A SOCIAL NETWORK STUDY
OF THE EFFECTS OF A DISCUSSION TOOL ON
COLLABORATIVE LEARNING WITHIN AN ORGANIZATION

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DEDICATION

I dedicate this work to my family who taught me the value of learning and to my husband, Louis who is my joy and inspiration.
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This study would not have been possible without the support of my mentor, Dan Suthers who set me on the right path. I wish to thank the police officers and civilians at the Honolulu Police Department who contributed their time and expertise.
ABSTRACT

This study investigated the social network structure of booking officers at the Honolulu Police Department and how the introduction of an online discussion tool affected knowledge about operation of a booking module. Baseline data provided evidence for collaboration among officers in the same district using e-mail, telephone and face-to-face media but showed minimal collaboration between officers in different districts. On average, knowledge of the booking module was low. After introduction of the online discussion tool the social network structure changed, showing an increase in collaboration between different districts and an increase in knowledge of the booking module, even though collaboration frequency did not increase significantly. The study suggests that the formation of new collaborative ties and passive participation ("lurking") are more significant for learning through information sharing in social networks than raw frequency of interaction.
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LIST OF ABBREVIATIONS

COMNET-IT, Commonwealth Network of Information Technology for Development

CRD, Central Receiving Division

CSCL, Computer Supported Collaborative Learning

CSSN, Computer Supported Social Network

HPD, Honolulu Police Department

ITD, Information Technology Division

RMS, Records Management System

SNA, Social Network Analysis
CHAPTER 1. INTRODUCTION

Purpose of this Study

This paper discusses the learning theories that explain how collaborative learning occurs in social settings and draws on examples from the literature to show how social structure can be effective for leveraging expertise of a group. It shows how Computer Supported Social Networks (CSSN’s) can assist in changing the social structure to allow increased collaboration among participants and how CSSN’s can be used to encourage communities of practice. The current social structure of the Honolulu Police Department is examined along with implications for officers learning to use a booking module in a new Records Management System (RMS). This paper covers the research questions, hypotheses, study participants, procedures and tasks, measures and analysis, results, a discussion of the study and implications for future research.

A booking officer is a police officer who has the primary duty of processing arrestees as they are brought into a district police station. Depending on the severity of the crime or availability of holding cells, the booking officer may decide to transfer the arrestee to the Central Receiving Division (CRD), otherwise known as the main booking station. The first phase of the study documented the social network structure between four (4) different physical locations (districts), a Central Receiving Division (CRD) which has the main function of taking custody of arrestees and processing the bookings from each district, and the Information Technology Division (ITD). The second phase of the study introduced an online discussion tool, called “Discus”, that allowed officers to
collaborate with their colleagues in different districts. Social Network Analysis (SNA) confirmed that the introduction of the new software lead to a change in the social network between districts. The results of a second performance test showed that there was an increase in knowledge of the booking module in the RMS and an increase in collaborative learning interaction among officers using Discus. However, there was insufficient evidence to support the expected increase in collaboration frequency among officers.

Research Questions

I. How will the introduction of an online discussion tool affect the existing social network structure at the Honolulu Police Department for officers learning the booking module of a new Records Management System?

II. Will knowledge of the booking module in the Records Management System increase as a result of using an online discussion tool?

Hypotheses

H1. There will be an increase in collaboration about the booking module of the RMS between participants in different districts using the online discussion tool compared to participants who do not, using pre and post interview instruments and SNA.
H2. There will be an increase in collaboration frequency about the booking module of the RMS between participants using the online discussion tool compared to participants who do not, using pre and post interview instruments and SNA.

H3. There will be an increase in knowledge of the booking module of the RMS for participants using the online discussion tool compared to participants who do not, using pre and post performance test instruments.

**Significance of this Study**

A new computerized Records Management System (RMS) was implemented at the Honolulu Police Department in August 2003. With it came the need to train officers on how to use the RMS to effectively enter and search for information. Entering accurate data and being capable of searching criminal history records is a mandatory and vital part of a police officer's daily duty and essential to effective police work. The degree of knowledge that an officer has about how to use the RMS system to locate pertinent information has a direct bearing on the outcome of criminal cases. The overall result of more effective information use is to allow officers to better serve and protect the community by solving more cases and working more effectively to identify crime trends. Currently officers at the Honolulu Police Department use a combination of e-mail, telephone, face-to-face discussions and other means to collaborate with each other in order to locate information, raise issues and propose more efficient ways to use the RMS. The ITD staff performs the role of the RMS system administrators. They are information technology professionals with a background in supporting and maintaining complex
information systems. They have a good understanding of how to troubleshoot system issues and how to use the RMS in more general terms (i.e. to search for a name).

However, police officers have a better understanding of what information they need to find and how it relates to police business processes, but not necessarily the best way to find it. The current collaboration process between police officers and the ITD staff is inefficient because knowledge is spread over many media, and due to the nature of these media needs to be repeated frequently to different parties at different times, is often lost and cannot be easily located and improved upon. Coupled with this, officers do not have a clear understanding of who knows what, and tend to communicate with a single ITD staff member for all information requests.

This study seeks to investigate the value of the introduction of an online discussion tool to improve collaborative learning interaction and knowledge of a booking module in the RMS.
CHAPTER 2. LITERATURE REVIEW

The following section covers the concepts of Social Network Analysis, then goes on to discuss social structure and how it can be used as an instrument to build relationships for learning. Social learning theories are discussed and how online discussion tools have been used to foster learning. Computer Supported Social Networks (CSSN’s) are highlighted as being able to support information exchanges and in turn encourage the development of a community of practice for the booking officers at the Honolulu police department.

Social Network Analysis

Social Network Analysis (SNA) is considered both from a theoretical perspective and as a set of methods. From a theoretical perspective, SNA is an extension of social science. Haythornthwaite (1996) describes SNA as an approach and set of techniques for the study of information exchange that focuses on patterns of relationships between people and examines the availability and exchange of resources between these people. From a methodological perspective, SNA focuses on measuring these relationships between people and providing a framework for analysis to which common social and natural science methods can be applied.

The following section presents an overview of the general concepts of SNA, its historical development and the two distinct approaches used in studies of communities, socio-centric analysis and egocentric analysis. Studies of how social networks have been studied and applied in communities are discussed.
General Concept of Social Network Analysis

SNA portrays social structure by way of a network. The network consists of nodes, which represent individuals, and lines, which represent relationships between the nodes. These relationships can be categorized as information flows and show what information is being exchanged, between whom and to what extent. These information flows provide insights into how information moves within the network and how individuals are positioned to facilitate or control the flow. This leads to the idea of categorizing each of the nodes in terms of their degrees, betweeness and closeness.

Krackhardt (1990) proposed a social network called the “kite network”. This network illustrates the distinctions between the three centrality measures: degrees, betweenness, and closeness. The degrees measurement indicates network connectivity for a particular node by the number of direct connections that the node has to other nodes. In Figure 1, Diane has the greatest number of direct connections in the network and is considered to be the hub. The betweenness measurement indicates a node or nodes that connects clusters of nodes. Heather plays the broker role in the network because she connects the cluster consisting of Ike and Jane with the cluster containing Diane. Nodes that have high betweenness have high influence over what information flows in the network. The closeness measurement indicates the proximity of an individual node to the other nodes. In Figure 1, Fernando and Garth have a highest measurement of closeness. The pattern of their connections allows them to access all of the other nodes in the network faster than any of the other nodes. Nodes with a high measure of closeness have
the shortest and therefore fastest path to other nodes. These nodes have the best visibility of the network.

In addition to the three measures of centrality, SNA has two concepts called boundary spanners and peripheral players. Boundary spanners are those nodes that connect their group to adjoining groups. In Figure 1, Fernando, Garth and Heather are considered boundary spanners as they are more central than their immediate neighbors whose connections are only local within their immediate clusters. Boundary spanners are considered the innovators of the network as they have access to information that flows in different clusters and therefore have the best opportunity to integrate ideas between these clusters. Peripheral players are those nodes that form the boundaries of the network. In Figure 1, Jane and Ike are considered the periphery players.

Figure 1: "Kite Network" developed by Krackhardt (1990)
Krebbs (2002) proposed the idea of network centralization that provides insight into an individual node’s location in the network. A few central nodes dominate a network with high network centrality. If these nodes are removed, the network risks fragmentation. A network with low network centrality is not dominated by a small number of nodes and as a result, has no single points of failure.

**Historical Development**

As early as the 20th century, German sociologists laid the groundwork for SNA. Many theorists at that time concentrated on describing social conditions such as war and religion. Simmel (1950) looked to a theory that would explain how these conditions occurred. Simmel proposed that there were differences in the interaction patterns between groups of two people (dyads) compared to groups of three people (triads). Simmel proposed the idea of urban systems being an interconnecting structure of circles and thus created formal sociology, which was the beginning of SNA.

Moreno (1934) was the first to operationalize a social network. He represented his network with a combination of circles and lines. He further demonstrated how different configurations of the network might affect an individual network member. To describe his configurations, Moreno coined the term “sociometrics”.

Following Moreno’s work, Cartwright and Harary (1977) recognized the possibilities of applying some of the concepts of graph theory to Moreno’s sociogram. The additions of giving direction to the lines and a positive or negative condition to a
relationship enabled more complexity to be illustrated in the social relations. Graphs became a fundamental tool for SNA.

Radcliffe-Brown (1940) had a significant impact on the work of groups at both Harvard and the University of Manchester. The work at Harvard centered on methods of locating subgroups of people within larger groups. They developed a notation for illustrating social networks and defined a set of rules describing the network relationships. They are also credited with representing social networks as matrices, which later led to the development of matrix-based clique-finding algorithms. At the University of Manchester, Radcliffe-Brown worked with Barnes, Mitchell and Bott to study the notion of networks being a “web of relations” and rather than focusing on society as a whole, they studied the network of relations surrounding individuals. All three researchers conducted studies, Barnes (1954) with Norwegian fisherman, Mitchell (1956) with rural migrants in Rhodesia and Bott (1955) with her work on English families.

These two branches of social networks, the first based in sociology and the other based in anthropology, developed independently until the 1970’s. At that time, the advent of computer systems made possible the collection and measurement of data from studies of large groups.

**Socio-Centric Methods And Analysis**

The socio-centric approach in the sociology field was influenced by the work of Simmel (1950). This approach focuses on the idea of networks as a whole, for example, relationships between people in a defined group such as the residents of a village or parishioners of a church. The relationships are represented as numbers and can thus be
analyzed statistically with the basic assumption that the members of the group interact more with each other than compared to a randomly selected group of similar size. The patterns of interaction can be measured and categorized to explain certain consequences, such as the concentration of power within the group.

The basic illustration for socio-centric analysis is a matrix, where the rows and columns represent members of the group. Each cell of the matrix contains a measurement representing the relationship between two members of the group.

There are a number of methods in which data has been traditionally been collected for SNA analysis. The first is through records, such as the work by Padgett (1994) who collected information on interaction between 38 prominent Florentine family trees and the marriages of 298 families of lesser renowned elite families in Renaissance Italy using marriage records. The second data collection method is through mutual affiliation. Allison Davis, Burleigh, Gardner & Gardner (1941), analyzed the relationships between socialites attending public events together. The third method is surveying people about their group interactions. It is interesting to note that Russell Bernard, Killworth, Sailer and Kronenfeld (1984) conducted a series of studies that compared records of human interaction with informants’ reports and found that people were generally inaccurate in reporting the amount of interaction they experienced with others in a group. Similarly, other researchers such as Freeman, Romney & Freeman (1987) have reported that people report interaction with others to be what they generally believe to be true.
Surveying people regarding their interactions with others remains the most widely used method of data collection. When the group is small (between 20-60 people), the researcher can request each individual to rate how well they know each of the other members of the group. The relative strength of each relationship can then be mapped in the form of a matrix for further analysis. When the group is large (over 1,000 people), the socio-centric method has been of limited value due to the limitations of computer software and processing power. However, with the advances in computer technology, this limitation is gradually being overcome.

Analysis of socio-centric network analysis focuses on the structural properties of relationships rather than the individual relationships themselves. There are two broad categories of structural analyses, graph based and statistics based. Graph based analysis is derived from graph theory where the focus is on the existence of a connection between two entities, rather than the strength of the connection. Graph theory defines a number of measures including structural equivalence where group members are classified by commonalities in the pattern of their relationships. Clique-finder measures locate subgroups such as groups of friends in a class group. Centrality measures determine to what extent relationships are concentrated around a few people in the group.

Statistics based analysis focuses on the concept of statistical distributions and variance to describe structure. Correlation coefficients are used to illustrate the similarity between the structures of relationships. Methods such as cluster analysis are used to locate subgroups and the strength of their relationships. Multidimensional scaling is used
to display data and to uncover the underlying reasons for relationships. Statistical packages such as SAS and SPSS are commonly used to analyze the data.

In addition to the two structural analysis methods, network visualization is another method of analysis that can be either graph or statistic based. This method is used to see the overall picture of the network. All of the groups and connections are visible at the same time and are color coded according to characteristics such as age, race and gender.

**Egocentric Methods And Analysis**

The egocentric approach arose from the field of anthropology and can be traced back to Radcliffe-Brown (1940). This approach focuses on the individual as opposed to a group. An egocentric network consists of people (alters) that a person (ego) knows. For example, the egocentric network of a computer programmer may consist of a spouse, a child, other relatives, work colleagues, university colleagues and friends. Egocentric SNA’s primary goal is to provide generalizations about the features of personal networks and their effects on voting behavior, consumerism and coping with life stresses, to name a few.

In contrast to socio-centric network analysis where the focus is on the pattern of relationships in a group, egocentric analysis focuses on the network of individuals where each person has their own network of relationships that may traverse many different groups. These relationships contribute to the individual’s behavior and attitudes. The strength of egocentric analysis is its ability to capture the diversity of a social environment and to allow the application of standard survey sampling techniques that
allow results to be generalized. For example, Burt (1985) added a social network component to the General Social Survey, which was an annual face-to-face survey of approximately 1600 Americans. The social network component was based on a list of people that the participants had discussed important matters with.

In egocentric studies, participants are asked for a list of their network members (alters). Researchers are then interested in constructing a network composed of each individual and their links to their alters and each alters link to other alters. It is difficult to survey each of the alters, so researchers must rely on participants to report their relationships to their alters. Network generators are then used to map the network.

The sampling method varies depending on the type of study. There must be a balance between the number of participants, the number of alters they are questioned about, the amount of data about each alter and the data collection method (mail, telephone, face-to-face). Some common questions include how well the participant knows the alter (family member, acquaintance, etc), rank indicating the strength of the relationship, education, annual income, age and gender of the alter. Other questions are specific to the study and may include, for example, how much assistance the alter provides with work issues.

A set of variables is used to summarize the data for the composition of the network. These variable become attributes of the participant. In addition to age, gender, education and annual income of the participant, the average age, average strength of ties with alters and the percent of alters that are family members or colleagues can be
generated. These measures may be used as independent variables to predict scores on factors such as depression.

It is possible to measure structure within each participants network using egocentric analysis. Participants must report not only on their relationship with each alter, but also on the relationships on all pairs of alters. Typically, participants are only asked about the existence of a relationship and possibly its strength. Questions about asymmetric relationships are avoided because participants are unlikely to have knowledge to report on it. For example, a participant is unlikely to know if two of their colleagues know each other unequally. Even when limiting these studies to symmetric relationships, the number of relationships grows geometrically as relationships are added. For example, for a study of 10 alters, a participant must report on 45 relationships. For a study of 50 alters, a participant must report on 1,225 ties. There is, of course some debate on whether a participant can report accurately as to the existence of relationships between so many pairs of alters. Given the difficulty of collecting data for this approach, studies such as these are rare.

In 1969, Milgram (1969) conducted a “Small World” study, which represents a less conventional approach to egocentric network analysis. In this study, a few hundred randomly selected participants in Nebraska and Kansas were sent packets and asked to send these packets to one or two targets in the Boston area. Milgram set the additional constraint that each person could only send the packet to someone they knew on a first-name basis and who they thought would most likely know the target better than them. To inform their decisions, Milgram provided the name, address and occupation of the target.
Milgram requested that each participant tear off a card and mail it directly to him at Harvard. Tracking the path of the packets provided information on how people knew each other and the average number of links between randomly chosen people across a large society. Studies using egocentric networks have been conducted on populations such as the homeless, rape victims and drug users (Killworth et al. 1998; Williams et al., 1995).

**Social Networks And Studies Of Community**

While there have been studies of communities using the socio-centric approach, most of the research in this area has used the egocentric approach. One of the earliest studies to use the egocentric approach was Barnes’ (1954) study of community integration in a Norwegian village. Barnes selected the community because it was relatively small and stable. This allowed him to examine the relationships in typical community arrangements such as social groups and governing bodies. Ethnographic studies such as Barnes’ are useful for small communities but are inappropriate for large communities like cities. In a study called the Detroit Area Study, Lauman and Schuman (1966) used standard survey methods to collect data for over 1,000 white males between the ages of 21 and 64 years of age. Each participant was asked to name up to 3 network alters. Lauman used multidimensional scaling to examine the underlying principles that organized hierarchy within occupations, and later to study friendships and social position.

In another study, Wellman (1983) collected narratives from participants in Toronto to determine how people retained a sense of community despite living in a
highly urbanized city. This study combined ethnographic and survey methods in a single study. Wellman has continued to use this approach in studies of social support and virtual Internet communities.

In the Northern California Study, Fischer (1979) used 1,000 participants and elicited up to 14 alters for each. The study provided insights into how egocentric networks differ according to the characteristics of participants and Fischer was able to link types of participant characteristics with characteristics of different type of communities.

Egocentric studies have been used in studies of many communities such as the mentally ill; students in classrooms and in schools; ethnic groups within larger populations; people adjusting to wars. The egocentric approach can be applied to a variety of communities by adjusting the participant selection criteria, the number of network alters and the information elicited about each alter.

While egocentric network studies have been popular in studies of communities, socio-centric network studies have been less prevalent. However, the strength of socio-centric network analysis has been found to be in studies of the diffusion of innovations. There is a long history of sociology literature that studies diffusion of information through such social links. For example, Ryan and Gross (1943); Coleman, Katz and Menzel (1966); Granovetter (1973); Rogers (1995) and Valente (1995). Coleman, Katz and Menzel (1966) conducted a pioneering study of the adoption of tetracycline among doctors in Peoria, Illinois. The study showed how adoption of the drug moved through the community and which characteristics of various network members best explained the
pattern of diffusion. It was found that while individual relationships play a key role in the diffusion of an innovation in the early stages, network roles play a more important part.

Davis, Gardner and Gardner conducted another community study using the socio-centric approach in 1941. The study focused on class and racism in Natchez, Mississippi. By using lists of attendees at formal events and parties, they were able to locate subgroups among a seemingly homogeneous group of women. These network subgroups that were difficult to observe ethnographically, helped to explain the inner workings of a caste system and interactions between black and white people.

Similar to Barnes’ study, Warner’s (In Olsen, 1980) Yankee City studies of Newburyport, Massachusetts showed how individuals were integrated into the community via informal and social groups. Through interviewing and ethnographic observation, Warner discovered a set of socially recognized informal groups (people that spend time with each other). This led to the formal concept of the clique and made it possible to understand the relationship between informal groups and formal institutions.

More recent studies in SNA have examined virtual communities. These are communities that are also referred to as networked or distributed communities that exist online, using mediated communication only. Wellman & Gulia (1999) state that social relationships that occur in virtual communities are no less valid than those that occur in ‘real’ life because ties to the community are also intermittent, specialized and varying in strength, regardless of the medium. They found that members of a virtual community bring their offline values into their interactions and discussions; therefore intertwining both online and offline social lives together. Similarly, Vivian and Sudweek (2003)
believe that virtual communities are sociologically, for all intents and purposes are the same as their brick and mortar counterparts. Just like traditional ‘real life’ social networks, Kimball & Rheingold (2000) equate the economic benefits of online social networks with high levels of social capital. An individual’s reputation within a given social network is considered an asset. Morville (2002) suggests the reciprocal nature of people (nodes) and information content extends to online communities. People use other people to locate content and at the same time, content is used to locate people.

Given that this study seeks to investigate and examine the social network of the booking officers as a whole and not their individual characteristics or personal networks, sociocentric network analysis will be used.

Social Structure

Simply establishing an online environment for collaboration will not necessarily lead to collaborative learning. Bogenrieder (2002) suggests the idea of organizational learning where social architecture can be used as an instrument to build relationships for learning. Two conditions are necessary for organizational learning: the existence of cognitive diversity and contact between diverse people. The specific design for this meeting point depends on the characteristics of the problem situation that includes goal uncertainty and technical uncertainty. Goal uncertainty is “ambiguity about the preferences or goals the decision-maker aims to satisfy” and technical uncertainty is “uncertainty in parameters, input data and initial states (resulting from ‘inexactness’ and ‘conflicting evidence’)” (Weber, 2000). Where conditions of high goal certainty and high
technical certainty exist, instrumental network structures are satisfying. However, where high goal certainty and high technical uncertainty exist (as is the case in learning to use the RMS), knowledge is the common denominator of the network.

Laboratory studies have indicated that some types of network structures are more effective than others for diffusing information throughout a group (Cummings & Cross, 2003). However, an issue here is that the task is usually pre-defined by the researcher that establishes a correct path for the diffusion of information. In organizations, information flow depends on the skills and expertise of the group. Therefore, while certain network structures may be more efficient for information diffusion, these same structures may not be effective for leveraging group expertise.

The literature suggests that from a cognitive perspective, network structures with greater integration (connectivity) may be more effective for leveraging group expertise. Studies of transactive memory suggest that groups benefit from knowledge of who knows what in the group (Liang, et. al., 1995, Moreland & Myaskovsky, 2000). In the same way, work in diffusion suggests that longer path lengths are both inefficient and result in the degradation of information quality (Rogers, 1995; Valente, 1995).

Social Learning Theories

How might learning take place in an organization? Some theories of learning, such as constructivism (Piaget, 1976; Vygotsky, 1978; von Glasersfeld, 1995) inform some of the other theories considered here, but do not focus on the social aspects of learning. Some social learning theories focus on small group interaction, particularly in
asymmetric relationships between learners and teachers (Brown & Palincsar, 1989; Vygotsky, 1978) but do not emphasize the community aspects of learning. The most relevant theories for the present study are those that do have such an emphasis, including organizational learning (Bogenrieder, 2002), collaborative learning (Kaye, 1992), knowledge building theory (Scardamalia & Bereiter, 1996) and communities of practice (Wenger, McDermott & Snyder, 2002).

Bogenrieder (2002) argues that organizational learning is a combination of both social-relational and cognitive activity. The social-relational aspect consists of the social networks fostered by the organization while socio-cognitive conflict (Doise & Mugny, 1984) is the vehicle for nurturing cognitive activity. Socio-cognitive conflict has two conditions that must be met for learning to take place. The first is that a social relationship exists between the participants and the second condition is cognitive diversity. The differences in ideas that participants can contribute are a trigger that encourages learning. For example, in a police department officers have different educational backgrounds, levels of experience in police work and varied expertise in certain types of crimes. These differences can be used to advantage to encourage collaboration and learning because the process of sharing ideas produces conflict in the individual who must then resolve the conflict by defending their own ideas or accepting the ideas of others.

Qureshi (2000) stresses the importance of an organizations ability to learn and to develop and remember how to use information for problem solving and decision-making. Expertise or experience that one officer develops in a specific area, if shared, could have
a significant impact on the efficiencies of officers in different departments or physical locations. Argyris and Schon (1978) refer to this collective knowledge as “know how” and claim that it has an impact on the ability of an organization to perform and to react to its environment. In a police department, the ability to react quickly to the environment is essential for more effective crime analysis.

One way to meet the social-relational aspect of organizational learning is through collaborative learning. Collaborative learning can be defined as the acquisition by individuals of knowledge, skills, or attitudes as a result of group interaction. It is individual learning as a result of group processes (Kaye, 1992). A key element of collaborative learning is making individuals feel responsible to the group. This can occur when a task involves an individual explaining a concept to other group members or when the group communication has the goal of producing a common item or solving a certain issue (Trentin, 1999). This idea of the creation and development of shared meaning among group members leads into the broader perspective of CSCL (Computer Supported Collaborative Learning). According to Koschmann (2002), “CSCL is centrally concerned with meaning and the practices of meaning-making in the context of joint activity, and the ways in which these practices are mediated through designed artifacts”. CSCL emphasizes the basis of learning as social. In this context, meaning is not simply presented to the student to be memorized; rather it is negotiated among group members (Pea, 1994; Roschelle, 1992). Stahl (2003) emphasizes that shared meaning exists in the observable world and that collaborators must make their understandings public in order for others to work with them and is necessary for shared negotiation to occur. In this way,
students can correct their own misunderstandings and gaps in understanding by observing others.

Warschauer (1997) highlights the certain advantages in social dynamics of computer mediated compared to face-to-face communication that can affect the effectiveness of collaborative learning. Differences occur in turn taking, balance, interruption, equality, consensus and decision-making. Sproull & Kiesler (1991) found that computer mediated communication resulted in more equal participation of participants of different status’. Warschauer links this increased equality to a) reduced social context cues related to race, gender, handicap, accent, and status (Sproull & Kiesler, 1991), b) reduced non-verbal cues such as frowning that could be perceived as intimidating (Finholt, Kiesler & Sproull, 1986) and c) freedom to contribute at any time and any pace (Sproull & Kiesler, 1991). However, a study by Weisband (1992) found that it was more difficult for participants to reach consensus using computer-mediated communication compared to face-to-face communication. Her results suggest that computer-mediated communication reduces conformity and convergence (Sproull & Kiesler, 1991).

According to the Institute for Knowledge Innovation and Technology (IKIT), *knowledge building* is “the deliberate effort to increase the cultural capital”, as compared to learning which is the process through which the existing cultural capital is made available to others. Knowledge building is concerned with the creation and improvement of ideas of the particular community. This knowledge becomes public knowledge and thus has a social aspect. Sha & Van Aalst (2003) conducted a study using server log data
to explore knowledge building in the classroom. The techniques of Social Network Analysis (SNA), (Wasserman & Faust, 1995) were used to analyze student participation and interactivity in an online discussion database called Knowledge Forum. SNA was used to map the structure of relationships, the major lines of communication and patterns of interaction within the social network. It provided valuable insight into the effectiveness of the class's ongoing efforts to improve their knowledge building and the conditions under which knowledge building occurred. Similarly, knowledge building is expected to occur between officers who share ideas and form new knowledge by working together on how to use or adapt the booking module of the RMS to fit with their booking processes and procedures.

Wenger et al. (2002) define a community of practice as a "group of people who share a concern, a set of problems, or a passion about a topic, and who deepen their knowledge and expertise in this area by interacting on an ongoing basis". It can be argued that the online discussion board is an excellent tool to encourage the development of a community of practice within the Honolulu Police Department for the booking officers. These officers are faced with a similar set of issues that non-booking officers may not be familiar with; they use the same software module in the RMS and are required to be familiar with specific procedures for booking. They must also be familiar with basic troubleshooting procedures because the software "experts", the ITD staff, are separated from the officers who must put the knowledge to use (Wenger et al., 2002). The online discussion board offers a common and persistent forum for booking officers to increase their awareness of system-wide issues and booking practices. Other media such as face-
to-face, e-mail and telephone lack persistence and are limiting for officers working in different districts or different shifts.

**Online Discussion Tools and Learning**

Research has been conducted on the effectiveness of computer supported online discussions for learning. A study by Thomas (2002) found that the non-linear branching structure of online discussion was insufficient for realization of conversational model of learning (Laurillard, 1999) because of the isolated mode of participation, the structural organization of the message threads and the conflict between computer-mediated written communication and interpersonal oral communication. In face-to-face discussions, participants share a common focus and interact with the group. When the focus of the conversation changes, the group moves together in this shift of focus. However, in online discussion, despite each thread being categorized into a topic, the branching structure of the threads causes a disjointed development of ideas. Individual participants create their own isolated focus that is not shared among the group.

Yet other studies have shown that online discussion promotes active learning. Active learning occurs when participants must articulate and negotiate their ideas with other participants (Greening, 1998). Sha & Van Aalst (2003) conducted a study using server log data to explore knowledge building in the classroom. SNA was used to analyze student participation and interactivity in an online discussion database called Knowledge Forum. SNA was used to map the structure of relationships, the major lines of communication and patterns of interaction within the social network. It provided valuable
insight into the effectiveness of the class’s ongoing efforts to improve their knowledge building and the conditions under which knowledge building occurred. Other studies by Brown et al. (2003), Fahraeus et al. (1999) and Le (2001) found that online discussion promoted collaborative learning among students in a classroom and Sullivan & Pratt (1996) and Chun (1994) found that online discussion was effective with students leaning a foreign language. Online discussion has been shown to be foster effective collaborative learning between geographically dispersed organizations such as the Commonwealth Network of Information Technology for Development (COMNET-IT); (Qureshi, 2000). However, there has been a lack of studies on how the unique opportunities of an online discussion tool can be used to improve collaborative learning in the context of a metropolitan police department.

**Computer Supported Social Networks**

According to Wellman (1996), when a computer network connects people, it is a social network. He draws the comparison between a computer network consisting of a group of machines linked by a set of cables, to a social network which is a set of people joined by a set a socially meaningful relationships. Wellman (1996) claims that the nature of the medium of Computer Supported Social Networks (CSSN’s) supports a focus on information exchanges. “People can easily post a question or comment and receive information in return. Broadcasting queries through CSSN’s increases the chances of finding information quickly and alters the distribution patterns of information. It gives those working in small or distant sites better access to experienced, skilled people.”
Additionally, “online information flows spill over unexpectedly through message forwarding, providing access to more people and new social circles, thus increasing the probability of finding those who can solve problems” (Kraut & Attewell, 1993).

A tool that has been successful for building and maintaining computer supported social networks are online discussion tools. Online discussion tools have the ability to support different time, different place communication (DeSanctis & Gallupe, 1987). This is essential to allow officers who are assigned to different work shifts to communicate. This asynchronous mode of communication is an ideal medium for supporting discussion. Participants are able to consider the contributions of others and to formulate reasoned responses. Oliver and Naidu (1996) claim that explaining, elaborating and defending ones opinions to others forces the learner to internalize and elaborate knowledge in ways that lead to higher-order learning. Similarly, Feenberg (1989) and Logan (1995) claim that the act of encoding ideas in textual format and communicating them to others forces cognitive processing and results in clarity that is strongly associated with effective communication and scholarly practice. Hillman (1999), Beals (1991) and Bates (1995) support these claims.

Thus, it is expected that it will be beneficial for police officers and ITD staff to collaborate in a cooperative online environment. The particular online discussion tool used in this study was called “Discus”. It was chosen because it used a simple user interface with a list of general topics that the user could browse (see Figure 2) and a list of threads within each topic (see Figure 3). It used a standard threaded format with an option that required a login and password prior to posting a message (see Figure 4) and
provided a free-text search capability (see Figure 5). It was necessary to allow the users to access the discussion tool via a web browser to allow the tool to be accessible on every computer that ran the booking module for the RMS. Questions could be posted as soon as an issue occurred, allowing officers to access information anytime and anyplace, not only when the ITD staff or CRD staff were available. In this way, Discus could be used as a persistent reference for information. Discus may be downloaded and previewed from www.discusware.org.

### Topics

Welcome to the HPD Infotrac & Computerized Booking discussion board.

<table>
<thead>
<tr>
<th>Topic</th>
<th>Posts</th>
<th>Pages</th>
<th>Last Post</th>
<th>Last Poster</th>
</tr>
</thead>
<tbody>
<tr>
<td>arrest report</td>
<td>45</td>
<td>19</td>
<td>07-12-04 09:45 am</td>
<td>jakamine</td>
</tr>
<tr>
<td>data entry</td>
<td>3</td>
<td>3</td>
<td>04-14-04 02:22 pm</td>
<td>atomisic</td>
</tr>
<tr>
<td>data review</td>
<td>1</td>
<td>2</td>
<td>05-10-04 05:49 pm</td>
<td>atomisic</td>
</tr>
<tr>
<td>data transfer</td>
<td>4</td>
<td>2</td>
<td>05-01-04 12:18 pm</td>
<td>bkeni</td>
</tr>
<tr>
<td>general</td>
<td>6</td>
<td>4</td>
<td>07-02-04 11:49 am</td>
<td>atomisic</td>
</tr>
<tr>
<td>imagetrak</td>
<td>22</td>
<td>12</td>
<td>07-02-04 03:35 pm</td>
<td>satkins</td>
</tr>
<tr>
<td>infotrac</td>
<td>10</td>
<td>5</td>
<td>07-12-04 04:58 pm</td>
<td>jakamine</td>
</tr>
<tr>
<td>searching for info</td>
<td>6</td>
<td>4</td>
<td>04-26-04 11:18 am</td>
<td>atomisic</td>
</tr>
<tr>
<td>system downtime</td>
<td>11</td>
<td>5</td>
<td>07-02-04 01:09 pm</td>
<td>atomisic</td>
</tr>
<tr>
<td>test</td>
<td>12</td>
<td>4</td>
<td>07-02-04 11:42 am</td>
<td>atomisic</td>
</tr>
<tr>
<td>upcoming events</td>
<td>3</td>
<td>4</td>
<td>06-08-04 04:00 pm</td>
<td>atomisic</td>
</tr>
</tbody>
</table>

To post a message, you will need a username and password. Please contact Asti Tomsic in ITD at 540-9291

![Figure 2. Topic layout in the Discus tool](image-url)
Figure 3. Format of the list of discussion threads in the Discus tool

### Mug Correction Form

#### Author: laguilar (laguilar)
- **Username:** laguilar
- **Registered:** 03-2004
- **Message:**
  
  Posted on Thursday, June 24, 2004 - 03:50 pm:
  
  When we need to make changes or corrections on mug photos, is there a form we need to submit to Dennis in PHOTO LAB, What is the HPD number, thank you

#### Author: atomsic (atomsic)
- **Username:** atomsic
- **Registered:** 03-2004
- **Message:**
  
  Posted on Monday, June 28, 2004 - 07:40 am:
  
  From Mark in CRD: Currently there isn't any form that CRD gives to Photo Lab for any corrections/changes. If we were to find a discrepancy in any of the mug photos we would let the LT know; he would then call either ID or PHOTO LAB.
Figure 4. Threaded discussion format with the option to post a reply in the Discus tool

Search Board

Search by keyword:
- Search for: [search term]
- Keyword options: "OR" (Match any keyword)
- Match method: Parts of words
- Match case: Case insensitive (case does not matter)
- Look in: Text of messages

Search by date:
- Recent posts: Messages posted within the last [number] Day(s)
- Registered users: Messages since [date] and any new since then:
  - Username: [username]
  - Password: [password]
  - Don't remember this check

Search options:
- Search topic: [all topics]

Perform search:
- Search now: Perform Search

Figure 5. Format of the free text search in the Discus tool
CHAPTER 3. METHODS

Participants

Forty-two police officers, civilian booking staff and seven Information Technology Division (ITD) staff from the Honolulu Police Department participated in the study. The officers were randomly selected from a pool of officers of different ages with different cultural and academic backgrounds from four different locations (districts) on Oahu. The participants were divided into two groups. Group A consisted of twenty officers from districts 5 and 8 and was given access to post messages on Discus. Group B consisted of twenty officers from districts 2 and 3. These officers were not given access to Discus. Each district collaborated with the ITD staff and Central Receiving Division (CRD) staff that were located in a different physical location to each of the other districts. This method of physical separation was used to prevent cross-collaboration between the two districts that had access to Discus and those that did not.

Procedures

The study was conducted over a six-week period in March/April 2004. Participants were asked to complete a performance test and an interview before the introduction of the online database and another performance test and interview after six weeks. The interview layout and content was adapted from surveys created by Krackhardt & Haythornthwaite, (1998). Both the performance tests and interviews were piloted with two officers who did not participate in the final study and were revised according to the officers’ feedback and suggestions for improvement.
The initial performance test was used to determine current knowledge of the booking module of the RMS system. The performance test consisted of five (5) questions with an estimated duration of ten (10) minutes. Each question consisted of typical problematic search tasks related to the booking module in the RMS that an officer is required to perform on a daily basis. Officers were required to use the RMS to answer the questions. An example question was, "What is the report number for the FRAUD incident that occurred in sector 1 beat 150 on 10/19/2003?" and "What is the police vehicle number for the arrest of XXXX,XXXX?" (see Appendix B).

The pre-interview was conducted to determine the current social structure. It consisted of questions to determine whom the participant collaborated with about the booking module of the RMS during the prior three (3) weeks. It asked how well they knew this person, the frequency of these collaborations, and the media they used to collaborate. The estimated duration of the interview was twenty (20) minutes (see Appendix C).

Following the pre-performance test and interview, participants in Group A, the ITD staff and CRD staff were asked to contribute to Discus. They were given introductory training as a group on the features of Discus and provided with individual logins and passwords to record questions, comments, ideas and suggestions about the booking module. The assigned login was necessary to provide visibility for the posters of messages. Discus displayed the login name adjacent to the message on the discussion board. Posting activity on Discus was initially slow, so the ITD staff posted useful tips.

1 Due to information privacy regulations, specific case information has been omitted from the example questions. However, the format of the questions has been retained.
and frequently asked questions on the booking module in order to generate activity. The ITD staff checked the board on a regular basis to ensure that questions were answered on a timely basis. This was done to encourage participants from other districts to post questions. During this time Group B continued to collaborate with the ITD staff, CRD staff and each other using the traditional face-to-face, e-mail and telephone methods of collaboration.

The post performance test was conducted to determine whether any changes in knowledge had occurred. It consisted of five (5) questions with an estimated duration of ten (10) minutes and was given to Group A and Group B. Similar to the initial performance test, the post performance test contained search questions on the booking module in the RMS but did not have the same questions as the initial performance test to avoid participants learning from the initial performance test. For example, “Who is the arresting officer for the arrest with report number XXXXXXX?” and “Who keyed in the data for an arrest on 2/8/2004 for arrestee XXXX,XXXX?” (see Appendix C).

The post-interview was conducted with the same questions as the pre-interview to determine whether any changes had occurred in the social structure between the districts.

**Measures and Analysis**

Scardamalia (2000) developed twelve descriptors that represent the “best practices” of knowledge building. Van Aalst and Chan (2001) used a modified subset to organize course evaluation and to scaffold knowledge building advances. These four principles are: 1. Working at the cutting edge, 2. Progressive problem solving, 3.
Collaborative effort, and 4. Identifying high points in the discourse. Sha & Van Aalst (2003) conducted a study where they focused on the pedagogical knowledge principal of collaborative effort. They analyzed the characteristics of student’s social interaction by measuring participation (posts), reciprocity (replies), connectivity (linked notes) and social interaction (reads).

Similarly this study measures characteristics of individual social interaction relating to collaborative effort, but groups these measurements into broader factors that investigate social interaction between police districts. These factors are:

I. **Knowledge** – defined as the understanding, familiarity and proficiency of a participant with the booking module of the RMS. It is measured by the results of the search tasks in the post performance test and the initial performance test. Rated on a scale of 0 for the lowest score with no tasks correct to 5 for the highest score for all tasks correct.

II. **Collaboration** – defined as any new social ties between participants that had not previously communicated. This study is particularly interested in collaboration between districts. It is measured by the messages contributed to the online discussion tool and the interactions reported in the pre and post interviews. This includes messages posted, replied to and read.

III. **Collaboration Frequency** – defined as the number of interactions between participants in the social network. It is measured by the number of messages
contributed to the online discussion tool and the number of interactions reported in the pre and post interviews. This includes the number of messages posted, replied to and read.

The UCINet suite of software programs (Borgatti, Everitt & Freeman, 1996) was used to create the data sets for SNA and a visual depiction of the sociocentric social network in the form of social network analysis diagrams. In SNA, each participant is referred to as a node. Each node is represented as a circle in the network with their interactions displayed as lines. These lines have arrowheads to show the direction of each collaborative interaction. The thickness of each line represents the number of interactions or tie-strength between each node. The minimum tie-strength was zero (0) and the maximum was ten (10). For the combined media diagrams, the minimum tie-strength was zero (0) and the maximum was forty (40) to account for two nodes that collaborated with each other using all four media. The district that each node belongs to was shown by the color of the node. District 5 was gray, district 8 was pink, CRD was red, ITD was black, district 2 was blue and district 3 was green. The score that each participant received for the collaborative learning tasks was shown by the size of each node. The minimum size for no tasks correct was four (4) and the maximum size for all correct was nine (9). The minimum of four (4) was chosen so that each node was visible on the diagram. Following the pre-interview, five different SNA diagrams were created, one for each different type of medium used: e-mail, telephone, face-to-face, other and one with all media combined. Six SNA diagrams were generated following the post-interview to allow comparison of differences in the social network structure. An additional diagram
was created to show the collaborative interaction using Discus. SAS statistical software was used to tabulate and analyze the results of the knowledge scores.

Berelson's (1952) definition of content analysis is "a research technique for the objective, systematic, and quantitative description of the manifest content of communication". Content analysis was used to gain a more in-depth understanding of what types of interactions were occurring in Discus that analysis of the server logs alone could not provide. Each message posted on the discussion board was identified and categorized using a list of behaviors suggested by Rubin & Goldberg (1992). The various behaviors are illustrated in Table 1. They include basic communication relations such as information seeking (IS) and information providing (IP). Other behaviors that Rubin & Goldberg (1992) term contractual relations are used to indicate messages where one participant posts a message in order to obtain a response. These are coded as confirming action (CA), seeking consensus (SC), statement of problem (SP), statement of solution (SS). Other behaviors that showed an outcome from the discussion were coded as making a decision (MD), notifying the occurrence of an event (NE) and volunteering assistance (VA).

<table>
<thead>
<tr>
<th>Content Analysis Behavior Types</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>IP Information providing</td>
<td>MD Making a decision</td>
</tr>
<tr>
<td>IS Information seeking</td>
<td>VA Volunteering assistance</td>
</tr>
<tr>
<td>RA Requesting action</td>
<td>RF Raising funds</td>
</tr>
<tr>
<td>CA Confirming action</td>
<td>SF Seeking funds</td>
</tr>
<tr>
<td>SC Seeking consensus</td>
<td>PF Providing funds</td>
</tr>
<tr>
<td>SP Statement of problem</td>
<td>CP Other people</td>
</tr>
<tr>
<td>SS Statement of solution</td>
<td>H Humor</td>
</tr>
<tr>
<td>NE Notifying occurrence of event</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Content analysis behavior types
Limitations of the Study

There are several limitations in this study. First, due to the small number of dedicated booking officers and booking civilians in each district within the Honolulu metropolitan area, there were only 42 participants in the study. To further verify the results obtained, it would be beneficial to use a larger sample size. Second, the interviews administered rely on self-reported data that is based on the willingness of the respondents to give truthful answers and on their ability to give accurate answers. Comparison against a different data source (server log files) was used to offset this limitation. Third, the study was conducted in a police department where some organizational variables such as authority structures and incentives are different to that of other organizations. It is believed that this is an important aspect that makes this study unique.
CHAPTER 4. RESULTS

This chapter describes findings of the performance tests that were conducted to measure the knowledge scores on the RMS booking module and the interviews that gathered data on the social network of the booking officers before and after introduction of Discus. Data from the server log files of Discus are presented. This is followed by results of the content analysis of the messages posted on Discus.

Table 2 shows the knowledge scores for each district for the pre and post performance tests. The two districts (2 and 3) that did not use Discus received a lower score and the same score respectively on the post performance test. Three out of the four districts (8, ITD and CRD) that used Discus received higher scores on the post performance test.

| Knowledge Scores by District (percent correct) |
|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| 2               | 3               | 5               | 8               | ITD             | CRD             | Average         |
| pre-survey      | 60.0%           | 30.0%           | 64.0%           | 53.0%           | 42.8%           | 60.0%           | 51.6%           |
| post-survey     | 38.0%           | 30.0%           | 55.0%           | 88.0%           | 48.5%           | 100.0%          | 59.9%           |
| % change        | -22.0%          | 0.0%            | -9.0%           | 35.0%           | 5.7%            | 40.0%           | 8.3%            |

Table 2. Knowledge scores by district

Table 3 shows the results of the content analysis of the messages posted in the discussion tool. The most common behaviors were those of IS (Information Seeking) and IP (Information Providing). RA (Requesting Action) and CA (Confirming Action) were the next most common action.
Table 3. Content analysis behaviors and breakdown of behaviors by district

Table 4 shows the number of posts, replies and reads in the discussion tool by district from the server logs. ITD was the most active in posting and replying to posts. All of the districts that used the discussion tool (5, 8, ITD and CRD) were more active in reading messages posted by others compared to posting. The ratio of reads to posts was almost 41:1 in the case if ITD, 50:1 for district 5 and 22:1 for district 8.
<table>
<thead>
<tr>
<th></th>
<th>2</th>
<th>3</th>
<th>5</th>
<th>8</th>
<th>ITD</th>
<th>CRD</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>POSTS</td>
<td>0</td>
<td>0</td>
<td>10</td>
<td>4</td>
<td>19</td>
<td>5</td>
<td>38</td>
</tr>
<tr>
<td>REPLIES</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>7</td>
<td>23</td>
<td>4</td>
<td>47</td>
</tr>
<tr>
<td>READS</td>
<td>0</td>
<td>0</td>
<td>502</td>
<td>156</td>
<td>791</td>
<td>62</td>
<td>1511</td>
</tr>
</tbody>
</table>

**Table 4. Number of posts, replies and reads by district in Discus**

Figure 6 shows the initial social network *before* the introduction of Discus. The nodes have been grouped by district to make the collaborative interactions among and between the different districts more distinct. Figure 7 shows the social network *after* the introduction of Discus. The initial social network shows collaboration within each district but a lack of collaboration between districts. The post social network shows how the social network changed with new collaboration between the districts (5 and 8) using the discussion tool.
Figure 6. Combined social network diagram showing the social network before the introduction of Discus. Interactions using e-mail, telephone, face-to-face, other online discussion and other are shown.
Figure 7. *Combined* social network diagram showing the social network *after* the introduction of Discus. Interactions using e-mail, telephone, face-to-face, other online discussion and other are shown.

Figure 8 shows that there was new collaboration using Discus between district 5 and district 8 and that the overall knowledge scores (the size of the nodes) had increased.
Figure 8. Social network diagram showing *online collaboration using Discus*.

Figure 9 shows the face-to-face collaboration between the nodes *before* the introduction of Discus. Figure 10 shows the resulting face-to-face collaboration *after* use of Discus.
Figure 9. Social network diagram showing face-to-face collaboration before the introduction of Discus.
Figure 10. Social network diagram showing *face-to-face* collaboration *after* the introduction of Discus.

Figure 11 shows collaboration using the telephone between the nodes *before* the introduction of Discus. Figure 12 shows the resulting telephone collaboration *after* use of Discus.
Figure 11. Social network diagram showing *telephone collaboration before* the introduction of Discus.
Figure 12. Social network diagram showing telephone collaboration after the introduction of Discus.

Figure 13 shows the e-mail collaboration between the nodes before the introduction of Discus. Figure 14 shows the resulting e-mail collaboration after use of Discus.
Figure 13. Social network diagram showing *e-mail* collaboration *before* the introduction of Discus.
Figure 14. Social network diagram showing e-mail collaboration after the introduction of Discus.

The SNA diagrams for collaboration using “other” media (not face-to-face, e-mail or telephone) are not presented because they show no links and hence no change to the social structure between the nodes before or after the introduction of Discus.
To investigate the significance of the results obtained for H1, the data was categorized into two groups, those that were given access to Discus and those that were not given access. Scores were tabulated based on how many times the participant collaborated outside of their district. Occurrences where the participant collaborated within their own district were not included. The difference between each participant’s scores for before and after the use of Discus was tabulated and used as the dependant variable. A t-test found $t = 2.57$, and $p = 0.0139$ (see Appendix E). The values for equal variance probability were used because $Pr > F = 0.0722$ is greater than 0.05 (Kerlinger & Lee, 2000). There is equal variance between the Discus and Non-Discus groups. Since $p$ is less than the chosen alpha of 0.05, there is a significant difference between the group that used Discus and the group that did not. Therefore the null hypothesis can be rejected. This result suggests that participants that used Discus were more likely to collaborate with districts other than their own, compared to participants that did not use Discus.

To test the significance of the results obtained for H2, the data was categorized into groups of participants who used Discus and those that did not. Scores were calculated based on how many times the participant collaborated with another participant. The difference between a participant’s scores before and after the introduction of Discus was calculated. A t-test found $t = -0.02$, and $p = 0.9818$ (see Appendix E). $Pr > F = 0.8905$ which is greater than 0.05 therefore the variance probability for equal variance was used. Since $p$ is greater than the chosen alpha of 0.05, the null hypothesis cannot be rejected. The result suggests that there is no significant difference in collaboration frequency between the group that used Discus and the group that did not.
Similarly, to test the significance of H3, the data was categorized into two groups, those participants that used Discus and those that did not. Then a performance difference score was calculated based on the pre and post performance tests. A t-test found $t = 5.41$ and $p = 0.0148$ (see Appendix E). $Pr > F = 0.0148$ which is less than 0.05, therefore the variance probability for equal variance was used. Since $p$ is less than the chosen alpha of 0.05, the null hypothesis can be rejected. The result suggests that there was a significant change in knowledge for the group that used Discus compared to the group that did not.

CHAPTER 5. DISCUSSION

The purpose of this study was to examine the existing social network structure of booking officers at the Honolulu Police Department and how the introduction of an online discussion board affected collaborative learning for officers working with the booking module of a new RMS. The social network structure was operationalized using egocentric social network analysis. This chapter discusses findings related to changes in the social network and the implications for learning. Collaboration between districts and collaboration frequency are discussed.

Social Network Structure and Learning

The results of the initial social network analysis indicate that officers tended to collaborate within their own districts for information and rarely chose to collaborate with officers in other districts. Furthermore, Figure 2 shows that there appeared to be significant collaboration between the nodes in the Information Technology Division.
(ITD), and especially between two of the central nodes (3 and 16). There was significant collaboration between individual nodes in ITD and individual nodes in the Central Receiving Division (CRD). Each of the districts appeared to have a unique network structure, with the one commonality being a central or liaison node that collaborated with others outside of the district. The central node is not necessarily the node that has the highest knowledge score (34, 15, 23). Similarly, some of the nodes (10, 42, 20) that were isolated received the highest knowledge scores, indicating that these nodes were underutilized. District 5 had an open or integrated structure with each node communicating with each other node in the district. Four of the nodes (22, 4, 12, 11) were boundary spanners that collaborated with nodes in other districts to bring new information into the district. District 8 had two boundary spanners (34, 40) that brought new information into the district via ITD and CRD. District 2 had two key nodes (15, 33), with node 15 bringing new information into the district by collaborating with ITD and node 33 distributed this information within the district. District 3 had the least collaboration, with one key node (23) that served as both the central node for the district and the distributor of the information within the district.

The initial performance test showed that the average knowledge score across all districts was 51.6%. This suggests that the current social network structure was not the most conducive to collaborative learning. In addition, each of the officers were subject to their own districts’ network structure (see Figure 2). The districts with the highest knowledge scores were district 5 with 64%, district 2 at 60% and CRD at 60% (Table 2). The similarity between the network structures of these 3 districts is that each of the
individual nodes collaborates with other nodes in the same district and also with nodes in other districts. The collaboration is two-way and the network structure of the districts that received the lowest scores, district 8 at 53%, ITD at 42.8% and district 3 at 30% (Table 2) tended to have one or two nodes collaborate outside the district and then share the information within the district. The collaboration appears to be mostly one-way. Interestingly, ITD staff had one of the lowest overall knowledge scores. Relating this to Figure 2, it appears that two ITD nodes (3, 16) are over-utilized, creating a bottleneck in the network between other ITD nodes and other districts collaborating via these two nodes.

The results from the post performance test showed an increase in average knowledge scores across all districts from 51.6% to 59.9%. This suggests that the changes in the social network structure (Figure 2) may have improved learning. Knowledge scores across districts showed that three of the four districts (district 8, CRD and ITD) that participated in Discus, showed increased knowledge scores while the two districts that were not given access to Discus showed either constant (district 3) or decreased (district 2) overall knowledge scores.

The districts with the highest scores were CRD with the highest score at 100%, followed by district 8 at 88% and district 5 at 55%. It appears that CRD received the highest score due to the increase in collaborative learning by two key nodes (28, 1). Node 28 was the only node in CRD to contribute in Discus. The social network structure of district 8 changed noticeably, with increased two-way collaboration between nodes 30, 14, 40 and 34 (Figure 2). These nodes were active participants in Discus. Interestingly,
node 10 did not participate in the online discussion and the knowledge score remained the same. The social network structure for district 5 remained essentially the same. Nodes 18, 21 and 26 increased their collaborative learning scores, however only node 26 participated in Discus. It appears that nodes 18 and 21 had increased two-way collaboration to other nodes (21 to 4, 11 and 18 to 12) that did participate in Discus (Figure 3). ITD marginally increased knowledge scores. This can be explained by the lack of participation by ITD staff in Discus. Only nodes 38, 3 and 16 chose to participate (Figure 3), with node 38 being the only node to increase its knowledge score. Nodes 3 and 6 maintained the highest scores. As part of the study design, district 2 and district 3 did not have access to Discus. District 2’s social network structure changed as a result of increased face-to-face collaboration. Nodes 5, 32, 15 and 24 marginally increased their knowledge scores. This may be explained by the social connections that these nodes have outside of their own district. District 3’s network structure remained the same as so did their overall collaborative learning score at 30%.

The results from the post performance test supports H3 that states that there would be an increase in knowledge for participants that used Discus compared to participants who did not. The results showed that there was an increase in knowledge scores for 10 out of the 14 nodes in Discus, with two of these nodes (3 and 16) receiving the maximum scores in both pre and post performance tests (Figure 2). There was an increase in knowledge scores for 4 out of the 16 nodes that did not participate in Discus. These nodes were from district 2 and may be explained by the social connections that these nodes have outside of their own district.
Results from the content analysis of the messages posted using Discus indicated that all of the districts that had access to Discus used the board mainly to seek and provide information (IS = 19, IP = 19 in Table 3). District 5 displayed the most Information Seeking behavior. They have the most integrated network structure (Figure 2). ITD, who asked for feedback on system changes, had the next highest level of information seeking messages. It is interesting that all districts participated in information providing (IP), not just ITD and CRD as expected. The IS and IP categories are an indication of collaborative learning interaction. To a lesser extent, the districts used the board to request actions (RA = 10) and confirm completed actions (CA = 14). An example of this is where booking officers ask booking officers in other districts to type data into the booking module in a certain way.

**Collaboration Between Districts**

The results from the social network analysis supports H1, which states that there would be an increase in collaboration between participants in different districts using the Discus compared to participants who did not. The results showed that there was a significant increase in collaboration between districts 5 and 8 (Figure 3) after Discus was introduced compared to the initial social network (Figure 2). The two districts that did not have access to Discus (2 and 3) showed collaboration within their own district but there was a lack of collaboration with any of the other districts (Figure 2).

**Collaboration Frequency**
To understand the collaboration frequency for the users of Discus, the server logs were analyzed to see the number of posts, replies and reads made by each district (Table 3). The number of posts was tabulated by the number of times cs-method was equal to "POST" and the cs_uri_query was blank (indicating a new post). The district with the most posts was ITD with 19, followed by district 5 with 10 and CRD with 5. It was evident that ITD actively posted when the board was started to encourage other districts to participate. ITD used the board to notify the districts of system-wide events such as scheduled downtimes (Table 6).

The number of replies was calculated by the number of times cs-method was equal to "POST" and the cs_uri_stem and the cs_uri_query were equal to a valid message link. Log entries where cs_uri_query was blank were not counted (indicating a post not a reply). ITD had the most replies at 23, followed by district 5 with 13 and district 8 with 7.

The number of reads was calculated by the number of times cs_method was equal to "GET" and the cs_uri_stem and the cs_uri_query were equal to a valid message link. Log entries where cs_uri_query was blank were not counted. The district with the most reads was ITD with 791, followed by district 5 with 502, then district 8 with 156. The logs indicate that many of the participants chose not to post messages but were active in reading messages posted by others. The ratio of reads to posts was almost 41:1 in the case if ITD, 50:1 for district 5 and 22:1 for district 8. This indicates that the collaboration frequency indicated by posting and replying to messages was low, with most participants preferring to only read messages. However, the learning of "lurkers" should not be
underestimated and may be of significant advantage in some online communities (Wenger et al. 2002).

H2 states that there would be an increase in collaboration frequency between participants using Discus compared to participants who do not. The results from the social network analysis tie-strength did not show results that were significant enough to support H2. The results indicated that Discus encouraged new ties to be formed between nodes that had not previously collaborated. For example, there are new ties between nodes 28 and 3, 3 and 40, 3 and 30, 38 and 34, 38 and 12, 38 and 4 (Figure 2). The only significant increase in tie-strength was between nodes 3 and 12. There was increased collaboration between nodes in district 2 but this was mainly due to increased face-to-face collaboration. The level of participation in the online discussion database may explain why the collaboration frequency between participants was low. To overcome this limitation, these results can be analyzed again once Discus has been used over a longer time span.

**Recommendations**

This study investigated the effects of an online discussion tool on the social structure and collaborative learning at the Honolulu Police Department. The literature review highlighted areas where learning in the organization can be improved through the use of CSSN's and the establishment of communities of practice.

- **Participation is essential to continual learning from the online discussion tool.** The timeliness of information and responses from the
ITD division is essential to continued use of the discussion tool. Continued success of Discus is in jeopardy if officers do not believe that they will receive timely or useful information from ITD or from their colleagues through this medium.

- **Widespread availability of the online discussion tool.** Comments from officers indicated that Discus was particularly useful in its availability. Discus was available no matter what booking computer they were assigned to.

- **A shared purpose and this purpose must be understood.** The nature of systems is that they grow and change over time. The effectiveness of the learning provided by the online discussion tool depends on the shared understanding of the participants as to its function, benefits and limitations.

- **Reminders of the existence and use of the online discussion tool.** With new officers assigned to booking duties and officers relocating from one district to another, it is recommended that the ITD staff distribute periodic reminders about the discussion tool and provide periodic training on the use of the tool.

- **Growth and flexibility.** One officer commented that the ability to post attachments such as screenshots would save time by allowing the officer to refer to the screenshot, thereby reducing the amount of textual description needed to explain a point. As the discussion board is used, it is
essential that the online discussion board can be improved or modified based on feedback from the officers.

Conclusion

Findings from this study have indicated that the introduction of an online discussion tool had significant effects on the social network for officers working with a booking module of the RMS at the Honolulu Police Department. Results support the hypothesis that there was an increase in knowledge of the booking module for participants using Discus compared to participants that did not. Results also supported the hypothesis that there would be an increase in collaborative learning interaction between participants in different districts using Discus compared to participants that did not. The results did not support the hypothesis that there would be an increase in collaboration frequency between participants using Discus compared to participants who do not. However, the value of non-collaborative interaction such as reading others' messages should not be underestimated.

Implications of these findings for future research are that technology alone cannot support a social network. Various types of media accomplish collaboration within the social network. Technology supported media must support the process of learning how to use the technology, how to adapt it to work processes and other social processes. This was evident by the need to maintain activity in Discus in order to encourage new activity. Technology supported media can be used to encourage collaboration between participants that would not necessarily collaborate through any other type of medium. Further
research into how different media are used for different work and social process would be of value. This study has focused on the social network structure at a police department. Further research into what types of social network structures are conducive to collaborative learning in different types of organizations would assist in determining what types of technologies would be best suited.
APPENDIX A

Interviews 1 and 2

Directions: Below you will find a list of names of many people who work at HPD. Some of these people you may interact with quite frequently; others you may not talk to very much at all. I am interested in whom you have communicated with about the Records Management System (RMS) in the last 3 weeks (Mar 1 – Mar 21, 2004), how often and through what means (e.g. e-mail, telephone, face-to-face, online discussion or other).

Please indicate your answer by placing either a 1. (never), 2. (monthly), 3. (weekly), 4. (daily), 5. (hourly) in the communication frequency boxes and a 1. (not at all), 2. (acquaintance), 3. (friend), 4. (close friend), 5. (confidant) for how well you know this person and a number corresponding with how often you communicate with these people by e-mail, telephone, face-to-face, online discussion or other. Please fill in the boxes for as many names as may be appropriate. If there is only one person you would generally communicate with then just fill in the boxes for that one person’s name. If there are several people you might communicate with, then fill in the boxes for these several names. If there is no one you generally communicate with then do not fill in the boxes for any names.

Thank-you for your participation.
<table>
<thead>
<tr>
<th>Group Member</th>
<th>How often do you seek or receive information from this person?</th>
<th>How well do you know this person?</th>
<th>How many times did you communicate with the person over the last 3 weeks about the Records Management System (RMS), using each of these tools?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participant Names</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
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<tr>
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<td></td>
</tr>
<tr>
<td>42</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
APPENDIX B

Performance Test 1

Directions: This performance test should only take approximately 10 minutes. Below you will find descriptions for 5 tasks that can be performed in the Records Management System (RMS). Please complete the tasks using RMS and provide your answers on this sheet of paper or place a mark in the “Don’t Know” column if you do not know the answer. Please do not spend more than 2 minutes on any one of the questions. Please complete the performance test by yourself without communicating with anyone else. Remember that this performance test is not meant to test your ability but rather to provide an indication if online tools will benefit HPD.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What is the booking number for the arrest with report number LHPXXXXXXXXXXXXXX?</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>How many people were arrested for DUI MD on 2/9/2004?</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Who keyed in the data for an arrest on 2/4/2004 for arrestee XXX, XXXX?</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>What is the police vehicle number for the arrest of XXXX,XXXX?</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>What is the report number for the FRAUD incident that occurred in sector 1, beat 150 on 10/19/2003?</td>
<td></td>
</tr>
</tbody>
</table>

Thank-you for your participation.

Please return to investigator by Monday, March 29, 2004.
APPENDIX C

Performance Test 2

Directions: This performance test should only take approximately 10 minutes. Below you will find descriptions for 5 tasks that can be performed in the Records Management System (RMS). Please complete the tasks using RMS and provide your answers on this sheet of paper or place a mark in the “Don’t Know” column if you do not know the answer. Please do not spend more than 2 minutes on any one of the questions. Please complete the performance test by yourself without communicating with anyone else. Remember that this performance test is not meant to test your ability but rather to provide an indication if online tools will benefit HPD.

<table>
<thead>
<tr>
<th>Question</th>
<th>Answer</th>
<th>Don’t Know</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Who is the arresting officer for the arrest with report number LHPXXXXXXX?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 How many people were arrested for PRO DANG DR 3 FC on 3/14/2004?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3 Who keyed in the data for an arrest on 2/8/2004 for arrestee XXX,XXX X?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 What is the police vehicle number for the arrest of XXX,XXXX XX on 1/4/04?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 What is the report number for an arrest that occurred in 2004 involving a red, 19XX Pontiac Grand Prix?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Thank-you for your participation.

Please return to investigator by Monday May 3, 2004.
## APPENDIX D

### Sample of Server Log Data

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<thead>
<tr>
<th>Date</th>
<th>Time</th>
<th>IP Address</th>
<th>User-Agent</th>
<th>Method</th>
<th>Request-URI</th>
<th>Referrer-URI</th>
<th>HTTP Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004-04-08</td>
<td>18:20:33</td>
<td>999 999999</td>
<td>GET</td>
<td>CCHNL.wt</td>
<td>/css/messages/1.0.4.html</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>2004-04-08</td>
<td>18:20:39</td>
<td>999 999999</td>
<td>GET</td>
<td>CCHNL.wt</td>
<td>/css/messages/1.0.5.html</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>2004-04-08</td>
<td>18:21:06</td>
<td>999 999999</td>
<td>GET</td>
<td>CCHNL.wt</td>
<td>/css/messages/6.6.html</td>
<td></td>
<td>200</td>
</tr>
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<td>18:21:06</td>
<td>999 999999</td>
<td>GET</td>
<td>CCHNL.wt</td>
<td>/css/messages/7.7.html</td>
<td></td>
<td>200</td>
</tr>
<tr>
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<td>18:21:33</td>
<td>999 999999</td>
<td>GET</td>
<td>CCHNL.wt</td>
<td>/css/messages/2.0.html</td>
<td></td>
<td>200</td>
</tr>
<tr>
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<td>18:21:39</td>
<td>999 999999</td>
<td>GET</td>
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<td>200</td>
</tr>
<tr>
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<td>999 999999</td>
<td>GET</td>
<td>CCHNL.wt</td>
<td>/css/messages/1.03.html</td>
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<td>200</td>
</tr>
<tr>
<td>2004-04-08</td>
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<td>999 999999</td>
<td>GET</td>
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<td>2004-04-08</td>
<td>18:21:41</td>
<td>999 999999</td>
<td>GET</td>
<td>CCHNL.wt</td>
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</tr>
<tr>
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<td>GET</td>
<td>CCHNL.wb</td>
<td>/css/messages/11.8.html</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>2004-04-08</td>
<td>18:27:19</td>
<td>999 999999</td>
<td>GET</td>
<td>CCHNL.wb</td>
<td>/css/messages/mark_top.gif</td>
<td></td>
<td>200</td>
</tr>
<tr>
<td>2004-04-08</td>
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<td>GET</td>
<td>CCHNL.wb</td>
<td>/css/messages/mark_down.gif</td>
<td></td>
<td>200</td>
</tr>
<tr>
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<td>GET</td>
<td>CCHNL.wb</td>
<td>/css/messages/mark_ottom.gif</td>
<td></td>
<td>200</td>
</tr>
<tr>
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<td>200</td>
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<tr>
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<td>200</td>
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<tr>
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</tr>
<tr>
<td>2004-04-08</td>
<td>19:20:46</td>
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<td>GET</td>
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<tr>
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<td>CCHNL.wk</td>
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</tr>
<tr>
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<td>/css/messages/33.05.html</td>
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<td>2004-04-08</td>
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</table>
APPENDIX E

SAS Statistical Test Results

HYPOTHESIS ONE T-TEST

The TTEST Procedure

<table>
<thead>
<tr>
<th>Variable</th>
<th>GROUP</th>
<th>N</th>
<th>Lower CL Mean</th>
<th>Upper CL Mean</th>
<th>Lower CL Std Dev</th>
<th>Upper CL Std Dev</th>
<th>Std Err</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINKS</td>
<td>D</td>
<td>26</td>
<td>0.4177</td>
<td>2.1298</td>
<td>1.6534</td>
<td>2.1082</td>
<td>0.4135</td>
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<tr>
<td>LINKS</td>
<td>ND</td>
<td>16</td>
<td>-0.965</td>
<td>-0.25</td>
<td>0.9911</td>
<td>1.3416</td>
<td>0.3354</td>
</tr>
<tr>
<td>LINKS</td>
<td>Diff (1-2)</td>
<td>0.3253</td>
<td>1.5192</td>
<td>2.7125</td>
<td>1.5256</td>
<td>1.6582</td>
<td>2.3776</td>
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</tbody>
</table>

T-Tests

Variable Method Variances DF t Value Pr > |t| Variance
LINKS Pooled Equal 40 2.57 0.0139
LINKS Satterthwaite Unequal 39.9 2.85 0.0068

Equality of Variances

Variable Method Num DF Den DF F Value Pr > F
LINKS Folded F 25 15 2.47 0.0722

T-Test for H1

HYPOTHESIS TWO T-TEST

The TTEST Procedure

<table>
<thead>
<tr>
<th>Variable</th>
<th>GROUP</th>
<th>N</th>
<th>Lower CL Mean</th>
<th>Upper CL Mean</th>
<th>Lower CL Std Dev</th>
<th>Upper CL Std Dev</th>
<th>Std Err</th>
</tr>
</thead>
<tbody>
<tr>
<td>LINKS</td>
<td>D</td>
<td>26</td>
<td>-11.63</td>
<td>2.9231</td>
<td>17.474</td>
<td>36.024</td>
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<td>LINKS</td>
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<td>29.837</td>
<td>36.342</td>
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T-Tests

Variable Method Variances DF t Value Pr > |t| Variance
LINKS Pooled Equal 40 -0.02 0.9818
LINKS Satterthwaite Unequal 31.3 -0.02 0.9818

Equality of Variances

Variable Method Num DF Den DF F Value Pr > F
LINKS Folded F 15 25 1.05 0.8905

T-Test for H2
## HYPOTHESIS THREE T-TEST

The TTEST Procedure

### Statistics

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<th>Mean</th>
<th>Std Dev</th>
<th>Std Dev</th>
<th>Std Err</th>
<th>Lower CL Mean</th>
<th>Upper CL Mean</th>
<th>Std Dev</th>
<th>Std Dev</th>
<th>Std Err</th>
<th>Lower CL Mean</th>
<th>Upper CL Mean</th>
<th>Std Dev</th>
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<th>Std Err</th>
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</thead>
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</tr>
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<td>17.579</td>
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</tr>
</tbody>
</table>

### T-Tests

| Variable | Method | Variances | DF  | t Value | Pr > |t |  |
|----------|--------|-----------|-----|---------|------|  |  |
| SCORE    | Pooled | Equal     | 40 | 4.79 | .0001 |
| SCORE    | Satterthwaite | Unequal | 39.5 | 5.41 | <.0001 |

### Equality of Variances

<table>
<thead>
<tr>
<th>Variable</th>
<th>Method</th>
<th>Num DF</th>
<th>Den DF</th>
<th>F Value</th>
<th>Pr &gt; F</th>
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</thead>
<tbody>
<tr>
<td>SCORE</td>
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<td>15</td>
<td>3.49</td>
<td>0.0148</td>
</tr>
</tbody>
</table>

T-Test for H3
REFERENCES


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(http://www.era.anthropology.ac.uk/ERA2/Kalela/)


(http://semanticstudios.com/publications/semantics/000006.php)

Oliver, M. & Naidu, S. (1996). *Building a Computer Supported Co-operative Learning Environment in Medical-Surgical Practice for Undergraduate RNs from Rural and Remote Areas: Working Together to Enhance Health Care.* University of Kansas, Missouri USA


