four, this is inverted. In module three, the activity is to tell a story of when you were in an online course, and encountered an experience that was challenging. In module four, the activity was a design activity. In each case, individuals had an opportunity to be interesting, and to contribute something of value to their groups. The higher levels of in degree network centralization during these modules may suggest

that a small number of individuals were nominally more productive, and produced nominally more interesting work that caught the attention of course participants.

Chapter Summary

In this chapter we reviewed the detailed cases of three groups in the course: Barriers Group, Individualist Group and Get-Along Group. The results of ethnographic field work, interviews and content analysis of discussion boards resulted in three distinct case studies that paint the rich story of each of these three groups. The cases also characterized the individuals in the three groups, and their contribution and participation patterns. This chapter identified distinct patterns of group development in three case studies. Themes and patterns for these case study groups are as follows:

❖ Barriers Group

- Theme: Cultural and Interpersonal Aspects of Performance
- Theme: Exaggerated, Punctuated Equilibrium
- Theme: Physical Distribution Changes
- Pattern: Tools as Power Proxies
- Pattern: Capacity and Performance

❖ Individualist Group

- Theme: Different Member Needs for Structure
- Theme: Differences Wrought by Technology and Tools
- Theme: The Skype Love-Hate Transmission
- Pattern: Within Group Changes in Social Ability
- Pattern: Articulation Work and Performance
- Pattern: Individual Knowledge Construction

❖ Get-Along Group

- Theme: Completely Online Identity Interchange; Individuals and Groups
- Theme: Creation of Multiple Places and Spaces
- Pattern: Sense Making and Social Comparison
- Pattern: Making Tasks Visible to the Group
- Pattern: Group Metacognition (Self Awareness)

Each of the cases and the associated themes and patterns for the case moves us toward understanding completely online group development from the ground up.

We also examined completely online group development from the top down, relating research questions regarding group knowledge construction, social identity, information horizons, group efficacy and social network characteristics to completely online group development. We learned that groups who are more central in completely online social networks experienced fewer observable issues with performance and working together. We found that individuals who are members of this completely online graduate school course bring diversity of expectations and experiences, and that the trajectories of small group development within this common context are similarly diverse. How completely online small groups develop is brought to the surface through an understanding of the diversity in knowledge construction, group identity formation and social network structure that characterizes these individual trajectories.

The relation between these diverse trajectories of completely online group development is related to information horizons, social ability and group efficacy. Group members who are at the fulcrum of task delivery in small groups whose performance is relatively low – like Barriers Group or Individualist Group – experience diminished

social ability in this study. Group efficacy is not as closely related to relative performance as we expected. Also, groups who experienced development challenges are the same groups who had high diversity in the information horizons of their membership. Together, these findings begin to paint a picture of how completely online group development is related to these more measurable dimensions of individual and group features.

Finally, we learned that adaptation of technology and information resources to the needs of completely online groups varied a great deal. Whether or not this variance is manageable, or completely online group collaboration environments may be deliberately improved in order to proactively create more consistent and positive group experiences online is addressed in the next chapter.

CHAPTER V

Chapter Five – Discussion and Implications

Overview of Chapter 5

This chapter presents a summary of the findings from this study and discusses key results for advancing knowledge of how completely online groups develop. This chapter includes seven sections: (1) A summary and discussion of findings, (2) theoretical implications, (3) practical implications, (4) design implications, (5) methodological implications, (6) limitations of this study and (7) conclusion.

Summary and Discussion of Findings

Question One: How do Completely Online Groups Develop?

In this study we learned about three specific online groups in great detail. We think of each of these groups as a single specimen of the completely online group phenomena. Through the identification of themes and patterns in each of these specimens, this work pushes the field toward the development of a set of completely online group archetypes that will provide new researchers, instructors, managers and completely online group participants a frame of reference for their experiences and work. Completely Online Group Archetypes will be amalgamated descriptions of sets of completely online groups whose patterns and themes recur across multiple instances of the same context, or in multiple similar contexts. The themes and patterns for the specimen groups in this study – Barriers Group, Individualist Group and Get-Along Group – are listed in table 57.

Table 57 - Patterns and Themes Described for the Completely Online Case Study Groups in This Study

Barriers Group
Pattern: Tools as Power Proxies
Pattern: Capacity and Performance
Theme: Cultural and Interpersonal Aspects of Performance
Theme: Exaggerated Punctuated Equilibrium
Theme: Physical Distribution Changes
Individualist Group
Pattern: Within Group Changes in Social Ability
Pattern: Articulation Work and Performance
Pattern: Individual Knowledge Construction
Theme: Different Member Needs for Structure
Theme: Differences Wrought by Technology and Tools
Theme: The Skype Love-Hate Transmission
Get-Along Group
Pattern: Sense Making and Social Comparison
Pattern: Making Tasks Visible to the Group
Pattern: Group Metacognition (Self awareness)
Theme: Completely Online Identity Interchange: Individuals and Groups
Theme: Creation of Multiple Places and Spaces

Patterns and themes identified in the case study studies contribute to an initial draft of archetypes for completely online group development, which we expect to be refined in future studies. As with software design that proceeds through a series of prototypes, we begin with sketches. Our first three sketches of completely online group development archetypes are described next.

1. Barriers Group – An archetype where social, cultural and technological barriers impede the development of group identity. This group archetype is identifiable by communication directed at individual members instead of the group. There is also discontinuity between this archetype’s sense of efficacy (which is relatively low) and actual performance (which in some instances is relatively high). On social network analysis measures, this archetype has low network centrality and

does not appear as a subgroup in SNA subgroup measures like factional analysis and F-Group analysis. Following a corrective event, involving instructor intervention, members of this group appear in the core of the social network for the first time. This may be an effect that is generally expected as a result of intervention from a leader or manager of completely online groups.

2. Individualist Group – An archetype where members are focused on their own individual needs, and maintain a low level of evidenced commitment to the tasks the group is responsible for, or the health of the group itself. While sometimes in the same virtual space, these members may actually continue to engage as though their point of view is necessarily well understood by the other members (even though it is not). The individualist group experiences unplanned and poorly communicated membership changes over its life.
 - a. Technology adaptation in the individualist group may look more like a series of “pairings” than a group. For example, this particular individualist group adopted a series of technologies, mostly based on the preferences of an unstable membership that shifted between two dyads over the course of the collaboration. Analysis of discussion boards and chat transcripts reveals members who talk past each other when collaborating; this is not discernable through CANS log analysis, but is from qualitative analysis of the discrete knowledge co-construction events themselves.
 - b. Social network analysis for individualist group showed a few distinctions. F-Group and factional analysis conducted on social network data at

different times in this group's development revealed two different dyads that existed at different times. This visible dyadic grouping of Cameron and Rabbit, then Cameron and Justin, triangulates reports from interviews, discussion board analysis and ethnographic field notes. Further, individualist members did not appear in the core of the course social network core-periphery analysis during modules involving heavy collaboration.

3. Get-Along Group – An archetype where the highest value is getting along, though the heavy task focus of this group suggests “getting it done” is also important. This archetype may become two distinct archetypes in future studies – One socially focused and the other task focused. The group is social, focused on maintaining harmony, and active in the development of reified practices that lower the cognitive and emotional load associated with completely online group work. Communication within this group type is enthusiastic and dominantly directed at the group itself, and not at individual members. Notably, this archetype gets off to a fast start, has a member who actively coordinates the work and develops a set of reified practices that are identifiable throughout the collaboration. These reified practices, which prove so beneficial, also are occasionally a source of performance impairment, especially when the type of task changes to one the group has not previously encountered. Members of a Get-Along group are found clustered together in SNA measures and in the core of core-periphery SNA analysis.

A detailed summary of the characteristics of each archetype categorized by the themes and patterns that emerged for each group and mapped to the research questions, is found in Appendix J. This is the first known sketch of completely online group archetypes.

In addition to the emergence of these three completely online group archetype sketches, there were several findings related to question one: (1) Unexpected diversity of group members and member practices, (2) The role of technology in the way groups develop, (3) The nature of completely online participation, contribution and trust, (4) The effects of articulation work and tacit coordination on completely online group development, (5) Completely online group development trajectories are identifiable through CANS log analysis and (6) Completely online group structures do evolve through the collaboration of a group and may reveal insights about group development.

Finding One: Unexpected Diversity Among Group Members and Member Practices

In the case studies we came to know three members of three different completely online groups. There are two dimensions to the diversity we observed in these group members: Diversity of behavior and diversity of observable characteristics.

Behaviorally, we discovered surprising differences in their task work, group participation and learning habits. We also noted diversity of observable member characteristics, including motivation for participation, available telecommunications infrastructure, age and gender.

Members of Individualist Group, Get-Along Group and Barriers Group each worked through the same tasks in the same context differently. We see Tommy's high level of participation influence his mates and build a team culture of frequent communication, and high group cohesion. Joplin starts out with a practice of editing

group work for grammar. Sally is slow to embrace online collaboration. Their individual practices evolve through their work in a team with Tommy.

Cameron's initial teaming up with Rabbit in membership-volatile Individualist Group resulted in a similar degree of frequent communication at first. Rabbit's practices moved with Cameron's in the beginning, when Rabbit and Cameron shared the coordination work for the group. Individualist Group coordination practices changed dramatically when Justin reappeared and introduced Skype. Cameron and Rabbit each had severe bandwidth limitations that are common in rural areas, making Skype a nominal hardship for them. Rabbit experienced a busy period of wedding planning in the middle of the collaboration. Justin had family events at the beginning. These circumstances pooled to drive the group into two distinct periods of dyadic existence. Rabbit and Justin's collaboration practices were less focused and organized than Cameron's. While Get-Along Group members adapted their practices to the needs of the group, Individualist Group members each pursued the group's work from their own perspective.

In Barriers Group, Malakai, Yoda and Steven began without a single member taking charge of their activities. Malakai emerged as the coordinator, and Yoda and Steven's practices belied their heavy course loads and complicated circumstances. When Malakai became aware that Yoda and Steven were in the different parts of the same building during the latter portion of their group work, this became a barrier to Malakai – She felt “left out”. Yoda described one set of practices and “being a different Yoda” when she was at home in Asia. Steven's practices kept him “active enough” in the group, though he and Yoda never engaged as completely as Malakai did.

The members and primary coordination workers in each group were also diverse in their makeup. Cameron (Individualist Group) is a Ph.D. student who works in a rural area and has a lot of experience online, while Tommy (Get-Along Group) is a masters student who has earned all of his higher education online. Malakai (Barriers Group) is a late stage Ph.D. student from Europe. Cameron's doctoral work is in agriculture, Tommy's master's work is in educational technology and Malakai's doctoral work is in the learning sciences. The members of the groups who took on less articulation work are equally diverse. Rabbit and Justin from Individualist group come from rural and urban areas respectively. Rabbit is pursuing a Library and Information Science degree and Justin an educational technology masters degree. Sally and Joplin from Get-Along Group are both masters students in the educational technology program, like their other group mate, Tommy. Finally, Steven and Yoda from Barriers Group are from diverse parts of the world; Steven is a PhD student and Yoda is a masters student. Each individual's observable and known characteristics are different. In a course with a narrow focus – Computer Supported Collaborative Learning – We did not expect this level of diversity in participants. Age, nationality, education, major and motivation for taking an online course in this subject in the summer were diverse across these nine members of the case study groups.

So & Kim (2005) note that diversity of languages among online learners hampers creativity and group work. In the case of Barriers Group, while the language of the course was English, the native language of each of three group members was different from English and different from each other. Hentea, Shea & Pennington (2003) address the difficulties of interactivity in online learning, suggesting that students have a wide

diversity of needs for support from online tools. Our close observations of the three groups in this study adds to this prior work, underscoring the importance of understanding and addressing the many definitions of diversity in a completely online setting. Researcher, instructor, manager and participant expectations of completely online groups should consider the influence of diversity in factors such as motivation, language, familiarity and access to technology and time zone when working with completely online groups. The tools these groups use and the narrow focus of tasks and curriculum have a tendency to mute this diversity by presenting members in the same way – through pictures and text. This allows the participant, manager and researcher to overlook the diversity of the membership.

Finding Two: The Role of Technology in the Ways that the Groups Develop

Technology adaptation influenced each group differently. By adaptation we mean the groups adopted tools, and then molded the specific features of those tools to fit the social and task context of the group itself. Each group adapted their practices and technology use differently. Individualist Group wafted between tools. Barriers Group used tools to control the flow of information within the group. Get-Along Group fluidly adapted a set of deliberately built up practices and changed the tools according to the needs of the tasks.

Individualist Group's experience with tools strikes us as almost accidental. We would not expect a member who was absent for an entire module to be able to come in and dictate tool usage. Justin did this. Cameron went along. We speculate this occurred in part because the tools used for collaboration are context poor; it is not important what the tools are if one is the member of a group, only that one is able to maintain

communication and coordination with ones group. Cameron adapted to Justin's tools – Skype – When Rabbit's participation declined because it was the only way to maintain connection with another member of her group.

Malakai and Yoda in Barriers group experienced many challenges when choosing tools for collaboration. Yoda perceived Malakai's insistence on certain tools as an act of control, and in some sense she was right. Malakai perceived that Yoda was indifferent to the requirements of the course, and in some sense she was right as well. The initial choice of tools – the course discussion board – could have worked for a group who collaborated across time zones as Barriers Group did for the first half of the course – but this did not work for them. This is an observation that supports prior assertions that tools interact with tasks and individual members to construct the participants whole technology-mediated experience (Dourish, 2001; Laffey et al, 2006).

Tommy's work setting up his group's tasks set the standard for the use of technology to coordinate work in a completely online small group, especially at the beginning of each module. The placement of organizing discussion boards that broke out the tasks for each module helped Get-Along Group to know what to do in the present, and understand what was coming up in the future. The quickly established practices of Get-Along group sometimes resulted in a slowness to adapt when the task types were different than those that came before; but the group did adapt and complete their work without intervention. Unlike Wenger's (1998) groups, who were physically co-located and able to routinely meet to adapt established work practices, Get-Along Group did not have enough sense of presence with each other to interrupt prior work practices, question

their appropriateness for a new task type, and adapt. Instead, this occurred in fits and starts. Importantly, it did occur.

Two of the three case study groups experienced difficulty managing their work through technology. Grudin (1988) was among the first to boil the failure of collaboration systems down to a concise array of phenomena: Disparity between who does the work and who gets the benefit, the breakdown of intuitive decision making and underestimating the difficulty of evaluating CSCW applications. While much work has been done in the years since Grudin's observations, we see echoes of these phenomena in the ways that our groups adapted technology to their purpose. Tool selection in Individualist Group and Barriers Group was dictated by a single member and adapted to by two other members who then needed to contribute to the work. Perhaps not surprisingly in these two cases, the selector of the tool also contributed a substantial portion of the work and was responsible for coordination of the group's work. A key distinction between Barriers Group and Individualist Group is that Barrier's Group's primary coordination worker (Malakai) selected the tools, and Individualist Group's primary coordination worker (Tommy) negotiated tool use with his fellows.

Star and Strauss (1999) pointed out that articulation work mediated through technology holds many of the same characteristics as invisible work, historically performed by non-dominant members of a population: To the extent that peoples work is ignored, more of this "shadow work" is created. Elements of this are present in the experiences of Cameron and Malakai, who perform the essential coordination work for their teams and ultimately feel somewhat put upon. Cameron actually throws her metaphorical hands up at one point and ceases to lead the coordination work. Malakai, in

contrast, takes over. These different actions may be understood as small scale manifestations of Grudin's observations as well as differing trajectories for invisible workers to follow in completely online settings. Malakai took a stand. Cameron simply got the work done.

These different adaptations of tools also echo some of Garfinkel's (1967) "breaching experiments", which show that complex real time negotiations are fragile and influenced by subtle, postural shifts by members. Perhaps actions by group members are interpreted as postural shifts in this way, leading to greater difficulty adapting technology in two cases. Brown & Levinson (1987) showed that when an individual's actions do not meet the expectations of a group, trust can break down. This is a dimension of the technology adaptation experience for Individualist Group and Barriers Group.

Tommy's straightforward and up front actions for Get-Along Group, within which he transferred the clear instructions from an authority figure – the instructor – to a more easily digested format (the discussion board) helped to build trust. Tommy's actions explicitly met the expectations set by the manager in charge. Perhaps this is accidental, but one distinction between how the three groups adapted technology is the difference in the level of risk taking to start off. Tommy's actions were both safe (starting with sanctioned tools) and useful (clearly making the work of his peers easier). In this way, Tommy's actions clearly met the expectations of his fellows, thus avoiding the danger of not meeting their expectations.

Finding Three: The Nature of Completely Online Participation, Contribution and Trust

Barriers Group and Individualist Group each experienced challenges of trust, which emerged out of their experiences as a group. Get-Along Group, in contrast,

experienced high cohesion and high trust. In the case of Barriers Group, Yoda and Malakai each had low levels of trust for the other. In the case of Individualist Group, Cameron's trust in both Justin and Rabbit diminished as a result of the actions of each. Both Individualist Group and Barriers Group experienced difficulty at the start of their collaboration, while Get-Along Group did not experience any difficulty and got right to work. These divergent starting points correspond with the trust trajectory differences between these three groups.

Distributed small groups are known to face complexities and development challenges that are significantly greater than non-distributed groups. Olson and Olson (2000) asserted that "reports of the death of distance have been greatly exaggerated". Their study focused on synchronous distributed work. In the time since their report, several new synchronous and asynchronous tools that enhance distributed collaboration have emerged: Webex in 2001, Skype in 2003, Writely in 2005, and Google Docs in 2006. The prominent uptake of applications like Facebook, cell phone texting, and twitter among youth (Ellison, Steinfield & Lampe, 2007) further suggest that humans are adapting new ubiquitous technologies in ways that were difficult to project a decade ago. We witnessed some of this adaptation of technology in the experiences of all three case study groups.

Barriers Group faced diversity in participant educational objectives and present state, as well as member online communication practices, like slow response and poor coordination between team members that fostered distrust within the group. Get-Along Group had similar diversity in communication practices and preference early on, but quickly adapted to the communication and coordination path Tommy established. The

socio-emotional behaviors of distributed teams are a large and complex component of the team process. Jarvenpaa & Leidner (1999) looked at the challenges facing culturally diverse, globally distributed teams and trust. They found initial trust to be highly predictive of final trust, with only 4 out of 14 teams that started with low trust ending their experience with high trust. They found that getting started on the “right foot” is essential to maintaining trust throughout the team duration. Other socio-emotional behaviors which can work to erode team trust and confidence are social loafing (Karau & Williams, 1993), domination, and attribution errors (Jarvenpaa, Shaw & Staples, 2004). All these various socio-emotional behaviors, when in a distributed learning environment, revolve around communication, a lack of communication, and the individual member’s perception and understanding of that communication. Both Get-Along Group’s and Barriers Group’s experiences reflect the findings of this prior research. Their experiences also contribute a picture of the precursors to completely online group struggle, including participation and contribution indicators that could help instructors and managers identify groups who are getting off on the wrong foot.

Frequent and timely communication is also a part of successful virtual teams, especially in the beginning (Meyerson & Kramer, 1996; Jarvenpaa et al., 2004; Jarvenpaa et al., 1999; Goggins et al, 2007). When frequent and timely communication does not occur, distrust and anxiety can arise among members. Carabajal, LaPointe & Gunawardena (2003) define communication anxiety (within the distributed teams’ context) as feeling like one is speaking into a vacuum. This can easily occur when time zone differences are large and communication is strained. We can see how Barriers Group members may have experienced their group as a vacuum early on. When

communication is either not predictable or members perceive too much time has passed between episodes, individuals are more likely to make attribution errors. In the case of both Barriers Group and Individualist Group the large windows of time that passed between communication episodes often reflected actual inattention to the group by members. Actual inattention is likely, of course, to be perceived as inattention. The evidence that this is the case for Yoda and Justin is clear. The quick and frequent communication among Get-Along Group members had the opposite effect.

Diversity within the group can be manifest along numerous dimensions, including work habits, expectations, age, gender and culture. Shaw and Barrett-Power (1998) model the impact of diversity on group processes and outcomes. They show nationality/ethnic origin, age, and gender to be the three most readily detectable attributes which then influence other interactions and processes. While their model is based on face to face interactions, these personal characteristics are detectable in the technology used for this study and data from Barriers Group show that these attributes played a role in the breakdown of collaboration. Barriers Group and Individualist Group also demonstrated a high degree of diversity in their information horizons. Though not studied elsewhere, the divergence of these two group's preferences for information resources combined with the challenges they faced when working within their group suggests that further research along these lines could prove fruitful.

Smith (2005) found in her qualitative cross-case study that, although diverse groups can increase motivation and innovation, diversity can also lead to greater conflict. When conflicts arose, members often were confronted with their own insecurities. Responses could include ironing out the difficulties or making assumptions which could

potentially lead to attribution errors about other team members or themselves. In addition, Smith found that coping strategies emerged among members to deal with the conflict. Examples of these patterns include: Flights of fantasy, not contacting other members for weeks at a time and limiting opportunities for discussion. Smith noted that those members who were able to calm their fears relating to their insecurities when conflict arose were able to resolve the conflict more readily. As such, one might be able to see how, in general, more experienced groups of individuals may take more ownership and therefore be able to resolve conflict more quickly. Through this lens, Tommy's substantial experience in online courses, combined with the fast start for Get-Along Group could be seen to have played a role in Get-Along Group's high trust and limited disruption.

Finding Four: The Effects of Tacit Coordination and Articulation Work in Completely Online Groups

Get-Along Group demonstrates the positive effect that active coordination by a member can have on group development. In contrast, Individualist Group demonstrates that when articulation work is assumed to be occurring and the articulating member stops serving this role, group performance declines. In effect, Get-Along Group demonstrated that completely online groups can quickly reify their practices. In contrast, Individualist Group demonstrated that frequent changes to tools and practices lead to challenges in group development and production in a completely online setting.

Tacit coordination is coordination that takes place without the actors involved performing any secondary coordination effort (Christensen, 2008; Crabtree, 2006). Individualist Group exemplifies this sort of tacit coordination, with Cameron effectively

acting in the coordinating role, but not assuming that as part of her duties. Tommy, and Get-Along group, in contrast, explicitly define their work. As previously noted Tommy serves a central coordinating role and actively performs articulation work for the group.

One dimension of the distinct experiences of Individualist Group and Get-Along Group can be understood through these different approaches to articulation work. The structure of the course or the task does not call for articulation work. Tommy took the role on and made it explicit. Cameron did not. While this is hardly empirical evidence that the absence of explicit articulation work in completely online groups causes a group to experience challenges, these two cases highlight two emergent archetype sketches of completely online groups. The cases suggest that tacit coordination is not sufficient for success in completely online groups.

Finding Five: Completely Online Group Development Trajectories Are Identifiable Through CANS Log Analysis

Social network graphs are helpful for monitoring group development and identifying patterns in completely online groups. For example, groups that are identified a priori do appear clustered together in social network graphs in this study, regardless of their pattern of development, when the snapshot is viewed from the “duration of the collaboration period” perspective. Periods of difficulty or challenge in each of the group archetype sketches are also identifiable by viewing those same social network graphs through narrower windows of time. When members leave or reduce participation with the group, this is visible in the social network diagrams, for example.

Social network statistics, including betweenness-centrality, in degree and out degree centrality and network centralization are also correlated with qualitative

characteristics of group development identified in the case studies. Prior studies have examined raw participation scores or participation over periods of time (Hassain & Chung, 2006; Liben-Nowell & Kleinberg, 2003; Tantipathananandh, Berger-Wolf & Kempe, 2007). Our work advances beyond these counting measures to explicate the relationship between social network measures derivable from bi-directional usage logs and completely online group development. For example, betweenness centrality helps to identify members who are actively reading a diverse and broad set of work, but possibly not actively posting. These types of members may be movable into the core with attention from an instructor or leader. Since we also observed a pattern of completely online groups having members in the core, identifying members who may be more easily motivated to contribute holds promise for the proactive development of completely online groups.

In degree and out degree centralization identifies members who are actively being read (in degree) and those who are actively posting (out degree) information to others. Tommy has high in degree and out degree centralization. This is visible from log analysis, and also from cursory examination of the discussion boards themselves. Agnes, in contrast, has high in degree centralization, suggesting her work is more widely read. She has influence in the course, and is an active reader herself. Prior to our identification of these measures and application of them to identify relationships within completely online groups, Agnes' contribution is invisible. There are a number of other individuals who are active viewing the work of others in this online course, but who do not post actively. As a result of our work, these structures may now be made visible, and we have made steps toward explaining what those structures mean.

Finding Six: Completely Online Group Structures Evolve and May Reveal Insights About Group Development

We saw that Individualist member Justin appeared on a different side of the social network graph from his fellow members during the period when his participation in the group was low. We also saw that the members of Barriers Group developed stronger ties with members of other groups than their own group members during their collaboration prior to module four. Yet, if we focused the view out to the duration of the collaboration, members of our a priori groups appeared in close proximity to one another in the social network for the course. The visible evolution of small group social networks in completely online and technologically mediated environments holds promise, therefore, for making group development changes – both advances and retreats – visible.

The visual identification of member distances or non-clustering in a priori groups will provide helpful feedback to instructors and managers. CANS logs overcome the barrier of web logs used in all of the prior work not originating from the Social Computing Research Group at the University of Missouri: Their one directional nature. This study extends that work by showing a way to apply the bi-directional information to create a visual representation of group structure. The next step will be the development of tools to provide that feedback to instructors and managers.

Question Two: What is the Role of Social Ability in Online Group Development?

Finding Seven: In These Completely Online Groups, Social Ability Declines for Members in Coordinating / Articulation Work Roles

Tommy, Malakai and Cameron were all the main articulation workers in their groups. Each of them experienced a decline in social ability from the time prior to

collaboration to the conclusion of the collaboration. Tommy's decline was the least significant, possibly a side effect of his group's low level of stress. Malakai and Cameron, who perceived abandonment by other members of their groups both experienced declines in their social ability factor scores. There are no prior studies on the role of social ability in group work. What we have observed in this study is that role of the member who coordinates work appears to lead to a lower increase in social ability than is the case for other members of the same group.

Get-Along Group member Joplin, for example, shows a dramatic increase in social ability factor scores from T1 to T2, belying her initial timidity and subsequent emergence as a contributor within a supportive completely online group. Tommy's role ensuring a fluid and friendly collaboration experience is a likely contributing factor to Joplin's improvement. Those responsible for monitoring completely online groups must balance the experiences of those who assume coordinating roles, as well as the benefits to those participants whose efforts are more effectively coordinated because a member takes that role on.

Finding Eight: Small Group Work Increases Peer Social Presence and Perceived Written Communication Skills

Yang et al (2006) examined the relationship between motivation and beliefs – Intrinsic, Self-Efficacy and Task Value – and social ability factors. They found that none of these motivational factors or beliefs was significantly correlated with the perceived written communication skills social ability factor. In this study, we find that members who participate in online groups experience increases in perceived written

communication skills and peer social presence, suggesting that completely online group work influences social ability.

The increase in perceived written communication skills that groups working together experienced may emerge out of developing comfort with other group members, resulting in a decrease in concerns about appearing ineffective to one's mates. While the Yang et al (2006) study looked at students across a range of courses, the focus of this study on a single course with group work at the center shows how social ability factors may change as the result of a completely online group experience.

The improvement in perceived written communication skills and peer social presence following group work among members of this course suggest that group work can positively influence social ability in group members. It is possible that the structuring of activities or the provision of social information to develop other social ability factors in completely online courses could work to improve the other three social ability factors and establish group work as a mechanism for actively developing social ability in completely online settings.

Question Three: What is the role of the Member's Information Horizon in Online Group Development?

Finding Nine: Diversity in Information Horizons is Associated with Group Development

Challenges in this Study.

Barriers Group members had little overlap in their principle information resources, possibly contributing to the challenges they faced in building a positive collaboration trajectory. Sonnenwald's (1999, 2003) characterization of information horizons as densely populated solution spaces appears to be confounded in this study by a

small, dense social network whose members have little in common. Though Sonnenwald's construction of Information Horizons addresses people and information in context, it does not consider the influence of information horizons on group development as we have here. She did, however, recognize that socio-technical systems evolve as people negotiate an understanding of knowledge that is valuable and that which is not. This negotiation for Barriers Group resulted in no alignment among members, and a fractured group. While we lack evidence as to cause and effect, the correspondence of this diversity with group difficulties is noteworthy in this case, and we suspect a compelling topic for future examination.

Finding Ten: In This Group Work Intensive Course, Member Information Horizons Center on Information Resources that are Used for Activity Coordination

The survey of all course participants in this group work focused course showed that the information resources that are prominent are those that members use to coordinate their work within their group. Exceptions exist, as with Malakai who relies heavily on resources outside of group coordination. Sixteen of the 21 people who responded to the survey had "Other people in my small group" in the top five information resources used. Twelve of those had that information resource at number one. Seventeen of 21 also had their small group discussion board in the top five information resources used. In a course with diverse tasks and diverse group experiences, finding the dominance of small group focused information resources is somewhat surprising. It implies that, for members of these completely online small groups, the information resources about their group are primary; coordination work takes precedence over information used to solve problems.

Question Four: What is the role of Group Efficacy in Online Group Development

Finding Eleven: Group Efficacy Measures do not Correspond to Relative Group Performance.

Group performance and group efficacy are not the same thing, although Hardin et al (2006) suggest group efficacy as a construct for measuring the effectiveness of groups, and establish the relationship between group efficacy and performance measured vis-a'-vis team grades in an online course. Finding eleven looks closer and more critically at performance and finds the relationship between group efficacy and performance to be non-existent in this context. Get-Along Group declined very slightly from T1 to T2, Barriers Group started with diminished group efficacy and continued to diminish through their work together. Individualist Group diminished in Group Efficacy from T1 to T2 also. Barriers Group performed relatively high on the rubric and Get-Along Group was in the middle. Individualist Group was relatively low in their performance, judged using our rubric in module four.

Our sample size is small, and this research was not conducted as an experiment. While it is therefore not possible to counterclaim Hardin's (2006) finding of a relationship between performance and group efficacy measures, this finding at least introduces cause for further inquiry. We suspect our finding here foretells a more complex dynamic of efficacy in the virtual world than Bandura (1997) described in the physical world. It is also possible that the original rating was made before members could really judge their group, so it was more hopeful than representative of a well thought out belief.

Finding Twelve: At the Course Aggregate Level, Group Efficacy Factors Related to Member Characteristics Improved, But Those Factors Related to Tools Did not Improve

Collaborating in small groups influences the two group efficacy factors that relate to the group members, but not the two group efficacy factors that relate to gaining confidence in the technology. *Ability to do distributed team work* and *ability to collaborate with people who cannot physically meet* both show a statistically significant improvement from T1 to T2, while *confidence in the use of communication technologies* and *confidence in collaboration technologies* do not. Put simply, the people in our groups build trust in each other through small group, completely online collaboration, but that improvement is not generalized to the technology. This finding is across the course, and does not consider variations within the groups, which were discussed at several other points in this work, including the previous finding and the case studies. Fuller et al (2007) describe the adoption of technology by groups as similar to the diffusion of innovation described by Rogers. However, from a group perspective the adoption of technology influences beliefs about the effectiveness of members, not tools. Our findings raise important questions about how groups adopt and use technology, and how their sense of group efficacy could be managed in the future.

This finding also suggests the possibility that the particular tools available to members of this course were insufficient for them to grow in their confidence that the quality of tools influence the feasibility of distributed work. Under these circumstances, confidence in ones fellows might grow in spite of the tools used to develop these working relationships. One potential future study to address this possibility would be a between

groups examination of two sets of people randomly assigned to different groups who use different tools.

Question Five: To What Extent Does Social Network Structure, Observed Through Online Communication Patterns, reflect the Observed Knowledge Construction, Identity Formation and Information Horizons of Group Members?

This question wrought a two part answer:

1. Finding Thirteen: We did not find a relationship between social network structure and knowledge construction, identity formation and information horizons of group members
2. Finding Fourteen: A relationship between social network structure and group performance was uncovered.

For the highest performing and lowest performing groups, there is a relationship between performance and network centrality. Groups with the highest rubric scores also had the highest out degree and in degree centrality. Groups with the lowest rubric scores had the lowest out degree and in degree centrality. The four groups in the middle for rubric scores had mixed in degree and out degree centrality. This suggests that network centrality is a helpful indicator of group edge cases at both the high and low end.

Out degree centrality and group efficacy scores also group together at the top edge. The three groups with high measures of out degree centrality also were in the top ½ of group efficacy scoring groups. Recall that centrality reveals the degree of connectedness a person has with other participants in the course. Combined, these two findings suggest that high in degree and out degree network centrality reflects some measure of engagement in the course. Centrality is an indication of participation breadth;

Not just frequency of participation and contribution. Frequency of participation and contribution in this online course did not correspond to performance or group member beliefs about their group's effectiveness; Diversity of participation, represented by network centrality, did.

Theoretical Implications

Social Network Theory

There are theoretical implications for social network analysis, which has a long history of examining physically present groups in communities, using sparse network data (Wasserman & Faust, 1994), but few theoretical advances addressing the special case of completely online groups. Several studies have looked at usage logs in various sorts of computer mediated environments (Ahmad & Teredesai, 2006; Aviv et al, 2003; Bakstrom, Falkowski, Bartelheimer & Spiliopoulou, 2006; Hildrum & Yu, 2005; Hossain et al, 2006; Yuan, Gay & Hembrooke, 2006; Yuan & Gay, 2006), but discussion of the theoretical distinctions between physically grounded social networks and completely online social networks is yet to occur in the literature. The absence of barriers to interaction in completely online collaboration combine paradoxically with the difficulty understanding and interpreting team member actions accurately to establish a clear opening for the extension of social network theory to the special case of completely online phenomena. There are two fundamental differences in the semantics of social network data in a completely online setting, as well:

1. Unlike physical social networks, which lack a ground truth for social network relations and instead rely on an observable subset of interactions, nearly all interactions in this study are represented in our social network data. The data set

is therefore substantially more complete in this study than in all physically situated social network analysis studies. The inclusion of both read and post data means that this study also examines a more comprehensive set of interaction data than other studies of online or mostly online groups.

2. The semantics of a social network tie are necessarily different in a completely online setting. This study presents bottom up analysis that will be extended and work toward theory to build understanding of the specifics of these different semantics.

The differences observed in this completely online setting between members who post actively and members who read actively suggests a semantically different nature of active and passive participation in a completely online environment. Another semantic implication for completely online social networks is the likely difference in quality of communication and it's correspondence with ties. What it means to simply have a connection, which is easier to come by but harder to make strong when completely online, changes for this type of social network analysis.

Albin-Clark (2008) and Rummel & Spada (2008) have started to speculate on how different types of electronically mediated social interactions should be analyzed using SNA. Like us, they have asked the question. Their work looks broadly across different types of technologically mediated experiences and different types of technologies. Our work starts with the premise of understanding these social networks at the small group unit of analysis. Development of theory around completely online small groups, incorporating social network analysis is an important next step in this work.

Social Ability at the Small Group Unit of Analysis

Social Ability has been previously examined at the individual unit of analysis, with trends and changes aggregated across larger online learning environments where participants were not distinguished by group membership. This study has looked at Social Ability and how it relates to small group development. The canonical definition of social ability is the intersection of tasks, tools and members in a technologically mediated environment (Laffey et al, 2006). Our study concerns itself with social ability as an indicator of group trajectory, and with the extension of social ability to the small group unit of analysis.

At T1 we recorded social ability at the course level, prior to collaboration. At T2, we recorded social ability after significant small group collaboration. The significant changes noted in perceived written communication skills and peer social presence factors at T2 suggest that small group activities help to develop these two factors in a completely online setting. Future work should focus on the development of an understanding of how group work fosters these two social ability factors, and might be designed to improve the other three social ability factors. Future work should also consider if there are aspects of completely online group work that slow the development of social ability or patterns of social ability trajectory in completely online small groups

Group Cognition in Completely Online Groups

Stahl (2006) characterized group cognition as the detailed experiences of social groups building knowledge together. He explored a decade long series of CSCL experiments that lead to the development of his theory of computer supported collaborative learning. The result was an explication of a theory of group cognition through examples. Group cognition is theory described from the point of view of the

experiments, philosophical lineage and thought processes that led to it. This study advances the theory of group cognition through the examples of individual and group knowing presented in our archetype sketches.

Like the specific cases Stahl describes, the cases in this dissertation are viewed from diverse interpretive perspectives. In our case, the learning community, the individual and the small group are the core perspectives. Stahl also included collaboration researchers and educational innovators, who are of course more likely than folks from other perspectives to read this work. Ostensibly we have analyzed our data and written from that perspective. In this respect, a significant portion of this work contributes directly to a theory of group cognition.

According to Stahl, the analytic perspective of small groups is meaning making. We have examined how small groups make meaning socially, in the uptake of specific technologies and from a task perspective. Our study has followed the different trajectories these groups travel and identified the social network structures that are observable, highlighting distinctions in social network structure that are associated with different patterns of group development. In this respect, we add a dimension of group development and it's visualization to the corpus of work that contributes to a theory of group cognition.

Practical Implications

Identification of Subgroups Through Usage Logs

Our study showed that subgroups are identifiable through usage logs in completely online groups. We also showed that different types of use – reading and posting – show distinct patterns and provide complementary views of the evolving social

network. Agnes and Tommy both had high betweenness centrality, but for different reasons: Agnes was widely read and Tommy was both widely read and active as a poster. In typical usage log analysis which only looks at posts, Agnes would not be visible. For managers of completely online groups, the analysis techniques outlined here promise to be the beginning of a set of tools that permit the monitoring of completely online group health. CSCL practitioners, the first to foster completely online groups on a wide scale, will likely also apply these lessons first.

Online Group Management Job Aids to Assist Instructors and Managers in the Formation of Healthier Completely Online Groups

The archetype sketches and the corresponding themes and patterns are immediately applicable by practitioners seeking to find qualitative indications of group development in their completely online groups. Helpful behaviors like organizing posts may be seeded immediately into existing online courses. Other themes and patterns will be identified and catalogued over time to enrich this list and aid practitioners in the identification of archetypes in their completely online environments.

Design Implications

Online Group Informatics

There are a number of possible interaction design implications arising out of these research findings. First, the notion of using time series data to further understand and make visible the trajectories of completely online group development is worth exploration. Social networks could be viewed as a series of constantly changing group assemblies, with the network changes over time proving more interesting and helpful in the long run than the snapshots analyzed in this study.

Second, the development of predictive algorithms to identify groups who are likely to experience difficulty in their collaboration could be developed, as an extension of the existing CANS logging system. The large amount of CANS log data already in existence for courses at the University of Missouri, combined with the analysis from this study may provide a *learning data set* that allows these algorithms to be put into practice quickly.

Third, the application of data mining techniques to make recommendations for discussion boards to read or information resources to access within completely online tools is possible. An earlier pilot study (Goggins, Proctor & Almosallam, 2009) showed that CANS logs can be applied using simple Jaccard+Pearson algorithms to produce meaningful clusters of information. That finding, combined with the more semantically developed distance measures used in this study point to additional tool development.

Fourth, connecting usage logs to text mining, using the content analysis results from this study as a starting point, promise to lead to less labor intensive means for identifying high levels of knowledge co-construction in the communications of completely online groups. Again, using the coded discussion boards from this study to define patterns, and implementing an ongoing coding and sampling regimen would permit the development of powerful tools to aid those responsible for participating in and managing completely online groups.

Each of these design implications relate to online Learning Management Systems like Sakai and to group support tools in general. These group informatics design ideas are generalizable to completely online groups: Which mostly exist in online courses right now. Therefore, implementing these designs in a tool like Sakai is a logical first step.

Methodological Implications

Completely Online Group Development Case Studies With Mixed Methods

The combination of case study research with social network analysis and performance measures in this study foretells a new way of examining distributed group work, especially in online learning environments. While a handful of prior studies have mixed different methods together to examine electronic learning environments (Aviv, 2003), those studies examined surface characteristics of the networks and knowledge construction. This study shows the importance of building full case studies and combining those rich studies with social network and knowledge construction data to paint the complete picture of completely online group development.

Development of Archetypes, Themes and Patterns Libraries

A concise study like this can only aspire to create completely online group archetype sketches. Our sketches show how the surfacing of themes and patterns, along with the description of social network characteristics, information usage, social ability and group efficacy build a picture of the completely online groups in this study that other researchers may follow. The implications for theory and practice that emerged from this approach create what we hope will be a compelling exemplar of how to study completely online group development.

Limitations

A course management system supporting graduate students in a time bound course is both similar to and different from other types of possible completely online collaboration environments. This study will add insight to other completely online group

development research, but since it is situated in a completely online graduate school course the reader should keep this limitation in mind.

The definition of completely online group has evolved through the execution of this study. We had one group who left the completely online farm by accident, and some of what we discovered in analyzing that group – Barriers Group – was that changes in distribution are a factor in group development. Given that a number of barriers had emerged before the change in distribution status the case remains a compelling study of a completely online group; where two of the members at least had the opportunity to meet face to face occasionally.

Conclusion

Completely Online Groups are an emerging phenomena. Like many technologically born phenomena, they are occurring first in university settings. We expect it is merely a matter of time before completely online groups become common place in other settings. Just as email, internet use and innovations of other kinds first emerged on campuses; completely online groups are also emerging in these settings first – Only this time, on virtual campuses.

This study looked at the development three completely online groups using knowledge construction, social identity and social network structure as the central components of group development description. We then compared the social network structure, information horizons, group efficacy and performance of eight completely online groups. What emerged were a set of completely online group archetype sketches and an enriched understanding of the diversity of experiences among those doing group work completely online. Group members brought diverse work practices, learning habits,

technology skills and collaboration preferences with them to these groups. The challenges of completely online group work are both diverse and significant.

Following these case studies, we examined a number of factors across all eight groups, and related group performance, group efficacy and social network structure patterns. These exploratory examinations of the relationship between completely online group characteristics and social networks derived from bi-directional usage logs will be the basis for the development of tools to aid managers and teachers of completely online groups in the early identification of difficulties, the design of teaching and managing strategies and the understanding of what the different types of completely online groups are. This will lead to improved completely online group management practices in the future.

Appendix A – Social Ability Survey

1. I feel connected to other students in this course
2. My interactions with other students are sociable and friendly
3. My online interactions with other students seem personal
4. In my interactions with other students I am able to be myself and show what kind of classmate I really am
5. I feel like I am a member of a group during course activities
6. I feel comfortable expressing my feelings to other students
7. When I log on I am usually interested in seeing what other students are doing or have done
8. I trust the other students in this course to help me if I need it
9. The actions of other students in the course are easily visible in our online system
10. When I see that other students are confused I offer help

11. I am concerned that my writing ability limits how well other students can get to know me
12. I am concerned that my writing ability limits how well my instructor can get to know me
13. I am concerned that my writing ability limits how effective I can be in this course

14. My interactions with the instructor are sociable and friendly
15. I feel comfortable expressing my feelings to the instructor
16. My online interactions with the instructor seem personal
17. The actions of the instructor in the course are easily visible in our online system
18. In my interactions with the instructor I am able to be myself and show what kind of student I really am
19. I trust the instructor in this course to help me if I need it
20. When I log on I am usually interested in seeing what the instructor is doing or has done
21. I feel connected to the instructor in this course

22. I feel uncomfortable with the amount of information about myself that I had to share with other students in this course
23. I feel uncomfortable with the amount of information about myself that I had to share with the instructor in this course
24. I feel uncomfortable interacting with others in the course because these interactions are recorded

25. Knowing what other students in the course have done helps me to know what to do
26. Knowing that other students in the course are aware of my work usually influences how hard I work and the quality of my work
27. The actions of other students in the course influence the quality of my work (such as trying to write better messages or working more carefully)

28. Interacting with the instructor helps me accomplish assignments with higher quality than if I were working alone
29. Interacting with other students helps me accomplish assignments with higher quality than if I were working alone.
30. The actions of the instructor in the course influences the quality of my work (such as trying to write better messages or working more carefully).

Appendix B – Information Horizons Interview

Prior to participating in a 1 hour telephone interview, informants will be asked to provide an information horizons map, describing information resources they use in the context of participating in online courses. They will be asked to *think about and document every person, web site, book, library or other information resource they utilize over the course of a semester. Informants will be asked to draw pictures of their information horizons within the online course management system, and their information horizons in the larger world.*

Informants will be provided with the following example (Sonnenweld, 2001) of what an information horizon map looks like.

This is a semi-structured interview, which will explore the information horizons presented by the informant, and seek to ensure:

- All information sources used in the context of the course are uncovered
- The nature of the information sources and their use in the online course are fully described.

The following questions are a loose guide for initiating the discussion, and ensuring coverage of the above goals. The first two questions seek to initiate discussion by eliciting a critical incident, as prescribed by Sonnenweld (2001). The third question initiates the walk through of the information horizons map.

Q1. Describe a time when you were working in an online course management system like Sakai and you had difficulty finding the information you needed.

- a. How did you eventually meet that challenge?
- b. Did you discover any new information sources in your search?
- c. Did you discover any boundaries which you thought to exist did not, in fact exist. For example, was there a person or website who you thought could not meet this particular information need, but ultimately did?

Q2. Describe a time when you were working on something to complete a task in an online course using information resources outside of the course management system, and you experienced difficulty finding the information you needed.

- a. How did you eventually meet that challenge?
- b. Did you discover any new information sources in your search?
- c. Did you discover any boundaries which you thought to exist did not, in fact exist. For example, was there a person or website who you thought could not meet this particular information need, but ultimately did?

Q3. When searching for information to complete an assignment, which of the sources drawn on your information horizons map do you go to first?

- a. Why?
- b. How long has this source been on your information horizon map?

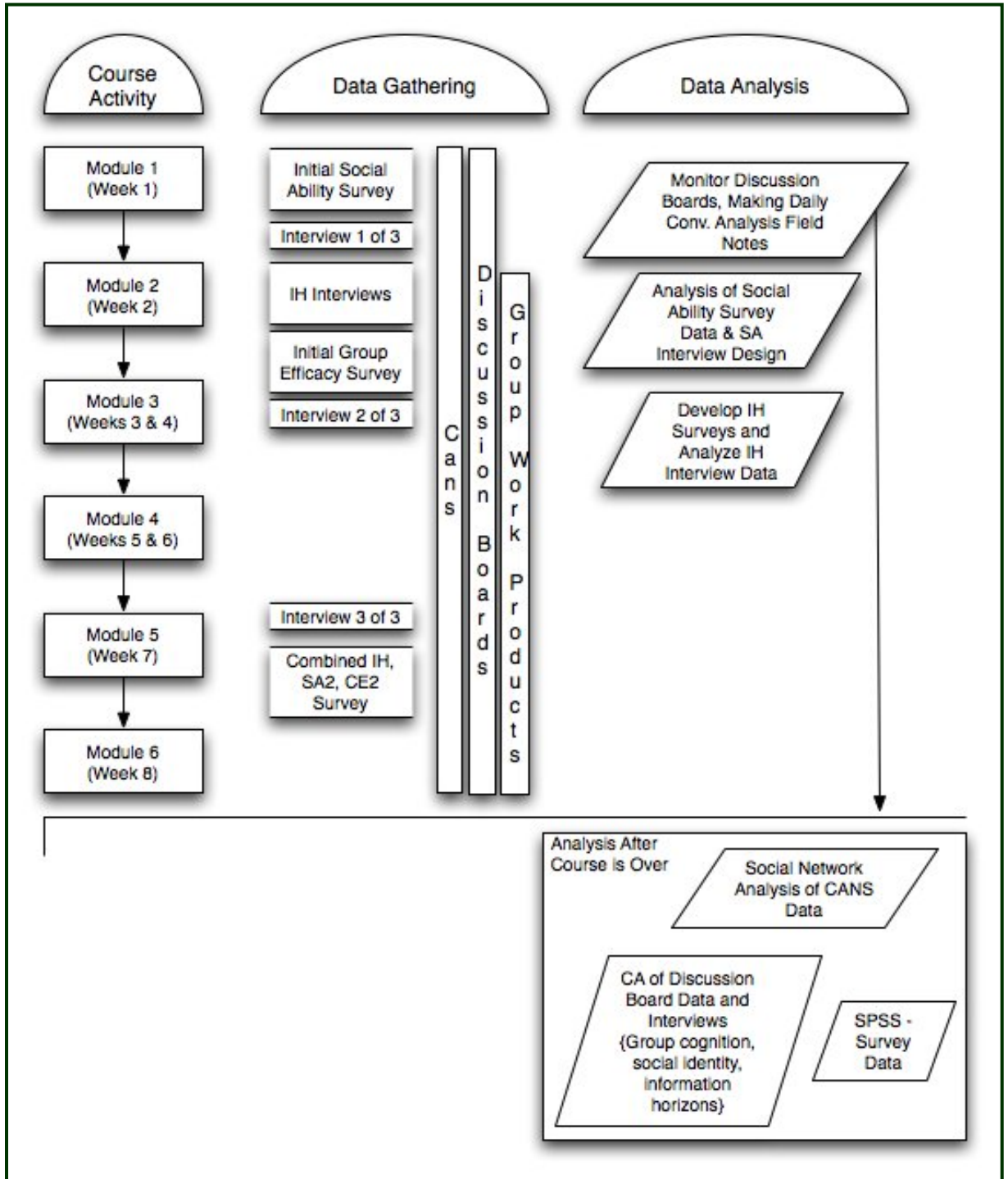
Q4. Let's walk through your information horizons map. {This is expected to take the remainder of the time allocated for this interview }

Q5. Describe a time when you were working within your course and accidentally discovered information that you found useful to you in the course itself, or in another context.

Appendix C – Group Efficacy Survey Questions

1. I believe my group has the ability to use communications software to collaborate with remote group members.
2. I believe my group has the ability to do teamwork in a distributed environment if we have access to the appropriate technology.
3. I believe my group has the ability to share information using technology with remote group members.
4. I believe my group has the ability to use communications technology to do work with people who can't physically get together to meet.

Appendix D – Data Collection Plan Visualization



Appendix E – Content Analysis Coding Schemes for Knowledge Construction and Social Identity

Content analysis was conducted on all group discussion board posts. Each coder was provided with identical spreadsheets containing those discussion board posts, and the codes were applied at the post unit of analysis. The samples were then coded according to Gundawardena’s coding scheme, as well as a coding scheme for social identity, developed in a pilot study and based on Tajfel’s (1978, 1980) social identity constructs.

Gundawardena’s Scheme

Description	Code	Example
Phase I: Sharing/Comparing of Information		
A. A statement of observation or opinion	Ph1/A	
B. A statement of agreement from one or more participants	Ph1/B	
C. Corroborating examples provided by one or more participants	Ph1/C	
D. Asking and answering questions to clarify details of statements	Ph1/D	
E. Definition, description or identification of a problem.	Ph1/E	
Phase II: The discovery and exploration of dissonance or inconsistency among ideas, concepts or statements. (This is the operation at the group level of what Festinger calls cognitive dissonance, defined as an inconsistency between a new observation and the learner’s existing framework of knowledge and thinking skills)		
A. Identifying and stating areas of disagreement	Ph2/A	
B. Asking and answering questions to clarify the source and extent of the	Ph2/B	

disagreement		
C. Restating the participants position, and possibly advancing arguments or considerations in its support by references to the participants experience, literature, formal data collected, or proposal of relevant metaphor or analogy to illustrate point of view.	Ph2/C	
Phase III: Negotiation of Meaning/Co-Construction of Knowledge		
A. Negotiation or clarification of the meaning of terms	Ph3/A	
B. Negotiation of the relative weight to be assigned to types of argument	Ph3/B	
C. Identification of areas of agreement or overlap among conflicting concepts	Ph3/C	
D. Proposal and negotiation of new statements embodying compromise, co-construction	Ph3/D	
E. Proposal of integrating or accommodating metaphors or analogies	Ph3/E	
Phase IV: Testing and Modification of Proposed Synthesis or co-construction		
A. Testing the proposed synthesis against received fact as shared by participants and/or their culture	Ph4/A	
B. Testing against existing cognitive schema	Ph4/B	
C. Testing against personal experience	Ph4/C	
D. Testing against formal data collected	Ph4/D	

E. Testing against contradictory testimony in the literature	Ph4/E	
Phase V: Agreement statement(s)/Application of newly constructed meanings		
A. Summarization of agreements	Ph5/A	
B. Application of new knowledge	Ph5/B	
C. Metacognitive statements by the participants illustrating their understanding that their knowledge or ways of thinking (cognitive schema) have changed as a result of the conference interaction	Ph5/C	

Social Identity Scheme

<u>Description</u>	<u>Code</u>	<u>Example</u>
Interpersonal	Erpers	<p>Musa, I think you are right in when you say people should work together in order to have a very good group collaboration. It takes working together and people illing to work in order to have the best working environment. Good insight!</p> <p>Lucy While I do agree with you, I believe that this solution is for what I called the perfect world. You can provide all the necessary tools and techniques for groups to interact as positively as possible and still the results can be not as expected. I've been party to many a brainstorming session where group members refuse to participate for many different reasons or even try to sabotage the result for their own selfish reasons.</p>

		<p>Its difficult to put everything logically into place and still have an illogical result.</p> <p>Comments: <i>Note that in the first case, the other person being addressed has their name used. In the second case, there is no addressing by name, and the interpersonal is derived by the statement and the surrounding context.</i></p>
Intragroup (Small Group)	Sragroup	<p>Genevieve, Your quote, "I think that most people will cooperate most of the time in most contexts but I am more realistic now that I've seen theives, backstabbers and loafers firsthand. To speak plainly, I now expect people to cooperate when it's convenient, to be nice when they feel like they are personally identifiable and to work hard if it will benefit them." is incredibly insightful. You get to the core of the operation of many people in our society today. I have shared similar experiences and find it frustrating. When I complain to my husband about a situation like that, he always says, "Why do you let it bother you? You know that is how he is!" My hope is that I can learn new ways to facilitate cooperation and increase productivity in these situations by understanding and applying the concepts from our class.</p> <p>Thank you for choosing to share this story with us, Lisa. I am fascinated by the student support model that has been created at your school. And like Gen, I loved the pixels/picture analogy describing the parts that make up the whole of the student. At our community college, a crisis intervention</p>

		<p>team, made up of instructors, counselors, students and administrators has been formed with the hope that together, our college community can learn how better to identify students in trouble and to intervene appropriately to help the student stay in college, avoid poor personal decisions, etc. Just as at your school, individuals with the ability to see the students from different perspectives can cooperate and share understandings in order in ways that the individuals alone would not be able to. The implementation is new this year, and I am interested to learn how knowledge is shared among team members and how strategies are designed and implemented toward helping students deal with stress</p> <p>Comments: <i>The first example seems almost exactly like the interindividual example. The only thing that makes it different is the context. The post was made in a discussion thread that included more than two people interacting with each other, and building on each others ideas. The second example is an easier one. In that case, you can see that the poster is summarizing and commenting on the contributions of several other parties.</i></p>
Interindividual	Erind	<p>You have done a good job Stitching seems to be something that I found exciting. One issue brought about in the product is ability of people to collaborate in varying physical spaces. The material used to stitch are easily available and one need not use a complicated device to perform the task. Clarification or improvement I did not hear you say anything about the freedom that a member has in disconnecting / opting out from a collaboration. This</p>

	<p>freedom is critical when using such an environment. It seems that there is an awareness problem in stitching. I felt that for one to collaborate with another, you simply could not use stitching to alert your collaborators that someone needs to collaborate. I also wonder how the system would work in an office environment with lots of tablets. Privacy issues will surely come into play and you need to say something about them because if members are not sure about privacy of the system, effective collaboration can be jeopardized.</p> <p>Overall I felt that group 2 did an excellent job presenting the eSpace system and critiquing it based on the given questions. Like the others, I would have liked to see a bit more information around its ability to truly serve as a CSCW system. To me, facilitating work between just 2 individuals really barely fits in the category. Maybe some additional features would be to link it in with a rating system that allows travellers to see others ratings of properties/destinations with comments and reviews. Maybe another possibility would be to allow multiple agents to work on a given itinerary. This idea does spawn a thought for me that maybe someone can answer... does any inherent artificial intelligence (AI) built into the system count as "other" collaboration -- like it would if other agents were involved?</p> <p>Comments: <i>This classification is at first difficult to distinguish from interpersonal and intragroup. Both examples are</i></p>
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		<i>classified as interindividual based on the context of the discussion thread. Something is interindividual if communication is occurring in a discussion context and a specific post addresses one individual when surrounding posts or the overall discussion board context is focused on group collaboration. Tajfel's intention for interindividual was to characterize a state of communication where two people interacted with each other, independent of group identity.</i>
Intragroup (Large Group)	Lragroup	Comments: <i>The distinction between this and the intragroup (small) is context – Is the overall discussion board context a small group (emergent or assigned) or a large group (the entire class).</i>

Appendix F – Course Module 5 Assignment Description

CSCL-Module 4

In module 4 there is some background reading and then you will work as a team to design a CSCL lesson. You will work in the same teams as in the earlier modules. You will be implementing this lesson in module 5 to two other teams of students.

This activity has 5 tasks to complete in 2 weeks. Some tasks should start before the prior one is completely finished so read all the tasks first and plan your work as a team. If for any reasons you fall behind or have a schedule problem please communicate with your team about when you will be able to get your work done. Your team members depends upon you to complete their own work.

Mod 4.1:

Listen to the audio component to Mod 4 and begin reading the articles I provide for you in the mod 4 resources folder. Join the discussion on the Mod 4 discussion board. I will post a question to get our conversation started ♦.please respond to it, but also start to add your own ideas and questions from the readings. Feel free to also use the discussion board to ask questions or clear up issues about the module. Throughout module 4, I may post additional questions and I expect each student to participate in discussing the issue or answering the question.

For our discussion we ♦ll use the Module 4 DB.

Also ♦.on Monday (July 7th at 6pm central) I will be in chat for anyone who wants to talk about the assignment or any other issues about CSCL and life in general. This is an **optional** chat so you are not required to participate.

The 2 articles to read are:

Kirschner

Dillenbourg

Mod 4.2:

In Mod 4 you will be working as a team to design a CSCL lesson with the objective of implementing that lesson for two other teams in Mod 5. Mod 5 will last for 8 days so you need to design with that in mind. Also keep in mind that teams in Mod 5 will be undertaking 2 lessons ♦.one from your team and one from another and that your team will be undertaking 2 lessons as well. I say this to emphasize that your lesson should not be too gIndividualistiose. I encourage you to shoot for about 4-5 hours of student activity to complete your lesson. Also to truly emphasize the collaborative learning aspects ♦.I encourage you to keep the readings or individual background work to a small amount of time and try to use your students time in co-construction, dialogue, co-learning, etc that emphasize interaction. This is an opportunity for your team to practice design for interaction ♦.guide it, support it, assess it.

There is no correct answer for what your CSCL lesson should be. Use the readings and your prior experience in this class and otherwise as your knowledge base and use interaction with your team members to develop your lesson. This guide will give you a set of steps (script) to work through with processes and deliverables but how you undertake those processes and what you provide as deliverables is up to your team. If you and your team work earnestly at the tasks and apply the knowledge you have been developing in this class I will be quite happy. You have only a short time to get this work done ♦.so do not procrastinate. At the other end of this module will be 2 teams waiting to take your lesson.

You can pick any lesson topic you want, but I encourage you to make it as appropriate as possible for adults in an ed tech program like yourself. It would be great if this lesson design activity was a springboard to a real lesson you will develop for your undergraduates, 4th graders, staff of your company or whomever you may have responsibility for their learning, but I suggest you use this lesson design to work on process rather than content. For example, use some co-learning process for how ed tech students might learn about a new system for implementing cscl, such as qwaq, or how they might learn about an argumentation strategy that can be used in discussion boards to discuss how to assess CSCL but have in mind your other subject matter and audience so

as to enable you to transfer the approach. If a team wants to get some feedback on their topic for the lesson ♦️..come to the monday chat or post a message on the mod 4 db.

In step 4.2 your team is starting to formulate and explore what lesson to offer. The Kirschner article provides a checklist of design questions (p24) for building a CSCL lesson. Use the first 3 sets of questions as a guide for getting your group started. Use your team thread to discuss the 3 sets of questions. At the end of this discussion your team should have reached consensus about a topic, general expectations for what type of interaction your students will have, and a task type for your lesson.

Summarize your discussion with a Post from one of your group members to the Mod 4 Lesson DB ♦️.the post can be short but should provide a lesson topic, key ideas about student interaction and some preliminary description of the task type. The summary post should be made no later than **July 8th**.

Mod 4.3:

Develop a scenario about how students will experience the lesson. The purpose of writing a scenario is to tell a story (paint a picture, start to envision, etc.) what the user experience will be like. For our purposes it need not be too technical. By creating a scenario you enact your ideas and then can play with them (see them, share them, discuss them, improve them). Enactment is a key part of design. By enactment I just mean making it come to life. When we are designing software we may start with a scenario and proceed through many sets of prototypes. Scenarios are good because they are cheap and familiar. We can create them fast and we all are experienced at telling stories. However, for a scenario to be really effective it must enact the key elements of the work or learning so that we really start to see the learning and the learning process, as well as the constraints on learning and process. For example if I am writing a scenario about building a house and I never mention getting my supplies ♦️.then key issues of cost, timing, quality and dependencies may never surface. Some of the key elements to keep in mind (from my perspective) are: how do the learners interact with the subject of the lesson, how do they interact with each other, how do they interact with you the instructor, how do they know what to do, and how is there learning represented (deliverables) ♦️.of course there are other issues ♦️.but these are a good starting point.

Some of you may have experience writing design scenarios from previous courses, but for those that would like some help in getting started I have created a folder of sample scenarios (see the folder ♦️sample scenarios ♦️) created by students in the CSCW course. I ♦️ve just picked a few as examples, they are not necessarily models ♦️.but in general

they are pretty good. Keep in mind they were designing systems and you are designing lessons ♦ ..so just use them as illustrations.

Your team should come up with a way of collaboratively writing your scenario. For example, one person could do a first draft and pass it to the next, etc.

You could co-write in a discussion thread or on the wiki or with other tools, you could each write a scenario and then use them to select the best parts, etc. It is up to your team to decide.

Your team scenario should be uploaded as an html doc to the Scenario folder by July 10th. Label it with the team name.

Mod 4.4:

In step 4.4 your team is developing the final lesson script. The Dillenbourg article can be helpful in thinking about scripts and you can reflect on my strategy of modules and steps as a form of scripting. Also return to the checklist of design questions (p24) of the Kirschner article. Use the final 3 sets of questions as a guide for getting ready to write the script. Create a thread on the Mod 4.4 db. Use that thread to discuss the final 3 sets of questions and developing a script for your lesson. At the end of this discussion your team should have reached consensus about the structure, the role of the instructor, and the ways the computer will be used to support interaction and represent the task for your lesson.

Your team should also specify how learning will be assessed.

The deliverable for mod 4.4 is a script that teams of students can follow for mod 5.

Your team lesson should be uploaded as an html doc to the Lesson folder by **July 14th**. Label it with the team name.

Mod 4.5

Return to the assignment document and respond to the reflection questions by Wednesday July 16th.

Appendix G – Module Four Assignment Evaluation Rubric Used by Two Raters

Criteria	Theory Supporting Work Task Production	Points			
		3	2	1	weight
Lesson Prospectus Discussion Board Post (Outcome)		In reviewing specific points below, partial credit may be granted in 1/2 point increments. For example, if three points are available, and each point is partially satisfied, then 1 1/2 points could be the total score. Where the outcome is more clear, then simple selection of point column 3, 2 or 1 is preferred. The scorer is allowed to exercise judgement on each point, however.			
Scenario (outcome)		<p>Clearly describes what learners will do (0,1/2, or 1 point), the outcomes (Goals) of the lessons (0,1/2, or 1 point) and presents a reasonable scope of work (0,1/2, or 1 point) for the time allocated.</p> <p>There is room here to question whether or not each point is partially met.</p>	Two of Three: Clearly describes what learners will do, the outcomes of the lessons and presents a reasonable scope of work for the time allocated.	1 Of Three: Clearly describes what learners will do, the outcomes of the lessons and presents a reasonable scope of work for the time allocated.	6

Criteria	Theory Supporting Work Task Production	Points			
		3	2	1	weight
Scenario (outcome)		<p>Interaction among members is clearly described</p> <p>For example, if the interaction clearly references how collaboration is going to be executed, and connects this collaboration to the objectives, then the interaction description is connected to the purpose and likely to be well described.</p> <p>Alternately, if the interaction points are enumerated in the lesson plan, but the relationship between these enumerated interactions and collaboration to achieve a learning objective are unclear, this is more likely a partial description.</p>	Interaction among members is partially described	Interaction among members is poorly described or not described at all.	6
Lesson Script (Outcome)	<p>Kobbe, Weinberger, Dilenbourg, Harrer, Hamalainen, Hakkinen & Fischer (2007) specify the important characteristics of CSCL scripts. The characteristics and mechanics they describe are constituted by this part of the rubric.</p>	<p>Script may be followed with ease. Students know what they are expected to do, and there are no ambiguities. (0, 1/2 or 1 point each for these, then divide the total by 3)</p> <p>Are participants described? Are Activities Carefully described? Are roles described? Are available resources described? How is task distribution addressed? Is task distribution addressed? How is group formation addressed? Is the role of the group in the collaboration made clear? Is task sequencing made clear?</p>			12
		<i>Are participants described?</i>	0, 1/2 or 1		
		<i>Are Activities Carefully described?</i>	0, 1/2 or 1		
		<i>Are roles described?</i>	0, 1/2 or 1		

Criteria	Theory Supporting Work Task Production	Points			
		3	2	1	weight
		<i>Are available resources described?</i>	0, 1/2 or 1	If they are merely enumerated, 0.5 If the resources are listed and explained, 1.0	
		<i>Are group deliverables addressed?</i>	0, 1/2 or 1		
		<i>Is task distribution addressed?</i>	0, 1/2 or 1		
		<i>Is group formation addressed?</i>	0, 1/2 or 1		
		<i>Is the role of the group in the collaboration made clear?</i>	0, 1/2 or 1		
		<i>Is task sequencing made clear?</i>	0, 1/2 or 1		
Lesson Assessment Plan (Outcome) [This is included in the Script, according to the assignment]	Preparing Instructional Objectives (Mager, 1984 [second edition])	<p>Assessment according to the criteria is likely, the criteria are aligned with the expected work product, and the criteria are well explained.</p> <p>1. Objectives included in the assessment plan 2. Objectives describe the intended outcome, not the process 3. Separate evaluation statements exist for each important outcome</p>	At least two of the three characteristics are met: Likely, Alignment and well explained	Fewer than two of the three characteristics are met... Use this scale: 0 - No addressing of assessment at all .5 - For reflection statement only 1 - For address	6

Criteria	Theory Supporting Work Task Production	Points			
		3	2	1	weight
				sing assessment in any way besides a reflection statement	

Appendix H – CANS Log Data Cleaning

Ninety-four events were cleaned from the event database because they were read only events from interloper members who either never posted to the database (two researchers) or read from it (LMS Admin user). When conducting SNA this caused a non-square matrix to form. The SNA tools used in this study, like other tools used to analyze two mode networks, can only address square matrices. A non-square matrix will occur any time there is a 2 mode network, as in this case, where there are members who participate only in a single direction. These members, whose roles are identified above, are not material to the questions of this research. Below is the query used to eliminate these 94 events from the database:

```
delete from CSCL_08Events
where event_author_id in ('researcher1','researcher2','admin')
or object_creator in ('researcher1','researcher2','admin')
order by object_creator
```

Appendix I – Degree Centrality Raw Data for Modules Two Through Six

Module Two

The degree centrality social network data for module two is below.

Table 58 - Module 2 Degree Centrality

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
tommy	293.76	205.864	17.946	12.576
dora	291.76	123.67	17.824	7.555
kylie	290.41	226.585	17.741	13.842
agnes	236.29	71.792	14.435	4.386
sandy	187.86	142.095	11.477	8.681
colina	163.12	183.502	9.965	11.21
john	148.56	94.932	9.075	5.799
poncho	145.19	165.263	8.869	10.096
sally	140.75	148.297	8.598	9.06
rabbit	138.91	185.05	8.486	11.305
liz	114.78	91.207	7.012	5.572
alice	113.18	168.672	6.914	10.304
cameron	107.75	147.813	6.582	9.03
cora	96.224	65.055	5.878	3.974
joplin	89.354	100.108	5.459	6.116
lolly	88.616	157.545	5.414	9.625
instructor	83.647	196.025	5.11	11.975
genny	82.233	103.596	5.024	6.329
jessica	73.575	47.142	4.495	2.88
malakai	72.298	108.677	4.417	6.639
winston	63.107	154.402	3.855	9.433
yoda	59.065	105.09	3.608	6.42
researcher	57.694	0	3.525	0
nellie	56.57	105.402	3.456	6.439
steven	55.216	74.669	3.373	4.562
ginny	44.531	56.918	2.72	3.477
jonas	32.5	50.75	1.985	3.1
justin	13.875	60.681	0.848	3.707

Table 59 - Module 2 Degree Centrality Descriptive Statistics

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
Mean	119.31	119.314	7.289	7.289
Std Dev	76.649	54.751	4.683	3.345
Sum	3340.8	3340.8	204.092	204.092
Variance	5875.1	2997.72	21.926	11.188
SSQ	563109	482542	2101.558	1800.877
MCSSQ	164503	83936.1	613.936	313.255
Euc Dist	750.41	694.652	45.843	42.437
Minimum	13.875	0	0.848	0
Maximum	293.76	226.585	17.946	13.842

Table 60 - Module 2 Network Centralization

Network Centralization (Outdegree)	11.052%
Network Centralization (Indegree)	6.796%

Module Three

The degree centrality social network data for module three is below.

Table 61 - Module 3 Degree Centrality

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
kylie	227.862	165.333	24.626	17.868
dora	216.753	70.574	23.425	7.627
agnes	203.396	70.123	21.981	7.578
sandy	190.25	128.018	20.561	13.835
tommy	184.991	104.295	19.992	11.271
colina	145.147	82.19	15.686	8.882
yoda	107.444	167.617	11.612	18.115
poncho	104.468	70.285	11.29	7.596
sally	101.847	135.431	11.007	14.636
malakai	101.709	44.96	10.992	4.859
jessica	91.005	127.29	9.835	13.756
joplin	89.402	95.909	9.662	10.365
liz	82.1	60.239	8.873	6.51
genny	77.909	97.784	8.42	10.568

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
john	76.986	51.336	8.32	5.548
cora	76.752	116.189	8.295	12.557
steven	75.117	73.513	8.118	7.945
alice	66.031	99.705	7.136	10.775
nellie	62.251	242.588	6.728	26.217
winston	60.65	62.186	6.555	6.721
rabbit	58.745	99.196	6.349	10.72
lolly	58.733	153.035	6.347	16.539
jonas	55.477	101.343	5.996	10.952
cameron	51.101	121.487	5.523	13.129
instructor	25.977	54.273	2.807	5.865
researcher	7.636	0	0.825	0
justin	0	4.841	0	0.523

Table 62 - Module 3 Degree Centrality Descriptive Statistics

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
Mean	96.287	96.287	10.406	10.406
Std Dev	59.751	50.324	6.457	5.439
Sum	2599.74	2599.74	280.959	280.959
Variance	3570.141	2532.537	41.698	29.579
SSQ	346714.156	318698.875	4049.46	3722.255
MCSSQ	96393.813	68378.508	1125.84	798.629
Euc Norm	588.824	564.534	63.635	61.01
Minimum	0	0	0	0
Maximum	227.862	242.588	24.626	26.217

Table 63 - Module 3 Network Centralization

Network Centralization (Outdegree)	14.77%
Network Centralization (Indegree)	16.42%

Module Four

The degree centrality social network data for module four is below.

Table 64 - Module 4 Degree Centrality

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
tommy	291.891	222.754	12.215	9.322
agnes	254.224	197.198	10.638	8.252
colina	241.614	236.28	10.111	9.888
sandy	226.364	108.564	9.473	4.543
kylie	199.324	174.615	8.341	7.307
sally	198.855	178.108	8.321	7.453
dora	184.136	50.368	7.706	2.108
john	177.966	126.918	7.447	5.311
poncho	155.773	179.418	6.519	7.508
rabbit	148.339	71.497	6.208	2.992
lolly	145.976	192.871	6.109	8.071
joplin	126.382	137.479	5.289	5.753
winston	108.502	110.605	4.54	4.628
instructor	106.108	405.202	4.44	16.956
malakai	102.739	181.933	4.299	7.613
jessica	90.358	116.8	3.781	4.888
steven	90.074	52.94	3.769	2.215
yoda	86.704	144.998	3.628	6.068
cameron	83.35	141.899	3.488	5.938
nellie	72.048	89.57	3.015	3.748
justin	66.031	97.476	2.763	4.079
alice	65.833	82.373	2.755	3.447
liz	63.071	38.735	2.639	1.621
genny	62.239	27.187	2.605	1.138
cora	60.059	91.322	2.513	3.822
researcher	41.135	0	1.721	0
jonas	39.412	31.399	1.649	1.314

Table 65 - Module 4 Degree Centrality Descriptive Statistics

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
Mean	129.204	129.204	5.407	5.407
Std Dev	69.4	82.249	2.904	3.442
Sum	3488.509	3488.509	145.983	145.983
Variance	4816.324	6764.92	8.434	11.846

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
SSQ	580770.188	633382.313	1017.023	1109.156
MCSSQ	130040.734	182652.844	227.723	319.855
Euc Norm	762.083	795.853	31.891	33.304
Minimum	39.412	0	1.649	0
Maximum	291.891	405.202	12.215	16.956

Table 66 - Module 4 Network Centralization

Network Centralization (Outdegree)	7.07%
Network Centralization (Indegree)	11.99%

Module Five

The degree centrality social network data for module five is below.

Table 67 - Module 5 Degree Centrality

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
tommy	283.248	203.616	14.086	10.126
agnes	177.584	89.45	8.831	4.448
kylie	174.99	67.123	8.702	3.338
sally	156.201	121.841	7.768	6.059
colina	155.683	177.912	7.742	8.848
steven	150.801	126.999	7.499	6.316
yoda	146.929	222.39	7.307	11.059
malakai	137.94	160.994	6.86	8.006
joplin	113.465	145.652	5.643	7.243
sandy	112.214	66.033	5.58	3.284
john	97.847	99.158	4.866	4.931
nellie	82.618	153.133	4.109	7.615
dora	82.239	46.911	4.09	2.333
jessica	78.038	88.716	3.881	4.412
poncho	71.66	93.301	3.564	4.64
researcher	69.186	0	3.441	0
winston	59.731	112.32	2.97	5.586
lolly	55.403	98.403	2.755	4.894
genny	51.034	26.137	2.538	1.3

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
alice	50.174	66.108	2.495	3.288
liz	47.465	31.805	2.36	1.582
cameron	45.541	66.642	2.265	3.314
justin	29.377	47.041	1.461	2.339
rabbit	24.869	27.877	1.237	1.386
cora	20.189	19.422	1.004	0.966
instructor	17.385	90.459	0.865	4.499
jonas	10	52.368	0.497	2.604

Table 68 - Module 5 Degree Centrality Descriptive Statistics

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
Mean	92.66	92.66	4.608	4.608
Std Dev	62.533	56.07	3.11	2.788
Sum	2501.811	2501.811	124.415	124.415
Variance	3910.405	3143.81	9.671	7.775
SSQ	337397.938	316699.906	834.41	783.222
MCSSQ	105580.93	84882.875	261.109	209.922
Euc Norm	580.86	562.761	28.886	27.986
Minimum	10	0	0.497	0
Maximum	283.248	222.39	14.086	11.059

Table 69 - Module 5 Network Centralization

Network Centralization (Outdegree)	=	9.84%
Network Centralization (Indegree)	=	6.70%

Module Six

The degree centrality social network data for module six is below.

Table 70 - Module 6 Degree Centrality

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
kylie	83.822	59.37	8.273	5.86
colina	72.868	44.217	7.192	4.364

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
researcher	57.13	0	5.639	0
sandy	55.739	54.02	5.501	5.332
dora	55.365	3.522	5.465	0.348
agnes	51.13	16.109	5.047	1.59
rabbit	45.717	52.957	4.512	5.227
john	40.813	42.913	4.028	4.236
tommy	35.957	28.109	3.549	2.774
instructor	35.109	9.522	3.465	0.94
cameron	33.946	83.196	3.35	8.211
sally	30.522	19.717	3.012	1.946
malakai	28.304	70.717	2.794	6.98
liz	26.326	28.522	2.598	2.815
steven	25.957	1.761	2.562	0.174
genny	24.696	28.239	2.437	2.787
joplin	18.783	87.376	1.854	8.624
poncho	16.63	30.13	1.641	2.974
nellie	16.239	12.261	1.603	1.21
justin	14.478	64.439	1.429	6.36
yoda	14.087	30.478	1.39	3.008
jessica	14.022	10.043	1.384	0.991
alice	1.761	10.761	0.174	1.062
jonas	0	3.261	0	0.322
winston	0	7.761	0	0.766

Table 71 - Module 6 Degree Centrality Descriptive Statistics

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
Mean	31.976	31.976	3.156	3.156
Std Dev	21.418	25.785	2.114	2.545
Sum	799.401	799.401	78.901	78.901
Variance	458.734	664.877	4.469	6.477
SSQ	37029.988	42183.563	360.732	410.937
MCSSQ	11468.341	16621.914	111.72	161.924
Euc Norm	192.432	205.386	18.993	20.272
Minimum	0	0	0	0

	Out degree	In Degree	Normalized Out Degree	Normalized In Degree
Maximum	83.822	87.376	8.273	8.624

Table 72 - Module 6 Network Centralization

Network	Centralization	(Outdegree)	=	5.33%
Network	Centralization	(Indegree)	=	5.70%

Appendix J

Table 73 - Summary of Themes and Patterns Evidenced by Three Group Archetypes described in this study

	Question One: Group Development	Question Two: Social Ability	Question Three: Information Horizons	Question Four: Group Efficacy	Question Five: Social Network Structure
Barriers Group					
Pattern: Tools as Power Proxies	The identity of the group is shown to be influenced by the choice of technology The network structures changes for this group are more well understood through the case	Tools are one of the aspects of social ability. In this pattern we see how the choice of tool by a member influences the social ability of the whole group	Tool selection acts as a constraint on the collaborative information horizons of the group's members in this case.		There is a nominal constraint on the view of this group's social network structure introduced by a tool that is controlled by one member, and not visible to the instructor.
Pattern: Capacity and Performance	Shows Knowledge Construction and Group Development may follow different trajectories			This pattern suggests that group efficacy and group development in this case are not related	Participation is greater for Malakai, who is a more advanced graduate student.
Theme: Cultural and Interpersonal Aspects of Performance	Individual identity is related to culture and graduate student standing.		Age, gender and cultural are factors contributing to information Horizon differences.	Yoda and Malakai have different standards for acceptable performance. Both suggest this is influenced by culture.	

	Question One: Group Development	Question Two: Social Ability	Question Three: Information Horizons	Question Four: Group Efficacy	Question Five: Social Network Structure
Theme: Exaggerated Punctuated Equilibrium	This theme is visible in the story of the case, but it also emerges from the social network data	Tools, work tasks and individual participation - the three aspects of social ability - all break down within the frame of this theme.		The measurement of group efficacy declined, even though actual performance increased.	The network structure and physical distribution change for Barriers Group. This influences identity formation and information horizons
Theme: Physical Distribution Changes	Physical distribution does change the identity of the group in a number of ways, including the reduction of already low trust	The physical distribution change is accompanied by tool change, altering the social ability of members.			
Individualist Group					
Pattern: Within Group Changes in Social Ability	Tool choices are driven by member preferences instead of the needs of the group. In turn, this influences group development	All aspects of Social Ability (Tools, Tasks, and Individuals) change in the course of this group's development.			Group interactions through different tools influence how the group evolves. Tools and member participation influence group structure.
Pattern: Articulation Work and Performance	Group development appears to be stifled by a failure of the members to coordinate with each other.				

	Question One: Group Development	Question Two: Social Ability	Question Three: Information Horizons	Question Four: Group Efficacy	Question Five: Social Network Structure
Pattern: Individual Knowledge Construction	Knowledge is constructed individually in a virtual space where members are co-present.	Social interactions occur at times that prove disruptive to task flow. Thus, membership and task interaction indicate challenges to social ability that influence performance and group development.			
Theme: Different Member Needs for Structure	Aspects of member identity related to the preference for structure in tasks impedes group development				
Theme: Differences Wrought by Technology and Tools	The two distinct dyads that form indicate an observable change in network structure	Tool changes influence and are influenced by member changes, but not tasks.	The rapid change of tools alter the information horizons of members, particularly related to their use of the group.		The changes in technology and structure reflect the group development challenges experienced by this group.
Theme: The Skype Love- Hate Transmission	Group development is harmed by the choice of a tool one member lacks the infrastructure to use.	Tool choice drives behavioral change in the group that has positive implications for Justin and Cameron and negative implications for Rabbit	Social and collaborative information practices of the group changed dramatically with the introduction of Skype. The group information space was altered by this choice.		

	Question One: Group Development	Question Two: Social Ability	Question Three: Information Horizons	Question Four: Group Efficacy	Question Five: Social Network Structure
Get-Along Group					
Pattern: Sense Making and Social Comparison	Group development is positively influenced by reifying practices based on sense making and social comparison activities of the group.			Reified work practices of the group impair performance when the type of task changes. The group does adapt, but after evidence of poor performance.	
Pattern: Making Tasks Visible to the Group	Group identity emerges through the practice of making the work at hand visible.		The use of the wiki and discussion board constrains and focuses the information horizons of this group and it's members		
Pattern: Group Metacognition (Self awareness)	Group development is directed in a specific way by the practices and awareness of members.			This group implicitly shares a common definition of what effective looks like.	The network structure of the group reflects the observed and articulated practices of the members and cohesiveness of the group.

	Question One: Group Development	Question Two: Social Ability	Question Three: Information Horizons	Question Four: Group Efficacy	Question Five: Social Network Structure
Theme: Completely Online Identity Interchange: Individuals and Groups	Group identity is forged from the individual identities of members, and their expressed intentions to contribute to the group.	Member interactions through technology are driven by tasks. The dominance of task focus within this group constitutes a particular trajectory for the development of group social ability.			
Theme: Creation of Multiple Places and Spaces	The group's identity incorporates these constructed group places and is shaped by them.	This group explicitly understands the relationship between tasks and tools in a completely online environment and manages each in the context of the other.			

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Vitae

SEAN GOGGINS spent 15 years shepherding socio-technical systems design for software product and technology companies around the USA prior to turning to a life of scholarship. Sean received a Master of Science in Software Engineering from the Computer Science department at the University of Minnesota in May, 2003. Sean is currently on the faculty of the iSchool at Drexel and lives in Philadelphia, PA with his wife Cynthia and daughter Sydney.