PROFESSIONAL LEARNING AND DEVELOPMENT

A SOCIAL NETWORK PERSPECTIVE

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Declaration

Except where otherwise acknowledged in the text, this thesis represents my own original work.

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Abstract

Human resource development in organisations generally relies on formal training programs as a tool for employee development. However, such formal programs are not sufficient to fulfil the entire learning needs of employees. The increasingly complex, contingent and idiosyncratic nature of work in today's organisations puts pressure on employees to learn faster and continuously, often rendering formal training unable to keep up. Consequently, employees are compelled to resort to informal learning. Here, formal learning refers to scheduled classes or other training programs, with standardised learning goals for a whole class of learners. In contrast, informal learning refers to more personalised learning, which may be spontaneous, and which can involve communication, spontaneous exchange, advice-seeking and advice-giving that are related to an individual's specific, personal learning needs.

The literature suggests that a large amount of learning takes place informally outside the classroom context. Such a learning process is inherently social and relational. One way in which such learning takes place is through interpersonal exchanges of information, ideas and other learning resources. However, the types of social relations that are instrumental in learning and the structure of these social relations have not received adequate empirical scrutiny, causing their applied values to be neglected in the human resource development practice. This thesis attempts to bridge this gap by examining some social relations that previous research indicates are instrumental for informal learning.

The empirical research for this study is based on the networks of social relations pertaining to informal learning among two groups of trainers in

Indonesia, one of which is a Government Training Centre (GTC) and the other is a Company Training Unit (CTU). The structure of their social relations is analysed using a social network approach.

The study compares and contrasts network structures in which the two groups of trainers are involved. The main issues addressed include the process of informal learning, the types of social relations that are facilitative for the trainers' learning, the overall characteristics of these networks of social relations, the internal subgroup structures forming the network cores, and the structures of positions based on the trainers' patterns of interconnections.

The empirical research reveals some similarities and differences between the two groups of trainers. In terms of similarities, both groups engage in and benefit from informal learning through their relations with other people, despite the fact that they are may not be fully aware of it. Their involvement in informal learning is driven by the less structured nature of their activities, by the continuous changes in their subjects of specialisation, by the intrinsic need to maintain a positive self-image and to stay competitive, and by the need to be ready for unexpected teaching opportunities.

The trainers' informal learning systems constitute networks of multiple social relations, consisting of communication, collaboration, advice-seeking and advice-giving ties. The combination of these four types of relations provides both groups of trainers with access to not only explicit knowledge, the type of knowledge easily delivered through formal training programs, but also to tacit knowledge which is helpful in getting their jobs done.

Although the trainers perceive that their relations are close, intimate, and mutual, results of the social network analyses suggest the contrary. The networks in both organisations appear to be sparse, disconnected, and externally oriented. Such structures are not effective in spreading learning resources as they lack the number of ties through which learning resources can reach all of the trainers quickly. However, they have the potential to support innovation because such sparse ties reduce the possibility for redundant information to circulate in the networks, and the extensive ties to diverse external associates could also provide them with access to a wide variety of information.

The differences were mainly found in the internal structure of the networks. The networks for each group of trainers contain subsets of actors who form cohesive parts of the networks. The division of trainers into these cohesive subgroups is influenced by the main organising principles of their organisations. For the public service trainers, members of subgroups tend to be homogeneous in terms of their rank and level of education, which reflects the hierarchical nature of the Indonesian public service. The private sector trainers are divided into cohesive subgroups based on their areas of specialisation, reflecting the expertise driven nature of commercial organisations.

The trainers are also divided into positions based on their patterns of interconnections. Structural equivalence and regular equivalence notions of position are used and the results from each are compared. For the networks in the two organisations considered in this study, structural equivalence appears to produce more meaningful position models. Thus, based on structural equivalence, the position models for each group of trainers exhibit different prototypes, which reflect the nature of their organisations. The public service trainers in the GTC are grouped into 'core-periphery' position models by rank, where the junior and the middle rank trainers occupy the core and the senior trainers are at the periphery. The structure of positions for the private sector trainers in the CTU forms 'cohesive subgroup' models. Each subgroup (position) is occupied by trainers of similar areas of expertise, reflecting a high division of labour in commercial organisations.

Overall, results of the study demonstrate the usefulness of social network analysis as a method of investigation. They also show the potential capacity of social network analysis as a management tool for understanding informal learning systems in organisations, which could become a basis for developing improved human resource development strategies. At the same time, this research is only a beginning. Future research will necessarily take up the challenge of more indepth measurement of the many dimensions of informal learning in modern organisations.

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CHAPTER ONE. AN OVERVIEW OF THE STUDY

Human resource development is, undoubtedly, one of the major concerns of management in any modern organisation. The development of human capacity has been largely attributed to arranged learning processes, which take place within a formal context, particularly those delivered through formal classroom-based programs of instruction. Consequently, formal programs of instruction have received much empirical scrutiny. This has led to a neglect of the learning that takes place incidentally through exchange of knowledge, ideas, or information in the work place.

In practice, informal learning in organisations tends to be intangible, unpredictable and *ad hoc* in nature which makes it difficult to reconcile with the dominant rational procedures of bureaucratic practices in today's organisations. The value of informal learning is often overlooked because of the pervasiveness of the more predictable formal classroom training, characterised by being intentional, prescribed by formal curriculum, competency standards and learning outcomes, which appeals more to the principles of bureaucratic organisations. For research, the characteristics of informal learning make it more difficult to study using the conventional cognitivist perspective, conceiving learning as a process that takes place inside the minds of individuals, and the standard study approach focusing on individuals' attributes.

This chapter provides a broad overview of the issues addressed in this thesis. It highlights the importance of informal learning and why it needs to be considered in human resource development. It demonstrates the relevancy of the social network paradigm in studying informal learning. It also discusses the study objectives and problems. Finally, it indicates how the remainder of the thesis will be organised and presents an overview of each chapter.

The Importance of Informal Learning

Today, organisational environments are characterised by increasing uncertainty, volatility and are fast changing. The nature of work itself is increasingly complex and unpredictable. This has important implications for the learning needs of organisations and their employees. For example, employees are compelled to learn faster and continuously in order to keep up with changes that affect their work. This has implications for the type of knowledge and mode of learning required. Due to the episodic, time-bound and space dependent nature of formal training programs, they are rarely sufficient to fulfil the on-going demands of a contingent and dynamic work environment. Consequently, employees increasingly have to take advantage of informal ways of fulfilling at least a portion of their learning needs.

Informal learning in organisations is inevitable. In Blau's (1963) study of the behaviour of agents in an American law enforcement agency, he demonstrated that the agents learned from one another by exchanging advice, despite the official rules prohibiting them to do so. As Gorard (1999) also noted, "much valuable and non-trivial learning already goes on, and has always gone on, outside formal programmes of instruction" (p. 544). Likewise, Taylor (1997) argued that the majority of learning takes place every day, informally, incidentally, implicitly, or even tacitly, but remains unacknowledged. More precisely, researchers have shown that up to 70 to 90 percent of learning actually takes place informally (see Leslie, Aring *et al.*, 1997; Day, 1998; Low, Tjongarero *et al.*, 2001). Thus, without harnessing informal learning, organisations miss the opportunity to capitalise on a cost-effective tool of human resource development.

Formal and informal learning, however, should be seen as complementary, rather than mutually exclusive. As Leslie, Aring and Brand (1997) note, formal and informal learning augment each other. Each learning mode has its own weaknesses, which are complemented by the strengths of the other. Formal training programs, on the one hand, are very useful in transferring explicit and codified knowledge to a large number of people simultaneously. However, their limitation is that they are not as effective at delivering tacit knowledge, a type of knowledge which is important in actually getting work done. In addition, formal training programs cannot accommodate on-going and incidental learning needs due to time and space dependencies. Informal learning, on the other hand, has the capacity to develop tacit knowledge, and it takes place irrespective of time and place.

Leveraging informal learning is, therefore, imperative to the success of employee development. Paradoxically, given its immense importance (see Taylor, 1997), it is largely unexplored and overlooked in research and in practice. As Boud and Walker (1991) note, although learning in highly controlled settings (task analysis, curriculum, trainers, support resources) has been well documented in research, we know little about learning in the messy reality of the workplace, that is, learning that takes place after people have completed their formal training.

There are two particular reasons for the slow progress of the recognition and appreciation of informal learning in practice and in research. Practically, as indicated earlier, it is incompatible with the principles of bureaucracy, a form of organisation which is still dominant today, thus concealing the significance of informal learning from management, human resource development practitioners, and policy makers. Stamps (2000), for example, showed the difficulty of instigating informal workplace learning initiatives even in a forward-looking organisation such as Xerox, and argues that such an effort requires a paradigm shift to succeed. Methodologically, informal learning is intangible, therefore it is difficult to observe and measure. As Hager (1998) noted, informal learning is implicit or tacit, where learners are themselves often unaware of the extent of their learning. Thus, this presents methodological difficulties if informal learning is to be taken as an object of empirical study. The conventional approach that focuses on individual attributes is not sufficient to examine such a covert process.

Social Network Paradigm

A social network approach provides an alternative perspective in understanding learning in general and informal learning in particular. The real ways people learn and get their work done can be found in the hidden associations among workers (Stamps, 2000), also referred to as informal organisation (Krackhardt and Hanson, 1993), rather than within the structure depicted in the formal organisational chart. The capacity of social network approach to reveal the structure of such implicit informal social relations in which informal learning is embedded can help to overcome methodological difficulties. From a social network perspective, learning takes place within naturally occurring and enduring networks of social relations, involving people from a variety of backgrounds. Thus, the boundary of the social relations is not limited to that of the organisation, group, profession, or rank.

The fruitfulness of the social network approach has been demonstrated in studies of various social phenomena, such as bank decision making (Mizruchi and Stearns, 2001), getting a job (Granovetter, 1973), diffusion of innovation (Valente and Davis, 1999), disease outbreak (see among others, Klovdahl, Potterat *et al.*, 1994; Curtis, Friedman *et al.*, 1995; Friedman, 1996), career mobility (Burt, 1992), disputes resolution (Kapferer, 1969), conjugal relationships (Bott, 1957) and many more.

Although the role of social networks in learning has not been widely appreciated, the connection between the two has been recognised in some recent conceptualisations of learning, such as in the concepts of situated curriculum (Gherardi, Nicolini *et al.*, 1998), situated learning (Lave and Wenger, 1991; Fuhrer, 1993; Singleton, 1998; Nidumolu, Subramani *et al.*, 2001), and communities of practice (see among others Wenger, 1998; Brown and Duguid, 2000; Kulkarni, Stough *et al.*, 2000; Stamps, 2000; Wenger and Snyder, 2000b; Hara, 2001; Mansoor and Dabbagh, 2002; Wenger, McDermott *et al.*, 2002). These conceptualisations conceive of learning as a social and relational, rather than purely as an individual, process. They place important emphasis on the social context within which the learning process takes place.

Researchers in this newer tradition generally challenge the widely held assumptions emanating from the traditional cognitivist concepts, applied mostly in formal training programs, where learning is conceived of as a process that takes place inside the head of individuals, and where the learning process is stripped of the genuine context where the learning outcomes are to be applied. Richter (1998) highlights this, arguing that our society has been dominated by a view in which learning is conceived of as an individualistic form of activity and knowledge is considered embedded in the invisible cognitive world of individual players. Similarly, Cross, Rice and Parker (2001c) also critique approaches in knowledge management initiatives in which knowledge is conceptualised as something that exists outside of social interactions, and where the fact that the creation and interpretation of knowledge is inherently a social process is overlooked.

In social network literature, moreover, learning has also been implicated. According to Podolny and Page (1998), network forms of organisation can foster learning by promoting the rapid transfer of self-contained pieces of information and encouraging novel syntheses of information residing within distinct nodes.

In fact, many of the standard social network concepts are highly relevant and very useful in explaining how the structure of informal social interactions may affect learning. For example, measures of *centrality* such as *degree*, *closeness* and *betweenness* (Freeman, 1979) are very helpful in examining the kind and the level of access that network members have to resources embedded in their networks. In addition, structural features such as network *density*, *centralisation*, *reachability*, *distance* and *subgroup* configuration can also reflect the potential capacity of social networks to spread learning resources. Other network concepts such as the "structural hole" (Burt, 1992) and "weak ties" (Granovetter, 1973) are also very useful in explaining how the way individuals are embedded in networks can affect their opportunities to draw on the network benefits, and can affect the overall effectiveness of the whole structure in mediating and facilitating learning activities and access to knowledge repositories and other learning resources.

Although still limited in number, some studies have started to specifically examine the relationship between social networks and learning processes in organisations, such as the role of networks in knowledge sharing (Hansen, 1999), network effects on the learning environment of jobs (Rhee, 2000), and the effects of informal social networks within the context of formal MBA programs (Baldwin, Bedell *et al.*, 1997).

In light of the concepts and theories discussed above, this study argues that informal learning which takes place beyond the context of a conventional formal classroom needs to be considered in order to account for the whole amount of learning that contributes to the employees' performance. Although the informal learning process is inconspicuous and is difficult to examine using the conventional attribute-based approach, its structure can be revealed using a social network approach.

The Research Problem

Using a network paradigm, this research compares and contrasts the structure of social relations pertaining to informal learning and knowledge exchange among two groups of trainers in Indonesia. These trainers are employed to teach in a Government Training Centre (GTC) and in a Company Training Unit (CTU). As far as the researcher is aware, this study is the first attempt to use formal network analytic tools to study learning in organisations in an Indonesian context.

Although a number of authors have looked at the social network phenomena in Indonesia, their arguments are not based on a formal network analysis (for example, see McVey, 1982; Campos and Root, 1996; MacIntyre, 1996; Djiwandono, 1999; Katoppo, 1999). There are a few studies that employ a formal network approach, such as those by Schweizer (1997), Schweizer, Klemm and Schweizer (1993), and Schweizer (1988), however, they focus on the social structure of people in rural Java in Indonesia, rather than in particular organistions.

Due to the lack of social network studies that employ a formal social network approach in Indonesian context, the present study was guided by basic, yet important, questions. How do the trainers learn informally? Do informal social networks play an important role in the informal learning process and, if so, what social relations make up the networks? Can the characteristics and the structures of these social relations be revealed, and if so, what do they look like and in what way the structure of the networks in the two organisations are similar or different? Finally, what implications do these network structures have on learning processes in organisations?

The Study Objectives

The aim of the study has been to explore similarities and differences of the structural form of social networks pertaining to informal learning in two organisations in Indonesia (GTC and CTU). This is possible because the basic institutional parameters of the two organisations are roughly comparable. For example, they are of about the same size and their members have more or less similar tasks and function. However, the context within which each organisation operates is quite different.

This is only a first step in studying the extent to which the characteristics of informal learning networks structure are common across organisations and to which they are unique to an organisation. By analysing data from two different sites, a comparison between them could be made, allowing some (preliminary, exploratory) inferences about features related to network structures and processes. This can become a foundation for a more structured comparative analysis in the future. The next logical step would be to investigate empirically and measure systematically actual effects of the network structures on the informal learning outcomes in each organisation.

The value of comparative study in this research context is attributable to several reasons. First, as social networks are highly contextualised, it is important to examine cross-organisational variations. Comparing two sites provides an opportunity to see alternative structures of similar systems, especially where the types of network studied based on the similar sets of relations (communication, advice-seeking, advice-giving and collaboration). Without a comparative analysis, there would be a tendency to consider that everything in the social networks is either generic, or that everything is specific to one set of organisation. Thus, it is important to avoid false assumption, erroneously thinking that the structures of informal learning are necessarily common.

Second, making observation on more than one cases can deepen understanding of the phenomena under investigation and can increase the credibility of the study. Empirical findings from two sites make a study more convincing than those based on a single site (see Stinchcombe, 1968). By implication, it can also be argued that drawing conclusions from multiple sites is more convincing than from a single site.

Third, studying more than one cases can increase generalisability of the study. Multiple site analysis can reveal the likelihood of the observed network features to be generalisable beyond the two cases studied here. Drawing on Denzin (1983), Guba & Lincoln (1981) and Firestone & Herriot (1983), Miles and Hubberman (1984) note that although some argue that generalisability is not relevant in a qualitative study, it is still important to know something about the relevance or applicability of our findings to other similar settings, to transcend "radical particularis".

The fourth reason is to fill in the gap in social network research which are mainly studying a single organisation. As Borgatti and Cross (2003, p. 441) point out "[t]he great bulk of work in the social network tradition has largely drawn conclusions based on a single social network within one organization in one industry". Thus, conducting a study on two organisations, with different but comparable characteristics could contribute to an improved understanding of organisational networks.

A comprehensive understanding of social networks in these two organisations can aid in designing a better strategy for developing trainers in particular, and other professional-based occupations in Indonesia in general, by demonstrating the need to harness informal social networks in order to leverage informal learning in organisations.

The study has also been expected to evaluate the usefulness of social network approach as a method for investigating the phenomena of learning in organisations, and as a management tool for designing improved human resource development measures. Furthermore, this study has been intended to identify areas that require further empirical examination, and recommends some directions for future studies along these lines. Finally, as the bulk of social network studies have been largely carried out in the US, UK, France and Europe in general, this study is expected to contribute to cross-cultural social network data from an Indonesian context. It is important to note that this study is exploratory in nature. It is hoped that it will stimulate more studies of social networks and informal learning in developing countries.

Outline of Chapters

This thesis is organised into ten chapters. This first chapter presents a snapshot of the study as a whole. Chapter Two discusses how this study was carried out. It elaborates on the research design of the study and its implementation procedures, covering methods used, research sites and participants, research instruments and their administration in gathering data, and data analysis. It also describes the research ethics safeguards that were built in into the research design, such as how research participants were recruited, and how their identities and the identities of their organisations as well as data about them were (and are) protected.

Chapter Three establishes the conceptual framework of the study by reviewing social network and learning literature. It demonstrates that although informal learning plays a significant role in employees' development, it is still largely ignored by those concerned with human resource development in organisations. It also shows that learning, especially informal learning, is a social process, as it is relational in nature. It takes place within the context of overlapping social networks. The argument of this chapter is that a social network approach is a fruitful method for investigating social networks in which informal learning is embedded.

Chapter Four describes the two organisations from which the two groups of study participants were drawn. It covers the types of services provided, the physical set up of the organisations, work organisations and degree of specialisation, incentive systems, information access through information technologies and the trainers' socio demographic features. Based on these characteristics, some speculations are made as to how the network structures in the two organisations might be similar or different.

Chapter Five presents the results of the qualitative data analysis, addressing factors that stimulated the trainers to engage in informal learning, areas in which the trainers were compelled to learn informally, and the issue of low awareness about the role and the benefits of informal learning and the role of social networks in learning. The discussion also covers the ways in which the trainers' informal learning takes place, the types of social relations that are instrumental for the trainers' learning, and the roles of these social relations in informal learning.

Chapter Six starts using some basic concepts from the formal social network approach to examine the overall characteristics of the social networks in which the study participants are involved. These include the measures of network *size*, *inclusiveness*, *density*, *reachability*, *components*, *distance*, and the network's overall *centralisation*. It also discusses the composition and the significance of external network associates. The results are discussed in terms of their implications for the learning processes and knowledge sharing activities among the trainers involved.

Having analysed the overall structure of the trainers' networks in the previous chapter, Chapter Seven moves on to examine the substructures of the networks by identifying the cohesive subgroups into which each of the networks can be divided. This is a basic starting point for understanding the more complex internal structure of the networks. In this chapter, various concepts of the *subgroup* are addressed. The subgroups are analysed for each network, including the communication, collaboration, advice-seeking and advice-giving, as well as the knowledge networks in which the other four networks are combined. The subgroups forming the core of each network are identified and interpreted. The chapter also discusses the important factors that bind the trainers together into these cohesive subgroups.

Chapter Eight also employs a formal social network approach to examine the positions of trainers based on the similarity of their learning and knowledge sharing patterns. The chapter starts by discussing the concept of position in social network analysis. It then identifies positions, consisting of groups of trainers who manifest the same patterns of relations across multiple network structures entailing learning and knowledge exchanges. The concepts of structural equivalence and regular equivalence – deemed most relevant for present purposes – are used for modelling the positions. It then interprets the identified position models using relevant actor attributes and the existing position topology or characterisation.

After examining the overall and the specific structures of the networks for both organisations in Chapter Five through to Chapter Eight, Chapter Nine specifically compares and contrasts the two groups of trainers in terms of the issues examined in those previous chapters, including their learning processes, and the features of their networks. The network features compared include the overall network characteristics, the cohesive subgroups and the structure of positions. In addition, the features of their organisational contexts are also compared and contrasted.

Finally, Chapter Ten concludes the thesis by presenting the summary of the key findings, the implications of these findings, and some limitations of this initial exploratory research. Also considered are some possible directions for future work.

CHAPTER TWO. THE RESEARCH DESIGN

This chapter is devoted to discussing the study design and its implementation. It provides a blueprint of how the study was carried out. Its main purpose is to describe the methods chosen and their implementation. The chapter starts by addressing the research approaches, covering both social network and qualitative analysis components of the study. Then, it continues by describing the research sites, research participants, and data. Finally, it outlines the research procedures, covering the phases of the research, the ethical procedures, data gathering instruments, data collection procedures and data analysis.

The Research Approach

Social Network Analysis

In general, a social network can be defined as a finite set of nodes or social actors connected by one or more social relationships of one kind or another (see Knoke and Kuklinski, 1982; Wasserman and Faust, 1994; Klovdahl, 1997; Borgatti and Foster, 2003). The nodes or social actors can be persons, organisations, countries, or other social entities. Relationships or social ties are linkages that exist between a pair of actors which in turn connect the pair of actors to a larger relational system. These ties can be resource-based or identity-based (Podolny and Baron, 1997). Alternatively, Bell, Atkinson and Carlson (1999) classify them into transmission and non-transmission.

The study of social networks requires a formal social network analysis, which has its own distinctive set of research questions, concepts and methods of data collection, analysis and presentation (Tindall and Wellman, 2001). Social network analysis has provided a fruitful approach in studying various social phenomena, including among others conjugal relationships (Bott, 1957), dispute resolution (Kapferer, 1969), bank decision making (Mizruchi and Stearns, 2001), getting a job (Granovetter, 1973), career mobility and individual advancement (Burt, 1992; Podolny and Baron, 1997), disease outbreak (Klovdahl *et al.*, 1994; Curtis *et al.*, 1995; Friedman, 1996), diffusion of innovation (Valente, 1995; Valente and Davis, 1999), the performance of individuals and groups (Sparrowe, Liden *et al.*, 2001), to mention a few. Sociometric method, an early form of social network analysis, has been used extensively in investigating social processes in educational settings (Saha, 1997). Today, the use of a social network approach has gained increased recognition from researchers across different disciplines (see Borgatti and Foster, 2003).

In this study, a social network approach was selected as a method of investigation as it is relevant to the characteristics of the study participants and their process of learning. The trainers, who became the study participants, are part of hierarchical organisations, but are not themselves organised into hierarchical structures. Their organisation is better viewed as a function of their informal interactions with a wide range of people. Thus, from a social network perspective, the trainers are the nodes or social actors, and the interconnections that facilitated the trainers' informal learning and professional development constitute their social ties. Social network analysis is specifically aimed at investigating such relational phenomena (Scott, 1991b).

The social network approach is particularly suitable for the topic under investigation, that is, informal learning. According to Cross, Parker and Borgatti (2002), social network analysis enables the researchers to visualise and understand the myriad of relationships that can facilitate or impede knowledge creation and transfer.

The present study highlights the nature of social network analysis as a fruitful method for characterising a loosely bounded system, that is, one not governed by a hierarchical chain of command. In addition, this study also attempts to demonstrate that the social network approach is highly relevant to investigating a complex social system of informal learning and knowledge sharing, which is not readily observable by means of conventional study approaches.

Using a network approach, however, also proved to be quite challenging, especially with regard to the implementation of ethical issues. This study, as with most other network studies, needed information about personal connections of individuals. Such information could be sensitive for some study participants, and they might not want to reveal it. Although this study is concerned with positive relations, it could not be assumed that every study participant would be willing to provide information without any concern about how the information that they provided would be treated, managed and used. This presented some dilemmas that required careful and proper management. In consequence, the research required more time than a conventional approach would normally take.

For example, it was important to maximise response rate without being too intrusive in getting the trainers to participate in the study. Although a network study rarely has 100 percent response (see Stork and Richards, 1992), trying to maximise it is very important. This is so because the building blocks of a network are relations. As relations are shared rather than individual properties, and the number of possible ties is exponentially related to the number of actors, missing just one respondent could mean loosing many potential pieces of relational data. However, trying to maximise the response rate in this study can possibly be perceived as being intrusive which may cause the study participants to feel uncomfortable. This could reduce response rates as the participants may relay – through their networks – unpleasant experiences to colleagues who have not yet been interviewed.

For the study participants, having to sign a formal consent letter for their involvement in a study was unprecedented. In their environment, where a large amount of personal information was not treated as confidential, requesting access to such information formally in written form caused some respondents to be initially hesitant to agree to participate, as they thought the study was going to gather negative information about them or about their personal relations. This was especially true as personal connections in Indonesia are often perceived as being associated, to some extent, with misconduct such as nepotism and collusion in organisations (see McVey, 1982; MacIntyre, 1996; Djiwandono, 1999). Although these issues could be dealt with by providing the study participants with more information, in most cases, the process of convincing them that these procedures were in fact to protect their privacy took much more research time than would likely be required in a study that viewed individuals as isolated from their social environments.

Nevertheless, the potential rewards of using a social network approach can outweigh the challenges. With this approach, insight into a complex social system not readily observable though other approaches may be obtained, and relational structures mapped and analysed. This approach provides an alternative perspective to the conceptualisation of organisational processes by focusing on relational patterns, rather than on individuals conceived as isolated one from another.

Qualitative Analysis

Although (quantitative) social network analysis was the primary study approach, a qualitative analysis was also required because some subjective and complex areas of the trainers' informal learning, which were deeply embedded in their natural context, required in-depth qualitative understanding beforehand. Examples of these include expression of how the trainers believe they learn and grow in their profession, what social relations are most instrumental in their learning, and how social networks contribute to the development of those embedded in them.

The capacity of qualitative analysis to deal with such areas has been well established. For instance, drawing on Barley (1986) and Leonard-Baron (1990), Miner and Mezias (1996) stress the strength of qualitative studies in providing insight into micro-processes that transform routines into taken for granted organisational practices. The qualitative approach was especially useful here as many aspects of the trainers' informal learning processes, including its input and output, were rarely articulated consciously by trainers. Such intricate and obscured processes do not immediately nor easily yield to a quantitative approach.

With regard to the topic of this study, Livingstone's (2001) recommendation is particularly relevant. He proposes that observation in situ and/or in-depth interviewing is necessary in studying informal learning, which includes tacit knowledge, so that the researcher is able to identify numerous dimensions of previously obscured, but vitally important learning in social contexts.

By combining (quantitative) social network and qualitative approaches, the study was able to explore the topic more thoroughly. The qualitative approach provided a different, but complementary, contribution to understanding the process of learning through social networks. The social network approach uncovered the structure of social relations among the trainers. The qualitative approach contributed to uncovering the meaning behind the observed social structure, and to providing insights into intangible processes of informal learning and the hidden social networks in which the learning processes were embedded.

The Research Sites, Participants and Data

Research Sites

This study was carried out in two organisations, with extremely different characteristics, so that it could contribute to the understanding of organisational networks. By analysing data from two different sites, a comparison between them could be made, allowing some (preliminary, exploratory) inferences about features related to network structures and processes. In addition, empirical findings from two sites make a study more convincing than those based on a single site (see Stinchcombe, 1968). In fact, this study could have benefited from some more additional sites. However, due to time and resource constraints, a design involving two sites with moderate number of trainers was most realistic.

One of the sites is a Government Training Centre (GTC), which provides training services for Indonesian public servants. It is important to note that the government training centre studied is only one of the many government training centres in Indonesia. Virtually all central government departments, ministries and local governments have their own training establishments. The National Institute of Public Administration, a central government organisation responsible for managing public service training in Indonesia, recorded 425 government training establishments in 2004 (SiDA, 2004). The other site is a Company Training Unit (CTU), which provides training services to employees of private companies. It operates as a business unit under a commercial organisation, and thus is exposed to a competitive business environment.

It is important to stress that the names GTC and CTU are only used in this study, so that the real identities of these organisations and that of their trainers remain confidential. They are not the real names of the respective organisations, nor are the organisations normally referred to by these names.

The sites were selected purposively based on the following criteria. First, the organisations needed to operate in different environments, so that a comparison could be made as to how contextual differences affected various aspects of social networks and learning. Second, the training institutions needed to have their own fulltime trainers. Some training institutions do not have their own trainers, and only hire external trainers as needed. In such institutions, scheduling and administering interviews and other instruments would have been difficult. Third, the number of trainers that the institutions had needed to be adequate and manageable to allow networks of interconnection among trainers to be constructed and analysed within the available time and resources.

Many organisations satisfied these criteria. However, GTC and CTU were selected because besides meeting these criteria, the management in these organisations were the earliest to give approval to provide access to interview their trainers and to make available ancillary documents (for example, some personnel records). It was important to choose the organisations that gave approval the earliest, as the time available for data collection was limited.

Network Boundaries

Boundaries of relational systems are not always easy to draw, and this has generated a considerable discussion in the literature. This is especially true because a particular network may be part of a larger network. As Tindall and Wellman (2001) put it, "social systems are networks of networks". Thus, deciding where to draw the boundary of a network can be problematic, as was the case in this study.

Although the main aim was to study the network of relationships among the trainers in the two organisations, it was important to try to learn more about the extent of their social relations by not placing restrictions on who or how many people they could nominate. Although the trainers belonged to their respective formal organisations, it could not be assumed that they only learned and exchanged knowledge through interactions with other trainers in their organisations.

In fact, some social network analysts tend to disregard group or organisational boundaries, and think of networks as having fluid, porous, permeable and overlapping boundaries (see, for example, Araujo, 1998; Tindall and Wellman, 2001). As Klovdahl (1989) pointed out, the potential of social network as a concept cannot be adequately understood if analysis stops at the apparent boundaries of groups or organisations. In addition, Scott (1991b), argued that ignoring connections outside the particular locale under investigation will render a social network studied an imperfect representation of the full network.

By the same token, if no restrictions are imposed on nominations, the number of actors could increase dramatically. The available resources clearly did not make it feasible to interview people from outside the targeted groups.

A possible solution to this would be to take only the persons of interest, in this case the two groups of trainers (referred to as internal actors), and discard external actors, that is, people nominated by the internal actors but not themselves internal actors. Such a technique has been used, for instance, by Molina (2001) in identifying informal organisation among a set of people in a non-governmental organisation (NGO). The advantage of this approach lies in its simplicity. However, it also means a large amount of information which could be meaningful would be thrown away. For example, the connections between internal and external actors could have important implications for the structure of the networks and, in turn, the effects of these structures on the internal actors at individual and organisational levels. In addition, some of the external actors might function as bridges, integrating internal actors' networks to a larger network, or even connecting otherwise unconnected pairs of internal actors. Characteristics of the external actors might also be consequential to the internal actors, such as the effect they have on the amount and types of knowledge that the internal actors could access (see Granovetter, 1973). In addition, a peripheral actor who appeared to be rather isolated from the rest of his or her workmates might in fact be a central player in relation to external parties. Finally, as social relations are not individual but shared properties (Scott, 1991b; Stork and Richards, 1992), it was important to consider the external actors with whom the trainers associated. Thus, external actors were important parts of the trainers' networks, and failing to account for them could distort the true nature of these networks.

Another possible solution, therefore, would be to include both internal and external actors. This is commonly done in the forms of snowball sampling (see Goodman, 1961), or random walk sampling (see Klovdahl, 1989; Liebow, McGrady *et al.*, 1995; McGrady, Marrow *et al.*, 1995). However, this is a very time consuming approach, especially when the data collection involves face-to-face interviews, as was planned for this study. Although using probabilistic sampling frames in selecting external actors would have been beneficial, time and resource constraints would have made study completion impossible.

A variation of this is to apply certain criteria in determining which external actors could be included. For example, Alba and Moore (1978) as well as Soo-Hoon and Keng-Howe (2000) included external actors if they were nominated by at least two internal actors. However, even if the number of external actors were reduced, the time required to recruit them based on the procedures in the human subjects protocol would still be considerable.

Here, as elsewhere, there was a trade-off between what might be ideal and what was realistically and practically achievable. This led to the adoption of an alternative solution, which was to define tentative boundaries *a priori*, including only the internal actors (44 in the GTC and 31 in the CTU). This technique belongs to what Borgatti (1998) refers to as an *"etic"* approach, that is, drawing network boundaries based on the researchers' needs and on the purpose of the study being undertaken. Alternatively, Laumann, Marsden and Prenksy (1989) refer to such technique as "nominalist" based on actor attributes. Recognising that the trainers' networks were potentially large and could extend beyond their organisational boundaries, and recognising the important implications that external relations might have, no restrictions were imposed on the number and the type of people who the trainers could name.

Thus, the extent of the trainers' interconnections could be revealed from the relational data. It might be noted, however, that the trainers were made aware during the interview that they should only name those who really contributed to their learning and development as trainers.

Extended boundaries were then drawn to include all the other persons named by the internal actors who were themselves not internal actors. By the end of the data collection, 148 and 104 additional actors for the GTC and CTU respectively were included within the extended boundaries. It is important to note that only the interconnections among the internal actors were established based on self-reports obtained through face-to-face interviews. The ties from the internal actors to the external actors were only based on one-sided reports given by the internal actors. The interconnections among the external actors were constructed based on the internal actors' knowledge or "cognitive social structure" (Krackhardt, 1987). Figure 2.1 shows a stylised network which could result from the adopted technique.

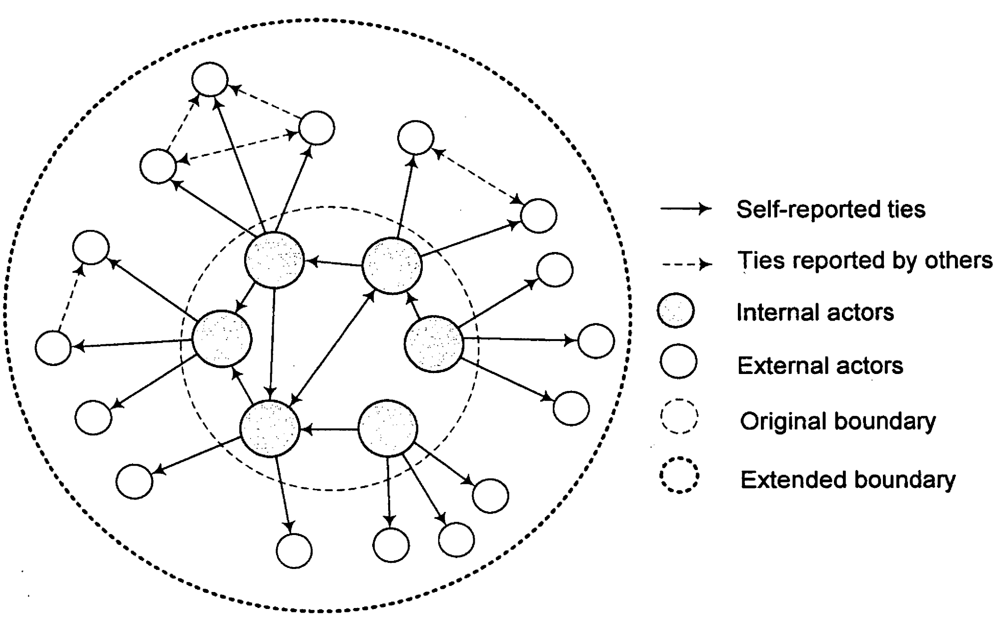


Figure 2.1. Internal and external actors

Ties other than those based on self-reports were established conservatively, and several measures were taken to ensure that the ties were not based on speculative estimates. First, a tie between a pair of external actors was regarded as present if a respondent was certain that the external actors knew each other quite well. Second, ties about which a respondent was definite were verified further by finding out how close the respondent was to those external associates. Closeness was indicated by one of or a combination of several factors, including having regular interactions (at least once a week) with them, working in the same organisation with them, and having social activities with them outside work hours, or being spatially close (in their work place or residence). Third, these closeness criteria also needed to be satisfied by the pairs of external associates between whom respondents reported relations.

This technique might not provide as accurate relational information as a link-tracing design might, or as the techniques used by Alba and Moore (1978) and by Soo-Hoon and Keng-Howe (2000). However, the approach used here should give a reasonable picture of the breadth of trainers' social relations in a situation such as this, in which resources did not permit external associates to be interviewed. Since the trainers only reported the presence or absence of ties, it was reasonable to assume that their perceptions would provide an approximation of the ties that would exist had the external actors been actually interviewed.

Nevertheless, relational data based on cognitive social structure were treated cautiously and were only used in certain analyses. When the analyses were, for example, density, subgroup and position, the main focus was on interconnections among the internal actors. The inclusion of the external actors in such analyses was only intended to provide a comparative point of reference.

However, when analyses focussed on network attributes of individuals, such as centrality, size of network neighbourhood, reachability and distance, external actors' connections were taken into account.

The approach used here has some advantages. Most importantly, it reduced potential biases if trainers named other trainers from their own organisation, even though their relations with external associates might be in fact more facilitative to their learning and knowledge sharing. Such biases could render some network measures (such as network size and densities) unrepresentative of the true extent of trainers' interconnections. In addition, this approach revealed the type of people who were important sources of knowledge, information and ideas for the trainers. It was also able to capture the trainers' interconnections within two layers of boundaries. Thus, within the time constraints, it made it possible to represent the extent of the trainers' interconnections that might be relevant for their opportunities to access knowledge and to learn informally from other people. More importantly, it provides a basis for future systematic investigations of larger probabilistic samples of trainers so that additional statistical inferences could be made. Since data about the trainers have already been collected in this study, and since the external actors have already been identified, an extension to this study could start with interviewing these external actors.

Study Participants

Trainers were selected as study participants because they are relevant to investigating informal learning and social networks. They are knowledge workers, and their profession is highly knowledge and information intensive. Although formal training programs are provided for them, they still need to learn informally in a continuous manner to keep up with their rapidly changing work environment. To fulfil their learning needs, trainers often resort to informal learning, much of which takes place within the context of their social relations with other people.

In addition, as indicated above, networks of social relationships are an important feature of the way trainers are organised. Although they are part of complex organisations, they are not normally organised hierarchically. Rather, they are defined by their interconnections. More specifically, for the trainers in this study, their opportunities to work, learn and grow are affected considerably by those to whom they are connected.

The records in the human resource division in each of the organisations were consulted to identify the population of potential study participants. In the GTC and CTU, 44 and 31 fulltime trainers respectively were recruited. Their distribution across various socio-demographic attributes can be seen in Table 2.1.

Table 2.1. Distributions of the study participants by attributes

Attributes	GTC	CTU
Male	34	26
Female	10	5
Junior	11	4
Middle rank/Senior[1]	22	22
Senior/Training Expert[1]	11	5
Undergraduate[2]	23	24
Post graduate[3]	21	7
Average age	53.41	40.13
Std. Dev.	7.76	3.17
Range	34-65	33-48
Average Tenure	4.88	13.35
Std. Dev.	2.90	7.21
Range	1-13	1-27

[1] Ranks in the GTC are divided into Junior, Middle and Senior. The trainers in the CTU are also divided into three levels of ranks, but using different terms: Junior, Senior and Training Expert.

[2] Undergraduate is a first university degree for those who have completed their senior high school (year 12). It is normally completed in about four years of fulltime study.

[3] Postgraduate is Masters or doctoral level degree

As can be seen in Table 2.1, female trainers are outnumbered by their male counterparts in both organisations, and middle rank trainers (or referred to as senior trainers in the CTU) are numerically dominant. However, trainers in the two organisations also have differences. A greater number of GTC trainers have higher educational qualifications than the CTU trainers. The trainers in the two organisations are also different in terms of average age and average length of service. In general, GTC trainers are relatively older with shorter tenure in the public service training career, whereas the CTU trainers are relatively younger with longer tenure in the training career. More precisely, the average age of the GTC trainers is about 53 years old, but they have only been about 5 years in their training career. On the contrary, the CTU trainers are only 40 years old on average, but with an average of 13 years in the training profession.

The contrasting age and tenure of the two groups of trainers is due to the different career systems and image of the training career in the two organisations. In the GTC, the system allows public servants to shift back and forth between managerial and functional careers. Public service trainer is one of the functional careers. However, because a training career is not very attractive for many public servants, they only take it as a last career choice. Therefore, many, or most of the GTC trainers started their training career when nearing their retirement. In contrast, the training career in the CTU provides higher economic rewards and, consequently, it attracts younger employees. Some of the CTU trainers also indicated that being associated with CTU as a big company was also a motivation behind their decision to become trainers in this organisation.

The trainers in both organisations had generally served in different parts of their organisations before becoming trainers. The majority in the GTC (93%)

had previously occupied managerial positions. The others are promoted trainers from technical staff positions. In the CTU, 24 trainers (77%) had served at various parts of CTU and at the parent company of CTU before being appointed trainers. The remaining 7 (23%) were recruited directly into the training position.

Response Rate

Participation in this research was entirely subject to the trainers' agreement. Therefore, it was anticipated that the response rate in this study would be less than 100 percent. In fact, researchers have reported that full participation is quite rare in social network studies (Stork and Richards, 1992). The main reason for non-response or partial participation was that the trainers had heavy workloads during the data collection stage of the study. As can be seen in Table 2.2, of the 44 trainers in the GTC, 39 (89%) participated in the study and five (11%) did not. Among the 39 participants, 37 fully participated, which means they attended interviews in which they answered open-ended and network questions as well as returning the self-administered questionnaires. Of the two partly-participating trainers, one of them returned the self-administered questionnaire but did not attend an interview. The other partially participating trainer attended an interview but was unwilling to answer the network questions. This trainer did not return the self-administered questionnaire either. Thus, network data for these partial participants could not be collected.

Five trainers did not participate in any part of the study due to different reasons and circumstances. One openly refused to take part. Two others dropped out after failing several times to turn up at rescheduled interviews. The remaining two could not be met at any stage during the data collection stage as one was on study leave and the other was on sick leave. Thus, relational data for seven GTC trainers (five non-participants and two partial participants) were not available.

Table 2.2. Response rate of the GTC trainers

Category	Targeted n (%)	Full Participants[1] n (%)	Partial Participants[2] n (%)	Refusal n (%)	Withdrawal n (%)	On study leave n (%)	On sick leave n (%)
Junior	11 (25)	10 (27)	0 (0)	0 (0)	0 (0)	1 (100)	0 (0)
Middle	22 (50)	20 (54)	1 (50)	0 (0)	0 (0)	0 (0)	1 (100)
Senior	11 (25)	7 (19)	1 (50)	1 (100)	2 (100)	0 (0)	0 (0)
Total	44 (100)	37 (100)	2 (100)	1 (100)	2 (100)	1 (100)	1 (100)

[1]Full participants were those who filled in the self-administered questionnaires, attended interviews and provided network data

[2]Partial participants were those who participated in other parts of this study, but did not provide network data

As Table 2.3 shows, the level of participation in the CTU was higher, where 30 out of 31 trainers (97%) took part. Among the 30 participants, 28 participated fully in all parts of the data collection. Due to heavy engagement in their daily activities, two of the full participants could not attend interviews but were prepared to provide data in writing. For them, a special set of open-ended questions and network questions with detailed instruction on how to answer them was provided. The two partly participating trainers also asked to take part in writing, but did not provide answers to the network questions. Nevertheless, these trainers were regarded as participating partially as they did answer the other parts of the questionnaire. Thus, relational data for three CTU trainers (one non-participant and two partial participants) were not available.

Table 2.3. Response rate of the CTU trainers

Category	Trainers Targeted n (%)	Full Participants n (%)	Partial Participants n (%)	Refusal n (%)
Junior trainers	4 (13)	3 (11)	0 (0)	1 (100)
Senior trainers	22 (71)	20 (71)	2 (100)	0 (0)
Training expert	5 (16)	5 (18)	0 (0)	0 (0)
Total	31 (100)	28 (100)	2 (100)	1 (100)

It is important to note that although some of the trainers in both organisations could not be interviewed, they allowed their socio-demographic data to be accessed through the division of human resource of their organisations. They could also be named by others who participated, therefore, partial relational data relevant to them could be obtained.

Although non-response rate was low, the number of possible ties missing is quite high because the relations were shared rather than individual properties. The maximum number of missing links is equivalent to the number of possible ties from the non-participants to participants plus the number of possible ties among the non-participants themselves, or simply $(x.y) + x(x-1)$, where x is the number of non-participants and y is the number of participants. Thus, with seven of 44 trainers in the GTC having no relational data, there can be up to 301 ties missing; and with three of the 31 trainers in the CTU, there can be 90 missing ties.

The Data

Two primary types of data were collected in this study, structural and compositional. The structural data were ties between pairs of actors, which became the basis for mapping the social networks. The compositional data were attributes of the trainers.

Structural Data

The structural data consisted of four types of social relations pertaining to learning and knowledge exchange, including communication, collaboration, advice-seeking and advice-giving.

Communication Relation

The communication relations show who usually talks together about general work-related matters. This includes regular and serendipitous exchanges of information. They were generated by the question, "Is there anyone with whom you normally exchange ideas, stories or information, or discuss work-related matters? If so, who are they?"

Advice-seeking relation

Advice exchange relations facilitate sharing or exchanging technical know-how. Whereas general communication exchanges could take place incidentally, an advice exchange is normally based on a more deliberate intention, where one party seeks advice from the other. It could also happen where one party gives advice voluntarily to the other. Thus, the two sides of advice exchange relations, advice received and advice given, were considered separately.

The advice-seeking relations show who consults whom for technical advice on a more or less regular basis. Advice-seeking relations are instrumental in learning as they provide learners with access to technical know-how, which is very important in getting work done. As they are based on the needs of the advice-seekers, this type of relation can deliver highly relevant learning materials.

Advice-seeking relations for this research were generated by the question, "Is there anyone whom you normally go to for advice when you have work-related problems, or when you want to consult someone whose professional opinions are in general of great value to you? If so, who are they?"

Advice-giving Relation

Advice-giving relations reveal who gives advice to whom, thus revealing the extent to which the actors see themselves as advice providers. One might think that advice-giving relations could be obtained by simply reversing the direction of the advice-seeking relations. However, doing so will not necessarily accurately reflect advice-giving relations from the respondent's point of view. For example, if A goes to B for advice, that does not automatically make B an advice giver, at least from B's point of view. B may think of his interaction with A as an ordinary communication exchange. It was important in this study to capture advice-giving relations as advice givers saw it. Therefore, a separate question was used to generate advice-giving relations. That is, "Is there anyone who usually comes to you for advice on work-related matters? If so, who are they?"

Collaboration Relation

The previous three relations are only effective in facilitating exchanges of codified or explicable learning resources. However, a considerable amount of knowledge is embedded in the practices of the trainers, and is difficult to pass on through verbal communication. Collaboration is a mutual involvement between two or more people in carrying out a professional activity. During collaborative activities, the trainers are able to observe directly how other people performed certain tasks in which they might be expert. Collaboration relations, therefore, are able to provide the trainers with access to the tacit knowledge of their collaboration partners. According to Stamps (2000), when people work together, not only do they learn from doing, but also develop a common way of thinking about how to get their work done.

As can be seen in Figure 2.2, due to its implicit nature, it is difficult to share tacit knowledge through the ordinary medium of exchange, such as the three social networks discussed previously, which rely largely on explicit expression of knowledge. Leonard-Barton's (1992) illustration of how a CEO in Chaparral Steel described the tight integration of knowledge and learning in individuals and in their interconnections shows how difficult it is to share or transfer tacit knowledge. 'Forward [the CEO] says he can tour competitors through the plant, show them almost "everything, and we will be giving away nothing because they can't take it home with them"' (Leonard-Barton, 1992, p. 24).

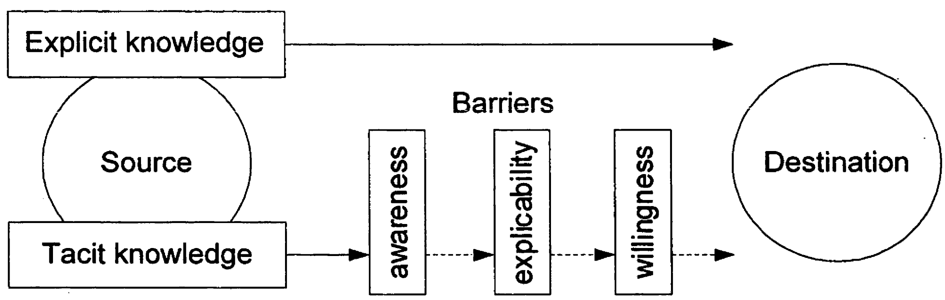


Figure 2.2. Barriers to tacit knowledge transfer

The first problem of transferring tacit knowledge is that the knower may not be aware of possessing valuable knowledge that may potentially be useful to other people. The second problem is that even if the knower is aware, he or she may not be able to express the knowledge in a clear and systematic way due to the complexity and the implicit nature of such knowledge. As Polanyi (1967) puts it, "we can know more than we can tell". Finally, the knower may be able to explicate it in certain ways, but he or she may not want to share it with the others, as such knowledge may constitute a competitive advantage.

A Collaboration network is regarded a medium through which tacit knowledge was co-created, shared and passed on, irrespective of the barriers above. As the collaborative actors normally work together in the same physical space and on their real work, the processes of learning, knowledge transfer and work can all take place simultaneously, rendering the barriers above less constraining, or even irrelevant. Thus, the instrumental role of a collaboration network in the process of tacit knowledge sharing is due to its capacity to provide a context for people to work together on actual professional activities so that working and learning take place simultaneously without necessarily having to rely as much on verbal or written expression to transfer the knowledge.

Collaboration relations were generated based on the question, "Is there anyone with whom you often collaborate in carrying out your professional activities? If so, who are they?"

Knowledge Exchange Relation

This relation was not generated by a question. Rather, it was established by combining the four relations discussed above. As these relations are conduits for different kinds of knowledge, a combination of these might be referred to as a knowledge network. In this study, a knowledge exchange relation exists between a pair of actors when they are connected by at least one of the four relations.

It is important to note that in the communication, collaboration and advice-seeking relations, the *out-degrees* indicate the opportunity to access or receive learning resources from the others. For example, if A indicates communicating and collaborating with, as well as seeking advice from B, it means A has the opportunity to access learning resources embedded in these relations from B. However, in the advice-giving relations, the opposite is true. A advises B indicates that it is B who receives learning resources embedded in the advice-giving relation from A. In the analysis where the flow of learning resources were important, the advice-giving relations were transposed so that the flow of learning resources in it was aligned with that of the other three relations. Transposing the relations did not alter their substantive meaning. It is important to note, though, that the trainers' responses indicated that they did not have to be at the receiving end of the advice-giving relation to receive learning benefits. Some reported gaining learning benefits from providing advice to other people.

Informant accuracy is an important issue in social network studies, and many researchers (see, for example, Bernard, Killworth *et al.*, 1980; Killworth and Bernard, 1980; Calloway, Morissey *et al.*, 1993; Fiske, 1993; Bondonio, 1998; Casciaro, 1998; White and Watkins, 2000; Butts, 2003) have indicated that informants tend to be biased in recalling their interactions or relations with others.

In this study, informant accuracy seemed a less critical issue as the participants were asked to indicate relatively long term and stable relations, rather than specific or incidental interactions. Drawing on the findings of many researchers, Wasserman and Faust (1994) imply that accuracy should not be a significant issue if network researchers are concerned mostly with intense, intimate and long term patterns of interactions. Nevertheless, to enhance informant accuracy, this study employed face-to-face interviews so that any inaccuracy due to misinterpretation of questions could be avoided. Some instances of potential inaccuracy in this respect were indeed prevented. For instance, a number of participants voluntarily clarified their understanding of what the researcher meant by each of the relations before giving their answers.

Composition Data

In addition to the relational data, socio-demographic data were also collected. These included age, gender, date of appointment as a trainer, tenure, rank, education, religion, ethnicity, work unit, specialisation, the number of training programs and seminars attended, associations joined, proportion of internal and external teaching assignments, information technologies used, and previous assignments. In addition, various data that characterised the organisations and the social environment of the trainers' works were also gathered, such as characteristics of the physical surroundings, issues that they faced, laws and regulations, national and local policies. These data were useful in interpreting the results of the network analysis.

Research Procedures

Phases of the Research

The study was carried out in two phases. This approach was necessary because although the topic was complex, previous studies on which this study could be based were limited. Figure 2.3 shows the two stages and how they are interrelated.

The first phase of the study was carried out in a Teacher Training Institute (TTC) in Indonesia from September to December 2002. This phase served two main purposes. First, it was used as a preliminary exploration to identify the types and the nature of social relations that were instrumental for trainers' processes of learning and development. Four social relations emerged from the analysis of the data, including communication, advice-seeking, advice-giving, and collaboration relations. These relations were the bases for building the structure of knowledge and learning networks in the second stage. The second purpose of this first phase was to test the validity and the effectiveness of the data gathering instruments as well as the soundness of the overall design of the study.

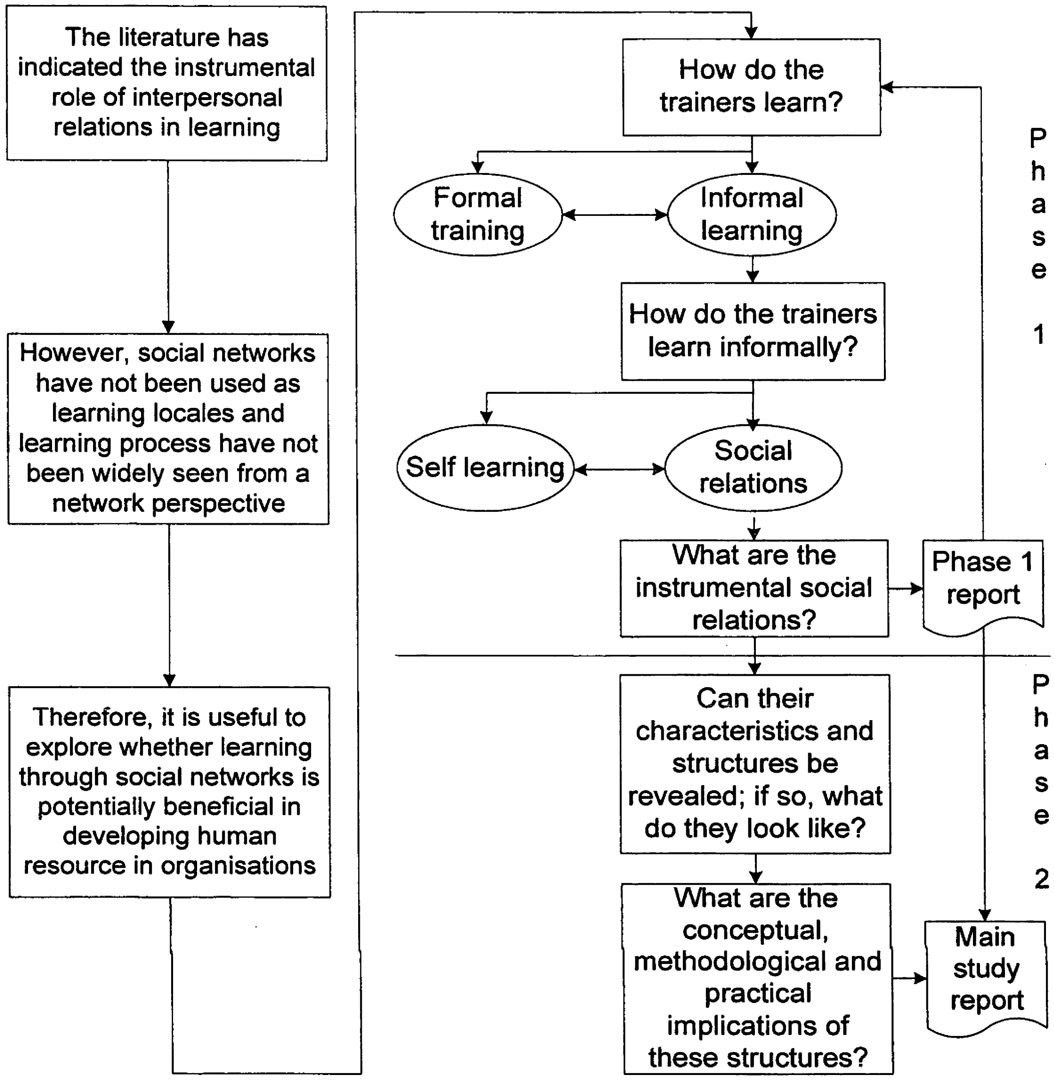


Figure 2.3. The study phase

Some revisions were made as result of the first phase. For example, connections among the main participants' external associates were not gathered during the first phase. However, it was found during the analysis of the phase 1 data that ignoring connections among external ties distorted the true extent to which the trainers were embedded in their larger networks that were relevant to their learning. Thus, the instruments for the main study were amended to obtain relevant information about ties involving external actors. In addition, some redundant questions were removed or merged with other questions; technical terms were replaced by ones that were more generally understood by the trainers. Question wordings and sequence were also improved in order to allow the participants to respond in a more logical manner.

The second phase, also referred to as the main study, was carried out from July to December 2003 in two different training institutions in Indonesia. The first phase provided a productive learning experience and contributed enormously to various stages of the main study. During the main study, the trainers were still asked to indicate any relations that they thought important for their professional development. However, they were also specifically asked to name who they were associated with in terms of the four relations identified from the first stage of the study.

Ethics (Human Subjects) Procedures

As this study involved humans, ethical issues were taken into serious consideration. An ethics protocol, containing a set of measures, was designed and integrated seamlessly into the design of the study. The protocol outlined the procedures for protecting the privacy of the research participants and the security of the data that they provided. The protocol (see Appendix 1) was approved by the Human Research Ethics Committee of the Australian National University before it was implemented. The protocol was implemented in both phases of the study, covering the data collection activities, the preliminary data analysis in the field, the primary data analyses and the publication of results.

The first contact in each of the study sites was the head of the human resources division. To access research sites, including research participants and other sources of data, a letter was sent to the human resources management division of each study site, explaining the purpose and the procedures of the study, as well as requesting interviews with the trainers.

To recruit the research participants, a research kit was sent to each of the trainers through the office of administrative division for each organisation. The kit contained a letter explaining the research and the ethical procedures, a copy of the consent form, an information sheet, a copy of the self-administered questionnaire and an envelope for returning the questionnaire. Telephone numbers and contact details were provided by the human resources division in each study site. After a few days, the researcher contacted the trainers and asked if they were willing to take part in the study. Some were contacted in person in their office; others by telephone. Times and places for interview sessions were arranged carefully, so that they did not disrupt the daily activities of the trainers. To avoid being repetitive, a detailed description of the ethical procedure's implementation in gathering data is integrated under the subsection of "Data Collection Procedures".

To strengthen the privacy protection measures, names of participating training institutions and research participants are being disguised in any reports related to this study. A name list containing linking information was created for each group of trainers. The name lists were never stored in the same place as the raw data, and they were sent separately from the study location to Australia via air mail.

Interview tapes and documents containing private information were stored in a locked briefcase. Electronic data were stored in a stand-alone laptop computer, which was password protected at hardware and software levels.

Instruments and Procedures of Data Collection

Data Collection Instruments

The data collected for this study came from multiple sources using several types of data gathering instruments (see Appendix 2), including a Self-administered Questionnaire, an Interview Guide, a Document Analysis Guide, and an Observation Guide.

The Self-administered Questionnaire was quite straight forward, containing questions about the participants' socio-demographic data. The questionnaire was translated into Indonesian language. The Interview Guide was divided into two parts. The first part contained semi-structured questions, which were used to elicit the study participants' social relations and the characteristics of these relations. More specifically, participants were asked to name persons with whom they had relations of any kind which they thought contributed to the development of their work-related knowledge and skills, as well as to their professional growth in general. The questions also asked the participants to specify the nature of their relations with those named, such as the types of resources that they exchanged, the benefits that they obtained from these relations, their closeness to one another, the frequency of their interactions, and the duration of their social relations. The participants were also asked to name their associates in terms of their communication, collaboration, advice-seeking and advice-giving relations. The interview questions used a "free choice" technique (Wasserman and Faust, 1994); that is, participants were not constrained with regard to who and how many people they could name.

The second part of the Interview Guide contained more open-ended questions, and was used to obtain in-depth information on various aspects of the trainers' relationships as well as the socio-cultural environment surrounding them. Unless participants requested otherwise, the first and the second parts of the interview were administered at the same time.

The Document Analysis Guide contained a list of documents that were considered relevant and important to consult, such as reports, laws and regulations, news stories, articles, and other publications. The list of items on the guide was kept open during the data collection stage so that other documents that might be found relevant later in the data collection period could be added.

The Observation Guide was almost similar in format to the Document Analysis Guide, except that it contained a list of objects or names of events to observe. The list was also kept open to incorporate additional events that were found to be relevant.

Data Collection Procedures

The bulk of the data were collected by means of face-to-face interviews. The interviews were conducted in Indonesian language. All interviews were administered by the researcher directly. Before a face-to-face interview session with a participant began, the participant was made aware of his or her right to take part or not, and the privacy protection measures that were put in place to safeguard data about him or her. The participant indicated his or her agreement to take part by signing a consent form (see Appendix 3). Once signed, they were asked if they would allow the interviews to be taped. The length of each interview varied depending on the time agreed by each participant, but on average they lasted for about 60 to 90 minutes. Due to trainers' commitment to other activities, some interviews could not be carried out in a single time period, in which case additional interview sessions were arranged.

At the end of the interview, the respondent could return the self-administered questionnaire, which was included in the research kit sent to him or her earlier. The majority of the participants were able to complete their questionnaires and return them to the researcher at the interview sessions. However, if a respondent had not completed the questionnaire, an arrangement was made to collect it at a later date. Some delayed completing their questionnaires because they wanted to clarify certain questions during their interview sessions. In all cases, the researcher collected these questionnaires in person.

In addition to the trainers, relevant officials were also interviewed. These informants provided additional information regarding organisational policies and procedures implementation that might have effects on social networks and learning processes among the trainers, as well as discussing their views on the training profession in general.

The timetable for the field observations was flexible. Unless there was a scheduled event that must be observed at a certain time, all the other field observation activities were normally conducted when there was no interview session. The observations were focused on daily activities in which trainers were involved, including teachings, meetings, and getting together in small conversations. On many occasions, the researcher was able to participate in the trainers' informal gatherings. The observations provided insightful information about the actual daily activities of trainers as well as the kind of topics that they normally discussed or felt were important and relevant to their tasks. The schedule for document collection was also kept flexible. Some of the documents were obtained from or recommended by participants during interview sessions with them.

Data Analysis

Before starting the data analysis, data preparations had to be carried out. The relational data for each case study were stored in square adjacency matrices (see Appendix 4), a dimension of which corresponds to the number of trainers targeted as study participants. For the GTC trainers, the data for each relation was stored in a 44 X 44 matrix, and for the CTU in a 31 X 31 matrix. As the trainers were not restricted in naming their network associates, a large number of people outside these targeted participants were nominated, resulting in the construction of extended sets of matrices of 192 X 192 for GTC trainers and 135 X 135 for CTU trainers. A "1" entry at which a pair of actors are adjacent in the matrix indicates that the actors had a relation and a "0" means they did not. The diagonal entries (reflexive ties) in the matrices were not considered meaningful (in the context of this study).

The socio-demographic data were stored in an SPSS table for quick access and retrieval. The qualitative data in the form of direct accounts made by the trainers from the in-depth qualitative interviews were transcribed from audiotapes into textual documents. Memos and field records were arranged and organised into themes.

Although the types of relations that are instrumental in learning are implicit in the literature, they were not determined *a priori*. Rather, they were allowed to emerge from the data. During the first phase of the study, the trainers were asked to name who they thought contributed to their process of learning to become better trainers. More specifically, they were asked to indicate who contributed to the development of their work-related knowledge and skills and the nature of these relationships. The trainers' responses were coded into meaningful categories. Four categories emerged from the analysis, including communication, advice-seeking, advice-giving and collaboration. Representative quotes for each category of relation are given in Table 2.4.

Table 2.4. Representative quotes for each category of relation

Category	Sample Quotes
Communication	I only talk about general issues with him because we have different subjects of specialisation. But many of the issues that we have discussed are useful in our teaching ... some immediately and some others in the future. In teaching, we do not have to focus on the subject matter all the time. The participants like to discuss popular or general issues too.
	There is a particular person who I learn from, despite having a rather awkward or .... let me say, a negative relation with him. He likes to criticise almost everything I say, but I learn how to defend my own point of view from having frequent debates with him.
Collaboration	We happen to teach the same subject. So, quite often we are assigned to teach together in the same class. We have also co-authored a training module, which has now been distributed nationwide. I am very fortunate because he is a senior trainer and has been recognised as an expert in the subject that we teach together. So, I have the opportunities to learn directly from the best.
Advice-seeking	Mr. [name] is a very nice and open person. He is willing to help and answer any of your questions as long as he knows the answer. Many other colleagues are smarter than him, but not as open. I don't know whether he is open to everybody else, but for me he is a resourceful person.
Advice-giving	He is more senior than I am. I do not see myself as a better trainer than him, but he often comes to me with problems, personal or about work. ... perhaps not real problems but he just wants to know what I think. For me, being able to help other people makes me feel more confident and feel appreciated, and I think I also learn from helping other people because it makes me aware of the issues and have better understanding about them.

In the main stage of the study, the study participants were asked to specifically name their associates in terms of the four relations that had already been identified in the first phase. In this case, they were asked to name the people with whom they had communication, advice-seeking, advice-giving and collaboration relations. The possibility for other types of relations to emerge was not precluded as participants were allowed to indicate other relations that they felt contributed to their learning.

Two new types of relations emerged: mentor and friendship. The mentor relation was indicated by six trainers in the GTC and two in the CTU. The friendship relation was indicated by four trainers in each of the organisations. Ideally, these two relations would have been established by asking all the other respondents with whom they have these relations. However, time did not permit the arrangement of an additional interview for every respondent. Therefore, the structures of these two new relations could not be established. However, it is recommended these be considered in future studies. The other responses fell into one of the four already determined types of relations. Thus, this could be regarded as a further confirmation of the categories already identified in the first phase of the study.

Once these relational data had been stored in matrices, various procedures were performed on them using UCINET 6 (Borgatti, Everett *et al.*, 2002) to characterise the networks. Three primary types of analysis were performed. The first analysis was intended to reveal the basic features that characterised the networks generally, such as size, inclusiveness, density, reachability, distance, and components. The second analysis dealt with examining substructures of the networks to reveal cohesive subgroups and the core regions of the networks. The third analysis was also concerned with substructures, but focusing on examining how the trainers were divided into positions within their system of learning and knowledge exchange relations.

Qualitative data analysis in this study was carried out in tandem with data collection activities. This preliminary data analysis provided cues for collecting additional relevant information while still in the field. Together with data from other documents, including fieldwork notes and memos, the interview transcripts were coded into meaningful categories. The codes were revised several times during the fieldwork and the actual data analysis stage in order to arrange them in a logical structure.

In summary, the study design outlined here was implemented successfully. It has been able to capture the extent of interconnections in which the study participants are involved by not putting restrictions on the number and the type of people that the participants could nominate. This free-choice technique may also have improved informant accuracy by reducing bias towards naming people within a predefined group when their learning relations are actually much wider than that. In addition, in future this could be extended to the use of link-tracing (e.g., snowball) sampling, as a number of people had been interviewed as a first step and the people who could be interviewed for the next step had already been identified.

By the same token, there are also some areas where the design could be improved further. Having discovered in this study that the trainers' learning and knowledge exchange relations extend beyond their organisational and professional boundaries, it would be useful to use probable sampling and allow the boundary of the networks emerge naturally. In addition, measuring data at different points in time could also provide a better understanding of the networks by looking at their development over time.

CHAPTER THREE. SOCIAL NETWORKS AND INFORMAL LEARNING

The increasingly dynamic work environment in today's organisations has an important implication for learning needs. Formal classroom training is not adequate to fulfil the learning needs in such a demanding environment, compelling workers to resort to informal learning opportunities in order to stay competitive or survive in their careers.

Despite suggestions of the important role of informal learning for employee development, informal learning is still largely overlooked. The reason is partly due to the tacit nature of informal learning, but more importantly because of the incompatibility of informal learning with the prevailing views underlying the understanding of learning. To better understand and exploit the benefits of informal learning requires a change in the conceptualisation of learning from an individualistic view to a more social and relational perspective.

This chapter establishes the framework of the study by exploring the literature on learning and social network, and finds out how these two social phenomena are related. Knowledge of informal learning characteristics can elucidate the relevancy of a social network as a perspective and as a method of investigation in this study. The Chapter argues that informal learning is essentially a social and a relational process and that a social network approach is fruitful in studying the structure of informal learning relations beyond metaphorical level.

The chapter starts by addressing the significance of informal learning, highlighting the richness of its content and the vastness of its scope. It argues that despite the significance of informal learning, there are some factors that prevent its effective use for employee development purposes. It also shows that formal and informal learning can augment each other and that informal learning is able to complement formal learning by delivering the type of knowledge that is not practical or not possible to deliver through formal classroom based instructions. Next, it argues that to adopt informal learning requires a change in conceptualisation of learning from the current individualistic to a more social and collective view. It shows that learning is inherently a social and a relational process. It supports this view by demonstrating that the conceptualisation of learning has developed from cognitivist and positivist paradigms locating learning inside the minds of individuals to a more sociological perspective situating learning within the context of social interactions among individuals. Finally, it shows that a social network perspective provides a more powerful conceptualisation of informal learning in organisations.

The Significance of Informal Learning

Torraco (1999, p. 249) argues that today "the nature of work continues to evolve from predictable, deterministic patterns to forms that are more contingent and idiosyncratic". Similarly, Taylor (1997) emphasises that for organisations, being at the leading edge of their field is vital for their survival. Such a trend has an important learning needs implication, as employees are compelled to learn faster and in a continuous mode in order to keep up and to cope with the changes around their jobs.

Due to the episodic, time and space dependent nature of the traditional classroom-based formal training programs, they are insufficient to fulfil such ambiguous and on-going learning demands of the increasingly contingent and dynamic work environment. For example, the traditional capacity building approach which employs isolated workshops and occasional technical assistance has been criticised as simply does not respond to the learning needs of the individuals and organisations involved (see PACT, n.d.). In addition, employees as adult learners are often active, progressive, reciprocal (Puliyel, Puliyel *et al.*, 1999), self-directed and problem-oriented (Cross, 1981), characteristics which are incompatible with some of the principles embodied in the traditional formal training programs. Consequently, employees and/or organisations have to resort to informal learning in order to fulfil part of their learning needs, and to remain competitive and to keep up with changing demands.

In this thesis, informal learning, in contrast to the formal training programs, is captured in several definitions and descriptions by various researchers. Informal learning can be defined as “any learning that occurs in which the learning process isn’t determined or designed by the organization” (Day, 1998, p. 31), unplanned (Marsick and Watkins, 1997; Boekaerts and Minnaert, 1999), and normally constituting long-term, non-institutional, and learner-controlled processes and outcomes (Rusaw, 1995). Informal learning is the pursuit of understanding, knowledge or skill without the presence of externally imposed curricular criteria (Livingstone, 2001), or which is not constrained by 'prescribed frameworks' (Gorard, 1999). There are other terms used by researchers which also stand for informal learning, such as incidental learning (Marsick and Watkins, 1997; Boekaerts and Minnaert, 1999), invisible learning (Taylor, 1997), free-choice learning (Falk and Dierking, 1998), non-taught learning (Taylor, 1997; Gorard, 1999), and self-directed or self-planned learning (Cross, 1981; Schugurensky, 2000)

Leslie, Aring and Brand (1997) suggest that "informal learning is a function of the context in which both organization and individual operate". Drawing on the studies associated with the Teaching Firm project, they point out that people learn and develop skills informally in three main areas: intra-personal skills such as problem-solving, creativity, coping with stress and dealing with novel situations; inter-personal skills such as interacting, cooperating, and sharing; and culture such as organisational practices, norms and values (Leslie *et al.*, 1997). Similarly, Gherardi, Nicolini and Odella (1998) note that in addition to learning specific skills, people also learn the local criteria of accountability, the specific set of values sustained by the community, and the local patterns of power relations, together with the proper strategies to cope with them.

The amount of learning that takes place informally should not be underestimated. It takes place simultaneously with the other daily routines at work. Researchers have shown that 70 to 90 percent of learning actually takes place informally (see Leslie *et al.*, 1997; Day, 1998; Low *et al.*, 2001). In studying four different professional groups, Daley (2001) found that for the professionals, attending formal training programs is only a way to reaffirm what they have already known or experienced in the course of their practice.

More specifically, Leslie *et al.* (1997) report the finding of the Bureau of Labour Statistics, suggesting that 70 percent of all workplace learning may be informal. Low *et al.* (2001) document the findings of other researchers who also report a high proportion of informal learning, including the finding of Morrison and Brantner (1992) in which they suggest that experience accounts for over 70 percent of adult workers' development, despite the plethora of formal training courses arranged by employers; as well as those of Brinkerhoff and Gill (1994) and Lovin (1992) in which they claim an even higher proportion of informal learning, that is, 90 percent in the workplace.

In addition, in examining the way health professionals in three African countries learned new management skills, a study found that formal training courses only played a part in one third of the new management practices learnt (Low *et al.*, 2001). Copeland and Wiswell (1994) also assert that specific job knowledge, acculturation, and interpersonal norms are derived in large part from mentors, supervisors, and co-workers (in Reio and Wiswell, 2000).

Despite its pervasiveness and its important role, however, informal learning has been largely discounted in human resource development in organisations. Employee development has been primarily carried out in the form of formal training programs, particularly those delivered through the traditional classroom-based mode of instruction. Richter (1998), for instance, points out that social constructionist theories of learning that emphasise informality, improvisation, collective action, conversation and sense making are still a somewhat overlooked framework for the exploration of organisational learning process and theory. Gorard (1999, p. 437) also indicates that "there has been little empirical research into learning that does not take the form of institutionalised, accredited participation in formal education and training". In addition, Van der Krogt (1998) argues that human resource management theory is still focused more on training and less on learning.

One reason for this has to do with formal training programs being attuned to the principles of today's organisational arrangements, which are largely based on the principles of bureaucracy. Although there has been a tendency to move away from rigid bureaucracy in more developed countries, the underlying bureaucratic dimension is still prevalent in general. As Ritzer (1996) argues, the rational procedures of bureaucratic practices expand continuously and permeate virtually all aspects of society. Such principles are highly compatible with the rationality and predictability of formal classroom learning, which is intentional, and prescribed by formal curriculum, competency standards and learning outcomes (Hager, 1998). This conception of learning is based on the cognitivistic school, which is underpinned by psychology of learning. It is important to note that the psychology of learning is more established than the sociology of learning, if the latter is at all. The application of learning paradigms, such as behaviourism, cognitivism and constructivism, is generally directed towards formal classroom instruction, despite the fact that these learning paradigms can be applied in informal learning contexts.

Another reason why informal learning is overlooked is related to its tacit nature (Hager, 1998). Informal learning is not necessarily a conscious or a deliberate effort, but it is embedded in everyday activities. Consequently, as Gorard (1999, p. 438) suggests, "it is likely that much of the learning that goes on in work is unnoticed by researchers and even by employers, who may, nevertheless, unwittingly depend on employees learning informally". In fact, even the learners themselves are often unaware of undertaking such implicit learning processes (Hager, 1998). As Livingstone (2000) suggests, self-reported estimates of informal learning and training very likely substantially underestimate the total amount of informal learning that people do because of the embedded and taken-for-granted character of such tacit learning.

However, the fact that informal learning takes place whether or not people are aware does not preclude the need to cultivate such learning. Wenger and Snyder (2000b) point out the paradoxical nature of communities of practice, a type of informal learning context, arguing that although such communities are self-organising and are resistant to supervision and interference, they do require specific managerial efforts to develop them and integrate them into an organisation. Thus, deliberately leveraging informal learning may bring greater benefit for individuals and for their organisations.

The characteristics of each learning mode, however, indicate that informal learning is not an alternative to formal training programs; nor that formal training programs can replace the informal learning. The two are mutually complementary instruments for employee development. Each learning mode has its own weaknesses, which are offset by the strengths of the other.

Generally, the formal training programs are effective in delivering structured or formalised knowledge and developing skills in dealing with predictable work routines and procedures to a large number of participants simultaneously. As Day (1998) points out, the formal training is more appropriate for standardised knowledge, such as safety procedures. However, employees also require specific knowledge and skills to deal with the contingent and context specific nature of their work which is difficult, if not impossible, to develop or transfer by means of formal training programs. Informal learning is more effective in this regard.

The differences between informal learning and formal programs of instruction reveal the areas of learning in which each mode of learning is effective, and show how these two learning modes complement each other. These underscore the need to try to better understand the process by which, and the structures within which, informal learning occurs.

Characteristics of Formal and Informal Learning

The differences between formal and informal learning are primarily related to the relevancy between the learners' needs and what they actually learn. The differences are discussed in terms of who determines learning needs, who is in control during the learning process, as well as time and space constraints and contents of each mode of learning. In general, informal learning is highly relevant to the learners' personal needs; thus, it can complement the formal training program which is externally imposed in many respects.

Informal learning may be spontaneous, immediate, and task-specific (Day, 1998). It is driven by intrinsic motivation and, therefore, it is voluntary, self-directed, self-discovering, flexible, open-ended and, more importantly, it takes place in natural social environments (see Boekaerts and Minnaert, 1999). Thus, informal learning is custom-tailored to the needs of individuals. In contrast, formal classroom training is often externally imposed in response to what other people, usually the managers, think the learners should know to be able to carry out their tasks (McElroy, 2000). As Skruber (1987) argues, bureaucratic organisations often rely on behaviourally oriented approaches to learning, at the expense of the real need of the individuals concerned.

Leslie (1997) and Day (1998) believe that because informal learning is need-specific, its content is extremely relevant to the learner's need, while that of formal learning is of variable relevance. In other words, the gap between what learners know and what they are to learn is narrower in informal learning because they learn incrementally according to needs. This is in contrast to the variable gap depending on learners' previous experience and knowledge in formal training (Day, 1998). This suggests that informal learning is more relevant to the specific needs of individual learners and, therefore, informal learning can compensate for what is missing from the externally imposed contents in the formal training program.

The difference can also be seen in terms of the role of the trainer and the learner in the learning process. Hager (1998) points out that the role of learners is central in informal learning, whereas in formal learning the trainers are in control and usually put an emphasis on teaching and its content. In addition, the trainers are accountable for results in formal learning, as opposed to the constructivist nature and the absence of standardised reported results in informal learning (Leslie *et al.*, 1997). This further indicates that in informal learning, content, place, time and method of learning are more relevant to the need of the learners as, according to Cross (1981), the learners are in control of the day-to-day decisions about what subject matter to cover, how to cover it, and when and where to carry out the learning efforts. This also suggests that learners are able to fulfil many aspects of their learning to compensate for what they cannot do in the more teacher-centred formal training programs.

In terms of time and place, informal learning brings learning activities and work practices closer together. Informal learning can take place naturally and spontaneously (Leslie *et al.*, 1997; Day, 1998; Hager, 1998) in an on-going manner, as well as at virtually any time and in a variety of settings outside the classroom, such as in the workplace, in meetings, or during breaks. This suggests that informal learning can occur in places where the knowledge learned is to be applied (Leslie *et al.*, 1997). As Hager (1998, p. 526) points out, "workplaces are by definition socio-culturally located and their consequently shared and site-specific experiences collectively available for educative purposes". The formal classroom learning, on the other hand, occurs in episodic mode within specific times and places, usually away from the workplace (Gherardi *et al.*, 1998). Therefore, what has been learnt informally tends to be applied immediately, while in formal learning there is a variable temporal gap to application (Leslie *et al.*, 1997; Day, 1998). Thus, informal learning can compensate for immediate learning needs which cannot be delivered by the time and space dependent formal training programs. Informal learning can incrementally complement the knowledge gap left by formal training programs which only take place periodically.

In terms of content, informal learning content seems to be richer, covering practical skills, intra-personal skills, inter-personal skills and cultural awareness (Leslie *et al.*, 1997; Day, 1998; Hager, 1998). However, formal training programs only cover the practical skills (Day, 1998).

The types of knowledge required by workers in carrying out their tasks also reveal why the formal training program alone is inadequate, and why informal learning is a necessary complement to the formal programs of instruction.

Dimensions of Knowledge

Formalised knowledge is only one of the two types of knowledge that workers require in carrying out their tasks. There are many contingent situations that require quick solutions, thus compelling the workers to learn and acquire or develop specific knowledge which has not been documented anywhere. Obviously, as implicit in the differences between formal and informal learning above, the formal training program which is time and space dependent cannot fulfil such needs.

Polanyi (1958; 1967) divides knowledge into tacit and explicit dimensions. Tacit knowledge is personal, contextualised, actionable, hard to explicate, and built into the practice and performance of the knower. Kusterer (1978) uses the term “working knowledge” to refer to tacit knowledge and argues that such knowledge is indispensable to the production process, and yet it is informally learned. The importance of tacit knowledge is also due to its immense proportion, which is bigger than that of explicit knowledge. This is reflected in Polanyi's (1967) claim that "we can know more than we can tell" (p. 4). Tacit knowledge is what people develop through "double-loop learning" (Argyris and

Schon, 1996), that is, learning to change underlying values and assumptions, rather than what is visible on the surface. Nonaka and Takeuchi (1995) attribute the success of many multinational companies in Japan to their ability to promote creativity and innovation through sharing tacit knowledge among employees.

Explicit knowledge, on the other hand, is easy to express because it has been formalised or structured, and it can be found in books, manuals, organisational routines or in general conversations. Krebs (1998) refers to such hard knowledge as "data" which can be found in computers and other traditional knowledge repository such as filing cabinets; and tacit knowledge as "intelligent" which can only be found in biological and social systems. Some believe that tacit knowledge is more valuable than explicit knowledge. Explicit knowledge can be effectively transferred through taught formal training programs, while tacit knowledge is developed incrementally over time through interactions in the workplace.

Therefore, the inadequacy of formal training programs in delivering the complete set of knowledge and skills required by workers to effectively perform their tasks is not necessarily due to the poor quality of these programs. Even a well managed formal training program cannot fulfil all learning requirements. Rather, their inadequacy is due to the fact that there are kinds of knowledge and skills beyond the capacity of formal training programs to deliver, which are integral to the informal learning.

Precluding informal learning, therefore, leaves this potentially effective and economical tool for employee development unexploited. It also means ignoring part of the knowledge and skills which play an important role in enabling workers to carry out their tasks. Leveraging informal learning, however, poses some challenges, which require a change in how we conceive of learning.

Social Perspective of Learning

As previously indicated, human resource development in organisations is still largely based on formal training programs, which adhere more to bureaucratic principles, thus masking the important role that informal learning plays in the background. The invisibility of informal learning is also due to its tacit nature. To understand, to appreciate and to exploit the benefits of informal learning requires a shift in conceiving of learning from an individualistic to a more social perspective. The social perspective assumes learning is at once a social and a relational practice.

Social Character of Learning

The social character of learning is well established in the literature. Many social scientists argue that knowledge, as part of learning, is socially constructed (see, for example, Mead, 1934, Witgenstein, 1953, Burger and Luckman, 1966 in Borgatti and Cross, 2003; as well as Borgatti, 2005b), and the creation as well as the interpretation of knowledge is inherently a social process (Cross *et al.*, 2001c). Jarvis (1987) argues that "learning is a rich social process and to restrict it to the individualistic processes of some psychological research is to render it a disservice" (p. 14). In addition, Cross *et al.* (2001c) argue that receiving information, as part of the learning process, involves more than just individual attributes, but also structural factors, comprising organisational factors, such as functional similarity, hierarchical proximity, task interdependency, and spatial proximity; as well as social factors, such as influence, trust, friendship, and gender. Furthermore, drawing on the findings of the Palo Alto based Institute for Research on Learning on how people learn, Stewart (1996) notes that "learning is social: However romantic the image of the scholar bent over his desk in a pool of lamplight, learning happens in groups".

Drawing on Weick and Roberts (1993), Torraco (1999, p. 257) notes that "in the group context, learning is a collective activity in which members of a group construct their actions, understand that the system consists of themselves and others, and interrelate their actions within the system".

A discussion of the trend in the development of learning theories, which progresses from an individualistic view to a more collective and social interpretation, can further help highlight the social nature of learning.

The Development of Learning Paradigms

The development of thinking on learning has encompassed several major theoretical breakthroughs as signified by three particularly important paradigms, including behaviourism, cognitivism and constructivism. This section only gives a brief account of each paradigm because the main objective is primarily to show the trend in the development of thinking about learning.

Behaviorism arose from an attempt to study human nature scientifically, hence to establish psychology as a science. Essentially, behaviourism views the human mind as a black box (Prestera, 2002). Mental constructs, according to behaviorists, are subjective and are not observable; therefore, they cannot be studied scientifically (Murphy, 1997). Such a view stems from Watson's (1913) "doctrine of behaviorism", which was later re-emphasised by Skinner in his "Radical Behaviorism" in the late 1930s and 1940s (in Harzem, 2004). As Watson (1970) notes, behaviorists in 1912 decided to get rid of subjective mental constructs such as sensation, perception, image, desire, purpose, thinking, and emotion because they cannot be subjected to scientific examination. Harzem (2004) further notes that according to Watson, for psychology to have the same credibility as the natural sciences, it must only study publicly observable phenomena, namely behaviour, and consequently must develop methods for publicly observing behaviour.

From behaviorists' point of view, learning is essentially a change in overt behaviour as a result of stimuli and responses. This is clearly indicated in Skinner's (1954; 1957) theory of operant conditioning, suggesting that behavioural changes are shaped gradually over time through positive and negative reinforcements and punishments. Thus, a human being is reduced to a biological machine whose behaviours are determined by external conditioning. It is apparent from the principles of behaviourism that the focus of investigation is at individual level. That is, it examines the changes in the individual's overt behaviour as a sign of learning.

Many believed that the stringent focus on observable behaviour demanded by the behaviouristic school restricted its usefulness, thus giving rise to a new learning paradigm known as cognitivism. Cognitivism challenges the basic assumption of behaviourists, claiming that the brain is not a black box, and that mental processes can, and should, be studied empirically (Mergel, 1998). The fundamental difference between behaviourist and cognitivist views rests on the change that signifies learning process. To behaviourist, learning is a change in behaviour, while for cognitivist it is a change in mental states.

It can be seen that in cognitivism, the unit of analysis still centres on individuals; in this case, it takes the mind of the learner as the subject of investigation, and conceptualises learning as an active mental process on the part of the learner. Further development in traditional cognitivist thinking, however, showed a tendency to acknowledge the significance of the learning environment in influencing the construction of knowledge. To pursue this new development, some cognitive psychologists departed from the positivist and objectivist view to new school of thought assuming that knowledge is tentative, situational and constructed by people as they interact with their environment (Moore, 1998). This paradigm came to be known as constructivism.

Constructivism departs from the brain-centred bias of cognitive psychology by assuming that knowledge is not an objective and absolute reality. Constructivists assume that there is no such thing as knowledge "out there" independent of the knower, but only knowledge we construct for ourselves as we learn (Murphy, 1997). Implicit in this assumption is that knowledge is tentative, depending on how individuals construct it as they interact with, and receives cues from, their social environment.

Constructivism recognises the importance of the social environment in providing stimuli to learning. Moore (1998), for example, notes that the traditional cognitive theories of learning have moved from "an egocentric perception, where ability is considered as a function peculiar to individuals, toward a more interactive process of assimilation and accommodation with the environment" (p. 162). Quoting Mayer (1996), Moore (1998) further notes that 'cognitive psychology is developing a more constructivist interpretation of learning .... in which mental activity is viewed more as "effortful construction (p. 157)" than as mere data processing' (p. 163).

Bruner (1966), sometimes credited with first setting out the primary tenet of constructivism, argues that the learner constructs his or her own meaning of experiences as he or she interacts with the world (in Prestera, 2002). Subject matter is assumed to emerge from the cues provided by the environment and from the dialogue among the learning community (Stein, 1998). It is obvious that the social character of learning is recognised in constructivism.

As the discussion so far shows, the three learning paradigms developed gradually from individualist thinking (behaviourism and cognitivism) in which individuals were regarded as the primary source of ability towards a more situative and sociological conception of learning (constructivism). The constructivism can be seen as an extension of cognitivism, and it clearly marks the transition towards the more social interpretation of learning.

Situated Learning and Communities of Practice

The constructivism underpins further social conceptualisation of learning. The consideration of learning context in constructivism reaffirms the social character of learning, giving rise to various notions which assume the context sensitive nature of learning, such as situated cognition (Gersten and Baker, 1998; Moore, 1998), situated curriculum (Gherardi *et al.*, 1998) and situated learning (Lave and Wenger, 1991; Singleton, 1998; Stein, 1998; Nidumolu *et al.*, 2001). The common thread in the concepts above is that knowledge is tentative, context-dependent, and detail-oriented as it is created and co-created by individuals working within a field of practice. Situated cognition theory conceives of learning as a sociocultural phenomenon, rather than the action of an individual acquiring general information from a decontextualised body of knowledge (Kirshner and Whitson, 1997 in Stein, 1998).

It is obvious that situated cognition emphasises the importance of an authentic work environment as the locale of learning, suggesting that all meaningful learning takes place in relation to real life contexts or situations. Stein (1998) notes that to situate learning means to place thought and action in a specific place and time, as well as to involve other learners, the environment, and the activities to create meaning.

This idea is further advanced through the conceptualisation of the learning environment as a "community of practice" (see Lave and Wenger, 1991; Richter, 1998; Wenger and Snyder, 2000b; Gherardi, 2001); that is, a collection of people who share common work practices and interests, and who engage in mutual learning (Lesser, Fontaine *et al.*, 2000).

Through a community, learners interpret, reflect, and form meaning. The community provides the context for the social interaction with others in which learners are exposed to diverse perspectives (Lave and Wenger, 1991; Brown and Duguid, 2000). By learning from the experience of their colleagues, employees can work more efficiently (See also Argote, Ingram *et al.*, 2000; Poell, Chivers *et al.*, 2000).

Lave and Wenger (1991) place the acquisition of knowledge in the context of social relationships that they refer to as "communities of practice". Legitimate peripheral participation (Lave and Wenger, 1991), which is the way members of communities of practice learn, is relational in nature. They suggest that situated learning involves social interaction and negotiation in communities of practice that leads to a dynamic, reciprocating relationship between understanding and experience. In their analysis of learning in five different settings, Lave and Wenger report a gradual acquisition of knowledge and skills as novices start learning simple peripheral tasks from their expert colleagues and advance to the more central and complicated ones in the context of genuine everyday activities in the workplace.

Implicit in the concepts of community of practice and situated learning is another trait of learning; namely, its relational nature. Cross *et al.*(2001c) argue that the situated learning literature has strictly demonstrated the importance of relationships in the workplace. The conception of learning as a relational process, however, is not commonplace and, therefore, constitutes another challenge in fostering informal learning.

Relational Character of Learning

Human beings cannot live a solitary existence. They need to relate to other people in virtually all of their activities, including in learning. The relational character of learning has been widely implicated in the literature. Research has consistently demonstrated that “who you know” has an important effect on “what you know”, hence “how you do” (Richter, 1998; Grootaert, 1999; Krebs, 1999; ID21, 2000; Cross, Parker *et al.*, 2001b; Carley and Hill, n.d.). In addition, Gherardi *et al.* (1998, p. 274) explicitly indicate that “learning ... takes place among and through other people”. Similarly, Richter (1998) suggests that learning is a social practice and that knowledge grows out of the interplay between interpersonal relationships and everyday "sensemaking" activities in the workplace context. In describing how executives learn, Richter (1998) further states that an individual executive is both defined by and defines relations, and learns through participation and sensemaking processes across a variety of contexts.

Experts unanimously demonstrated that informal opportunities such as dialogue with colleagues facilitated workers' learning (Taylor, 1997). In fact, Cross (1981) reports that in self-planned learning, which is a form of informal learning, the involvement of human interaction is higher compared to that in classroom learning. More specifically, the findings of the Honeywell study suggest that 30 percent of the ways in which managers learn to manage comes from interpersonal relationships (Marsick, 1987).

In fact, the relational character of learning has started to emerge in constructivism, where learning is seen as a process closely associated with the learner's connection with other human beings. As Mergel (1998) notes, "Constructivists also believe that much of reality is shared through a process of social negotiation...".

In studying twenty adults who are undertaking doctoral program, Barlas (2001) found that learning-within-relationships emerge from and underscore almost every learning experience recounted by the study participants. In addition, Sternberg (n.d) argues that individuals rely on one another's knowledge and the information in the environment to access and stimulate their own abilities (in Moore, 1998). Drawing on the extant studies, Cross, Rice and Parker (2001c) further specify the importance of social relationships for learning in many respects, including in acquiring information, learning how to do one's work, and collectively solving cognitively complex tasks.

Thus, to be able to appreciate and exploit informal learning, a social and a relational perspective should be employed. The focus needs to shift from individuals and their attributes to the collection of individuals and the relationships that bind them together.

Social Network and Informal Learning

A social network is generally defined as a set of actors and the social relations linking them (for example, see Knoke and Kuklinski, 1982, p. 12; Wasserman and Faust, 1994, p. 20; Klovdahl, 1997, p. 684; Borgatti and Foster, 2003, p. 992). Social network perspective has been widely used in characterising various social phenomena.

For instance, organisations, which are conventionally perceived as hierarchies, may alternatively be conceived as a structure of interpersonal relationships. Such view is normally applied to the informal organisations. For example, Krackhardt and Hanson (1993) note that the formal organisations can be thought of as the skeleton of the organisation, but the informal one, that is the network of interconnections among organisational members constitutes the "central nervous system" (p. 104). Using a slightly different metaphor, Krebs (1999) refers to the hidden informal network as an X-ray of an organisation. More specifically, Podolny and Page (1998, p. 59) define the network form of organisation as "any collection of actors ($N \geq 2$) that pursue repeated, enduring exchange relations with one another and, at the same time, lack a legitimate organizational authority to arbitrate and resolve disputes that may arise during the exchange". Although social networks have often been applied to informal organisations, Podolny and Page (1998) contend that even a formal hierarchy in a complex organisation may be seen as a network; that is, a centralised network where ties mostly flow to or from the top manager (see also Borgatti, 1997).

The principal argument is that social networks, also often regarded as informal organisations, play an important role and make a considerable difference in organisations. As early as the 1920s, the human relations school of management theory has paved a way to understanding the important role of social networks in organisations. A study conducted by Elton Mayo and colleagues at the Hawthorne Plant of the Western Electric company found that workers were not just economic beings but also social animals, and so there is more to bureaucratic organisation than just formal routines and financial compensation (see Borgatti, 2000; Van Krieken, Smith *et al.*, 2000). Workers can fulfil some of these needs by forming informal organisations. The tendency for people to develop relations with their colleagues can also be seen in Blau's (1963) study which suggests that despite formal rules and procedures, employees create their own informal ways of accomplishing their jobs, which are equally if not more effective.

The roles and the effectiveness of social networks are well known. For example, Kapferer (1969) found that the structure of interactional relationships of disputants affected support mobilisation, and ultimately the opportunity to win in an industrial dispute. Krackhardt and Hanson (1993) show that despite the formal organisations, much of the real work gets done through informal organisations, which constitute a complex network of relationships that cross functions and divisions. They illustrate this by demonstrating that CEO's understanding of communication, advice and trust networks helps them formulate solutions to their various organisational problems. In addition, Burt (1992) found that the rate of promotion correlated with structural holes in the network. Similarly, Podolny and Baron (1997) also demonstrate how social networks affect job mobility within an organisation. Furthermore, Sparrowe, Liden, Wayne and Kraimer (2001) found centrality in advice-networks correlated with individual performance.

Learning, which is an important and an integral part of organisational life, can also be seen from its informal side using a social network perspective. As Cross, Rice and Parker (2001c, p. 438) stress, "given the centrality of social interaction as a vehicle for knowledge creation and learning, it is important to better understand these processes from a social network perspective". The pivotal role of social networks is clearly implicated in the discussion regarding the social and, especially, the relational nature of learning in the previous section.

One of the facilitative roles of social networks in learning is that they can become vibrant media through which knowledge, information, products, skills, expertise and even personnel can be exchanged (Taylor, 1997). Such vibrant learning environments can facilitate the development of a broad range of knowledge and skills, encompassing know-how, technical skill, and cultural awareness, which are acquired and developed through interaction with fellow workers by way of sharing ideas or exchanging resources (see Leslie *et al.*, 1997; Day, 1998). In addition, Carley (n.d.) notes that relationships among individuals can facilitate individual access to knowledge and serve as a form of organisational knowledge. This is attributable to the capacity of social networks to preserve a greater diversity of search routines and to convey richer, as well as more complex information (Podolny and Page, 1998), which can be passed on through these networks.

More specifically, Podolny and Page (1998) argue that there are two ways in which network forms of organisation can foster learning. First, "they encourage learning by promoting the rapid transfer of self-contained pieces of information" (62); and second, they can yield new knowledge "by encouraging novel syntheses of information that are qualitatively distinct from the information that previously resided within the distinct nodes" (p. 63). Such network support is available irrespective of whether or not the learners are aware (see Borgatti, 2005b).

At an organisational level, Hamel (1991) shows how inter-firm collaborations provide participating firms with opportunities to internalise one another's skills. Using a metaphor, Hamel associates the collaborative exchange as a membrane through which learning resources such as people, facilities and documents penetrate from both sides.

In studying working knowledge in the factory floor, Kusterer (1978) clearly demonstrates the instrumental role of social networks in informal learning. In fact, he shows that social networks and informal learning are mutually enhancing. On the one hand, social networks facilitate informal learning. As Kusterer (1978) finds, 'acting together through communal networks, workers are able to use their knowledge to carry on an informal "craft administration" for the production of useful goods and services ...' (p. iv). On the other hand, Kusterer also contends that working knowledge constitutes a glue for the formation and maintenance of work communities (multi-faceted informal relations among workers), and overcomes social isolation and alienation.

In addition, drawing on an early study on student culture in medical school, Becker, Geer and Miller (1972) demonstrate the inevitability of informal learning and the facilitative role of informal social relations and social exchange in such learning. The study shows how medical students turned to one another as a learning and coping strategy during their period of doubt and confusion as freshmen, and how they learned from their superiors' practical tips on diagnosis and treatment – they called these "pearls" – while working in hospital environment during their clinical years.

The role of social networks in learning is also reflected in the fact that informal learning involves a large amount of tacit knowledge. The usefulness of the tacit knowledge, however, can be optimised only if it is shared. Sharing such knowledge is apparently a difficult process precisely because, as discussed earlier, it is intangible, personal, context-specific, and it resides in the experience and skill of human beings, thus is hard to represent in a formalised form (Horvath, 2001; ARDA, n.d.).

According to Nonaka and Takeuchi (1995), to be able to explicate and exchange tacit knowledge, it has to be initially made explicit, for example, through a process of externalisation which may take place through sharing metaphors and analogies during social interactions. In addition, to transfer tacit knowledge, it requires long-term observation of people who have the knowledge, such as through mentoring and apprenticeship programs (Taylor, 1997; Davenport and Prusak, 1998).

The fact that a large proportion of knowledge is tacit, and that tacit knowledge is difficult to exchange or share further suggest that social networks have important role to play in informal learning. Social networks can be facilitative in co-creating tacit knowledge by providing an environment in which people can be exposed to one another's viewpoints or methods of work. People hold conversations and expose one another to the possibility of becoming not just different, but better and more capable as a result (Zemke, 2001)

By co-creating tacit knowledge, the knowledge is automatically and simultaneously shared by those involved in the collective knowledge construction. These knowledge transformations, as described by Nonaka and Takeuchi (1995) are essentially relational processes. Social networks, therefore, can become a medium through which the process of knowledge transformation takes place

It is important to recognise, however, that the barrier to tacit knowledge exchange, as part of learning, is not solely due to difficulty of explicating such knowledge, but is also influenced by personal interest. Thus, the flow of knowledge in a network is neither free nor is it uniform. According to an actor politics perspective, "actors negotiate with each other, engage in conflict, compromise, form coalitions, and so on, in an attempt to shape the learning system structure and processes to their own best interest" (Van der Krogt, 1998). More specifically, Davenport, Eccles and Prusak (1992) argue that information has become the key organisational 'currency', and that people regard it as too valuable to just give away. Therefore, Stenmark (2000) suggests that lack of proper reward mechanisms on the individual level will effectively hinder sharing of ideas regardless of potential organisational benefits.

This implies that tacit knowledge, which many believe to be more valuable (see, for example, Polanyi, 1967; Nonaka and Takeuchi, 1995; Horvath, 2001), is even more difficult to share because it constitutes a competitive advantage. Some suggest that even if technically it is possible to exchange tacit knowledge, people may still be unwilling or reluctant to do so because of the competitive value of tacit knowledge.

With regard to the competitive value of tacit knowledge, Leonard (1998) indicates that our tacit knowledge may be considered a valuable competitive advantage that we would not want to share with others without getting something in return (cited in Stenmark, 2000). As Carter (n.d.) also argues, it is naive to assume that it is in the best interest of employees to have their personal knowledge turned into organisational knowledge. Citing Kamoche (1998), Carter and Mueller further note that there is some evidence showing employees are reluctant to freely share their tacit knowledge in the context of team-working and problem-solving groups.

The role of social networks in this regard is to provide a medium through which people may exchange tacit knowledge naturally, without being too competitive and conscious about what knowledge to give and what to gain in return.

It follows from the arguments above that social networks can provide a richer learning experience. A network can provide access to both human knowledge sources and non-human knowledge repositories. It can also facilitate exchange of tacit knowledge. In other words, network members have the benefit of being able to seek information directly from their network ties or obtain direction about how to find (the source of) the information that they seek. The dimensions of advice networks (Cross, Borgatti *et al.*, 2001a) are a good illustration of how social networks can provide not only direct information benefits in the form of solutions, but also additional learning benefits in the form of information on where to find solutions, which they refer to as meta-knowledge; as well as other benefits such as problem reformulation, validation and legitimation.

The fact that the conception of learning is also inherent in network concepts and studies further shows the close relationship between social networks and learning. Many of the standard concepts in social network analysis, for example, measures of *centrality* such as *degree*, *closeness* and *betweenness* (Freeman, 1979) are consequential to the kind as well as to the level of access that network members have to the resources that are embedded in their networks. In fact, learning is even inherent in network studies which were not designed to investigate learning. In a study of how people search for jobs, the instrumental role of "weak ties" (Granovetter, 1973; 1982) in providing access to non-redundant job information is parallel to the role of such network ties in providing access to non-redundant work-related knowledge, ideas and information in a learning process. In a different study concerning career mobility, Burt (1992) shows that spanning many "structural holes" or network chasms affects actors' job promotion due to access to strategic, non-redundant information or knowledge. Thus, it can be assumed that access to non-redundant information, either through weak ties or structural holes, is also instrumental in learning processes and in fostering innovation. Indeed, in epidemiologic studies (see among others Klovdahl *et al.*, 1994; Curtis *et al.*, 1995; Friedman, 1996), the characteristics of networks that cause the diseases to spread is comparable to how the networks may facilitate the diffusion of knowledge, ideas or innovation as part of learning processes.

The advantages of using a social network perspective is that it can extend the context of learning beyond the immediate or physical organisational or group boundaries. Limiting the boundary of learning environments has been widely criticised. For example, Araujo (1998, p. 317) argues that "the organizational learning literature relies mainly on a topographic view of organizations and ...regards the organization as a container of knowledge and a locale of learning". Araujo (1998) argues further that learning should be seen as a social process that takes place in "a series of non-localizable associations between social and material elements ... that transcend and bypass conventionally defined organizational boundaries" (p. 331). The understanding of the boundaries of learning contexts as porous is especially important due to the increasingly high mobility of people and the availability of communication technologies, which can supplement the traditional face-to-face exchange of information.

Another advantage of a social network perspective is that the actual structures of the individual learning relations can be examined closely. Thus, the exact configuration of social relationships can be revealed and their effects on individual players and organisation can be explored (See for example Emirbayer and Goodwin, 1994; Molina, 2001).

To conclude, the literature suggests that informal learning has a potential role to play as part of employee development schemes. Despite having much less recognition than it deserves, informal learning continues to take place in the background to satisfy the learning needs demanded by the increasingly contingent and idiosyncratic nature of work in today's organisations.

In order to fully exploit its benefits, however, informal learning needs to be deliberately leveraged. Such an effort requires a better understanding of this intangible process. A social network perspective has the capacity to provide a better conceptualisation of informal learning by revealing its internal relational structure, so that it can be examined beyond metaphorical level.

Although the relationship between social networks and learning using a social network approach has been implicitly and explicitly discussed in the literature, the number of studies that specifically examine the structure of learning relations has been limited. Some of the existing studies in this area include, among others, the role of networks on the search for and transfer of knowledge (Hansen, 1999), the effects of networks on the learning environment of jobs (Rhee, 2000), and the effects of informal social networks within the context of formal MBA programs (Baldwin *et al.*, 1997). Thus, much more remains to be done in this line of inquiry.

CHAPTER FOUR. DESCRIPTIONS OF THE TRAINERS' ORGANISATIONS

Before discussing the characteristics of the networks in the two organisations, it is useful to address the organisational contexts in which the two groups of trainers work and learn. This is necessary as organisational contexts can have some direct or indirect consequences on networks and on the usefulness of network structures in facilitating the process of learning among the trainers.

This chapter covers several aspects of the trainers and the organisations in which they work. It starts by describing the ownership status of the organisations and the degree of independence from their parent organisations, as well as their clients and the types of services they deliver.

The chapter also addresses the physical setup of the organisations, the organisation of works and the degree of specialisations of the trainers in these organisations, career structure and incentive systems. Towards the end, the information access and information technology support as well as sociodemographic features of the trainers are presented.

Organisational Status and Services Rendered

The two organisations are very different in many respects. The GTC is a training establishment under a central government agency, while the CTU is a training unit under a government-owned company. The two training establishments also differ in terms of their degree of independence from their parent organisations. While the GTC is fully integrated into its parent organisation, the CTU constitutes a more independent business unit. They further differ in terms of their operational principles, where the GTC operation is governed by public service standards, and the CTU is ruled by commercial business principles.

Both training organisations provide services for internal clients within their parent organisations as well as offering training programs to external clients. Despite the similarity, the two organisations have different area of training services and deliver their services to different groups of external clients. The GTC provides training programs for the public servants, ranging from one day seminars or workshops to two-month residential training programs, such as managerial training programs, training for trainers, as well as policy and service management training programs. The CTU provides training programs in the area of air transportation for the aviation industry and its related businesses. In addition, the GTC is more flexible in the type of training programs delivered. In the CTU, by contrast, the training programs are more highly standardised. Many of their training programs are subject to international regulation, requiring standardised sets of teaching materials and certified trainers.

Physical Setup and Work Organisation

In terms of the physical distribution, the GTC trainers are more dispersed than the trainers in the CTU. GTC trainers are distributed into six locations. Some trainers are located in the Jakarta headquarters. Some others are located at the outskirts of Jakarta about five kilometres from the headquarters. These trainers are further divided into three groups of offices. Two other groups of trainers are located at subsidiary offices in two different provinces. One of these subsidiaries is about three hours by car, bus or train from the office headquarters, and the other is on a different island, about two hours by airplane from the Jakarta headquarters. For GTC trainers who are physically close, the common places where they usually meet and exchange information informally include their offices, trainers' halls, cafeterias and the libraries.

In contrast, the trainers in the CTU are all located in the same area. Their offices are in different buildings near each other. Consequently, the trainers have more opportunities to meet with one another in the course of their workday. They generally meet during lunch breaks, after observing daily religious prayers, during their visit to the library, as well as during weekly aerobics and sport sessions on Friday mornings.

In terms of work organisation, the GTC trainers are allowed to teach in virtually any government training centre. Frequent external assignments limit the chances for the GTC trainers to meet with one another. Even those who share the same office are not necessarily able to meet with one another every workday. The GTC trainers are generally involved more in external teaching assignments than in internal ones. In fact, having external assignments is viewed as a privilege and, to some extent, a symbol of professional recognition. Such assignments often require trainers to be away from their offices for several days, in which case they do not have time to return for the duration of the assignment. However, although work organisation limits the opportunities for GTC trainers to interact with their own colleagues, they have a higher possibility of meeting and interacting with people from outside their profession and/or organisation.

In contrast, the CTU trainers spend much of their time teaching within the CTU. Only occasionally do some trainers have external assignments to teach in on-the-job training programs in client organisations elsewhere. Consequently, they have more opportunities to interact with their colleagues but have fewer opportunities to meet people from outside.

These different work organisations, in turn, affect the type of learning resources to which the trainers in each organisation are exposed. On the one hand, GTC trainers have more opportunities to access novel and diverse information from outside their immediate environment. The CTU trainers, on the other hand, are exposed to more uniform learning resources through exchanges of information and knowledge with their own colleagues, especially those who specialise in similar areas.

Areas of Teaching Specialisation

The trainers' areas of specialisation in the CTU are much more obvious than those of their counterparts in the GTC. Each CTU trainer specialises in certain teaching subjects, which correspond to the service delivery area of his or her work unit. For many of the trainers, specialisation in particular areas is necessitated by the fact that they teach subjects that require them to have international certificates. In contrast, the GTC trainers tend to teach a broader range of subjects. The physical distribution of the GTC trainers into different units is not strictly based on their areas of specialisation but many trainers located in different units teach the same subjects.

The difference in the extent to which the trainers specialise in certain areas is clearly evident from the level of subject overlap between the two groups of trainers. As can be seen in Figure 4.1, considering the number of possible pairs of actors from 44 and 31 trainers in the GTC and CTU respectively, there is a marked difference in the number of pairs who teach one subject in common, accounting for 231 in the GTC compared to only 52 in the CTU. The difference is still high for the number of pairs who teach two subjects in common, accounting for 77 pairs in the GTC and 27 in the CTU. The difference for the higher level of overlaps is very small. It is important to note that the subject overlap in the CTU occurs primarily among trainers within the same units, while in the GTC it occurs within and between units.

As teaching is the primary task of the trainers in both organisations, the level of subject overlap has important implications for the trainers' opportunities to interact with their colleagues. This could also have implications for the learning resources that trainers in each organisation can access. For CTU trainers, they have opportunities to learn from their colleagues in the same unit, that is, the same area of expertise. The GTC trainers, in comparison, can learn from their colleagues who specialise in different areas. Thus, they are probably less likely to be exposed to redundant learning resources.

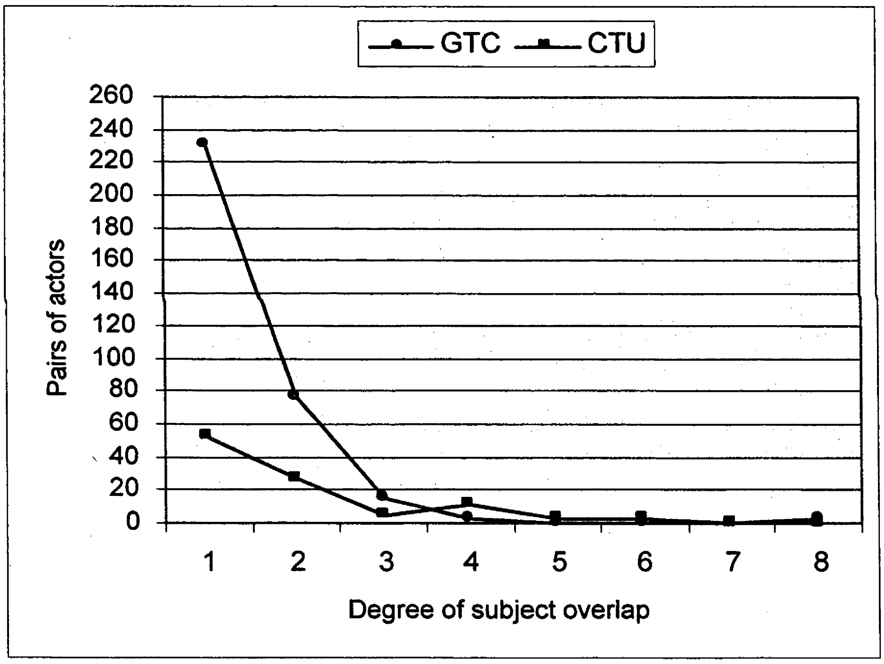


Figure 4.1. The degree of subject overlaps in the GTC and the CTU

Career Structure

The career structures in the two organisations are also very different. The GTC operates under the Indonesian public service career system. For the training career, the lowest grade is III/a, and the highest IV/e. In fact, IV/e is the highest grade in the Indonesian public service system. GTC trainers have to go through eight promotions within this range to reach the top grade of IV/e. The grade is tied to individuals rather than to the tasks. To illustrate, if a trainer leaves the training career, he or she can be promoted on the basis of his or her highest grade in the training career. Similarly, under normal circumstances, a public servant who enters the training profession would normally start at his or her current grade in their previous (non-training) work. The grade system in the CTU is much simpler and flatter. In their career structure, only three grades are recognised, including junior, senior and training expert. Under the current "job pricing" system, the grades are tied to tasks rather than to individuals. A trainer would have to leave the training profession if he or she wanted to pursue a grade higher than that associated with being a training expert.

The difference in the number and the levels of grades in the two organisations contributes to the pattern of internal interactions among the trainers. In the GTC, grade determines many aspects of the trainers' professional lives, including which training programs they are eligible to teach, and the types of activities in which they can be involved, as well as many of their other entitlements. The system discourages trainers in the lower grades from working together with colleagues in higher grades, resulting in lower frequency and intensity of interactions between trainers of different grades or ranks. In contrast, the relatively flatter grade hierarchy in the CTU allows trainers of different grades to be involved in the same activities; hence, this seems to promote interactions and exchanges of learning resources between trainers of different grades.

Incentives System

The different types of incentives, especially financial, in the two organisations also contribute to trainers' associations. In the CTU, the trainers have much higher fixed pay rates, and the financial incentives that the trainers obtain is not influenced by the number of hours they teach. Therefore, there is little economic incentive – in this business organisation – to encourage them to seek additional teaching opportunities outside the CTU.

In contrast, the GTC trainers have relatively low basic salaries. In fact, this is one of the on going complaints made by the public service trainers in general. Because they receive additional income from teaching honoraria, they are induced to seek additional teaching opportunities, many of which are available outside the GTC. As they are not constrained to only teach within the GTC, many of the trainers spend more time teaching in other government training centres. In fact, as indicated earlier, not only does teaching in other training centres provide financial benefits, but it also provides emotional fulfilment, such as sense of prestige. The trainers, to some extent, measure their effectiveness by how much their expertise is sought by other training institutions. This involves self-images of competence and professional reputation. In fact, those who do not get opportunities to teach outside the GTC are labelled "housekeepers". In addition, teaching also contributes to the credit points that the trainers have to accumulate as one of the main requirements for promotion. These multiple incentives encourage GTC trainers to pursue work relations with people from within and outside the GTC. It also leads them to interact not only with other trainers but with other people as part of building and securing long-term working relations. Consequently, they are exposed to a wider variety of associates than CTU trainers.

Information Technology Support

The CTU supports its trainers with adequate access to the Internet, which serves as an alternative source of information and a learning resource. Many of the CTU trainers point out that they gain considerable learning benefits by having access to the Internet. Some of them indicate that they get much useful information from mailing lists to which they subscribe, and others say they use email to exchange the latest information and ideas with people who work in the same areas. For the trainers who are certified by certain international bodies, use of the web pages of the certification institutions to update their knowledge in their areas is reported. In view of the state of information technology utilisation in Indonesian organisations at the time, this represents quite advanced use.

Thus, CTU trainers are able to extend their relations beyond the traditional face-to-face mode to virtual interactions with people who might have a wider range of ideas. Despite the apparent benefits of such non-traditional interactions, this study has focused only on the non-mediated relations, which are more common. That is, trainers' interaction with people through the Internet is largely *ad-hoc* in nature, while this study focuses on more stable kinds of relations. Nevertheless, it is recommended that future studies in this area should devise a method to include such interactions.

Sociodemographic Features

GTC trainers are generally older than CTU trainers. On average, GTC trainers are 53 years old, compared to 40 years old for the CTU trainers. However, in terms of length of service, CTU trainers generally have longer tenure in the training career. The average tenure of CTU trainers is 13 years, compared to only 5 years for the GTC trainers. In addition, the GTC trainers have relatively higher levels of educational qualification than those in the CTU.

This is influenced by the use of education as a formal measure of qualification in the GTC, and in the Indonesian public service in general. In other words, trainers are rewarded by their level of formal qualifications in the GTC. Trainers are generally recruited from different parts of their training units' parent organisations. About 93 percent of the trainers in the GTC were formerly managers in different units, at various levels, within the GTC's parent organisation. In the CTU, the trainers were formerly from disparate service delivery units within their parent company. These individual attributes also affect, directly or indirectly, the type of people with whom trainers might come into contact and establish learning relations with after they became trainers.

Expectations

Based on the review of the literature in the previous chapter and on the characteristics of the two organisations discussed here, it is possible to anticipate some similarities and differences in terms of the learning process and the network structures pertaining to the informal learning in which the two groups of trainers are involved.

In terms of learning process, it can be expected that the trainers from both organisations would have quite similar perceptions on and experiences of informal learning through social relations. This is due to the implicit nature of informal learning, as has been noted in the review of literature in Chapter Three, which would make the differences in organisational features relatively weaker in affecting the way the trainers learn informally. It is also expected that awareness of informal learning and its benefit would be low as such learning constitutes a covert and a taken for granted process. The bureaucratic nature of both trainers' organisations would further highlight a sense of formality, hence overshadow everyday informal learning through social interactions.

It would, however, be reasonable to expect the features of the networks for the two groups of trainers to be markedly different due to the differences in their organisational environments. In this study, the differences in the organisational status and the types of services rendered by each organisation could lead to differences in the types of people with whom each group of trainers associate. As a business organisation servicing a specific segment of the market (mostly flight industries), it is expected that the CTU would expose its trainers to people from a narrow variety of backgrounds compared to those in the GTC. However, the wider variety of training services catered for by the GTC and the higher variety of client organisations they have could bring a wider opportunity for its trainers to meet and interact with people from different backgrounds within the public service.

The differences in the physical distribution of the trainers could also lead to different network characteristics. A number of researchers have indicated that spatial arrangement and physical distance can affect the likelihood of people to establish connections. For example, in studying the spatial ecology of group formation in the Westgate and Westgate West, Festinger, Schacter *et al.* (1950) found that even differences in distance as small as 20 or 30 feet were effective in determining patterns of friendships. Likewise, Allen (1970) and Conrath (1973) indicated that the frequency of face-to-face communication dropped precipitously beyond the first 75 to 100 feet (cited in Monge and Contractor, 2003). Monge and Contractor (2003) further noted that the relationships between physical distance and communication relations constituted a reverse exponential function. That is, as the distance between two individuals is increased twofold, the probability of communication is decreased by more than a half.

As GTC trainers are more dispersed into several office locations, they are likely to have more fragmented networks compared to those in the CTU who are located within a single office complex. As a consequence, it is also likely that the GTC trainers might be connected to sparser and less reachable networks compared to those in the CTU. This different degree of physical propinquity could further result in different levels of opportunities for serendipitous meetings and encounters of trainers in the two organisations. This physical setup could also compel the GTC trainers to associate with more people from outside their own organisations compared to their counterparts in the CTU.

The way the trainers' works are organised could also lead to different network characteristics. Frequent external assignments would increase the opportunity of the GTC trainers to establish connections and gain learning resources from people in other organisations. However, this external access might limit the trainers' opportunity to build and maintain internal learning relations with their own colleagues within the GTC. This could also mean the size of the networks in the GTC if external associates are taken into account would be larger than those in the CTU. The opposite would be true for the trainers in the CTU who were appointed or recruited to mainly teach in programs conducted within their own training premises.

Areas of teaching specialisation could have a strong effect on with whom the trainers are likely to associate. As areas of specialisation are much more clearly defined among the trainers in the CTU, it is reasonable to expect that the trainers in this institution are divided into groups along this line. It should be noted that areas of specialisation coincide with the units to which the CTU trainers are assigned; hence it is possible that any grouping among the CTU trainers would also be confined within the same unit. On the contrary, groupings in the GTC would contain trainers with different areas of specialisation as they tend to have a greater number of teaching specialisations. In fact, the degree of subject overlap is higher in the GTC than in the CTU. Therefore, opportunity to make ties with people from outside the GTC might also be enhanced by their broad range of teaching specialisations.

The difference in career structure could also have impacts on the network structures. The emphasis on the hierarchy of the ranks in the GTC would affect the opportunities of the trainers in this training institution to establish connections across different ranks. On the contrary, the flatter career system in the CTU would mainly affect the level of pay but not the types of work in which the trainers are involved, hence the people with whom they are likely to interact. Therefore, it would be less likely for the CTU trainers to be divided along the rank line.

Incentive system would be another important factor shaping the trainers' networks in the two organisations. The GTC trainers who have incentive from teaching outside their organisations would make the most of this opportunity, rendering them to be more external-oriented in building their networks. For the CTU trainers, in contrast, teaching internally would be more beneficial which could drive them to associate mainly with their own colleagues.

The availability of information technology (IT) support, especially Internet access, for the CTU trainers would increase their reach to external associates. Trainers in the GTC, on the contrary, would still need direct person-to-person links in order to maintain access to various learning resources because IT support is very minimum.

Finally, different socio-demographic features could also lead to different network shapes. The most highly contrasting characteristics between the two groups of trainers are age and length of service. The older but shorter teaching experience of trainers in the GTC could encourage them to expand their relations in order to access learning and teaching opportunity structure. On the other hand, the relatively younger and longer teaching experience of the CTU trainers would be inclined to be more specialised on their existing area, hence limit their connections with people from the same specialisation.

The speculations above will be verified with the actual results of analysis of empirical data in the next few chapters, and discussed in more detail in Chapter Nine.

CHAPTER FIVE. THE ROLE OF SOCIAL RELATIONS IN INFORMAL LEARNING

Today, the pressure on professionals to learn is ever increasing, as it is necessary to maintain and improve their professional capabilities as well as to stay up-to-date. As Cross, Parker and Borgatti (2002, p. 1) note, "... even within narrow technical specialities, it is becoming more and more difficult just to stay current".

To fulfil this learning need, managers generally send their employees to relevant training programs. However, formal training programs only fulfil part of these learning needs. Although formal training programs have been effective in delivering codified knowledge, they fail to meet the specific and personal learning needs that the employees require to deal with the problems that they encounter in their daily work. To solve such problems, employees often need to resort to informal learning. According to Gorard (1999, p. 437), "much valuable and non-trivial learning already goes on, and has always gone on, outside formal programs of instruction".

Informal learning is taken to mean any leaning activities involving knowledge creation, acquisition and sharing which are not officially arranged. This is in contrast to a formal training program that traditionally takes place in educational or training institutions, which often can lead to a formal qualification, certificate or diploma. This definition of informal learning is similar to the one proposed by Leslie, Aring and Brand (1997, p. 13), which is "learning for which the process is neither determined nor specified, and which may take place inside or outside the classroom". The learner decides what to learn, where to learn, with whom and how to carry out the learning process. This is also similar to Livingstone's (2001) definition as any learning activity which occurs without the presence of externally imposed curricular criteria. One of the ways in which informal learning takes place is through social relations, such as exchange of information, ideas, tips, tricks of the trade and advice, or collaboration activities.

This chapter examines how the trainers in the two training institutions in Indonesia learn informally through their networks of informal social relations. The trainers learn when they access and acquire various skills, information, knowledge and ideas from their diverse communication, collaboration, and advice-exchange associates, which enhance their understanding and professional practices, and help solve their work-related issues. Thus, the Chapter demonstrates the importance of social relations in informal learning, hence the appropriateness of a social network approach in studying informal learning.

As a starting point here the nature of informal learning and social relations is explored qualitatively based on the in-depth interviews with the two groups of trainers. Some themes emerged from the analysis. These themes are used as the organising framework for reporting the findings in this chapter. The chapter starts by outlining the factors that stimulate the trainers to engage in informal learning. Next, it addresses the areas in which the trainers are compelled to learn informally. The issue of low awareness of informal learning and of social relations is also presented in this section. After that, the way in which informal learning takes place is discussed. The types of instrumental social relations for the trainers' learning are also addressed. Finally, the roles of social relations in informal learning are examined.

The discussion of the qualitative data refers to the informal learning processes and social networks of both groups of trainers, except where it is indicated otherwise.

Learning Drives

The trainers' job is information and knowledge intensive. Their dynamic and fast changing work environment requires them to learn in continuous, rather than in episodic mode. The data from the in-depth interviews clearly indicate that there are some factors that stimulate the trainers to engage in continuous learning mode, including the unstructured nature of their activities, the constant changes in their areas of specialisation, the need to maintain positive self-image, lack of previous experience in teaching and instruction, the need to stay competitive, and frequent unscheduled assignments.

Firstly, the trainers report that they constantly encounter problems, issues and challenges in their daily activities. These stem from the fact that there is no clear set of procedures that the trainers have to follow in carrying out their tasks; rather, much of their work requires creativity. In fact, trainers generally describe their work as an "art" that requires "creativity and personal touch". The trainers feel that they constantly encounter novel situations; each requires them to respond differently. For example, a trainer said, "Teaching the same subject to different classes requires some modification to the material and delivery strategies".

The trainers commonly find the delivery phase of the teaching activity to be the most unpredictable part of their work. Although they generally prepare an instructional plan in advance, they often have to modify or even abandon the plan on the spot if class conditions require it. This is especially true when they do not have any prior general knowledge about the class that they are going to teach, as many of their teaching assignments are given on short notice. That is why "it is important for trainers to keep developing and adding new tools into their toolboxes", so that they are ready to deal with whatever situations they face. Such dynamic nature of the trainers' activities stimulates their learning drives.

Secondly, constant changes in the substance of their specialised teaching areas also compel the trainers to learn continuously. As the GTC trainers' subjects are in the area of public administration, the rapid changes in the political, social and economic situation of the country after the economic crisis in 1990s has had implications for their areas of specialisation. The dynamic character of the business and commercial environments under which the CTU trainers operate produce the same effects. The trainers in general feel the pressure to update their knowledge of current developments so that they can relay the most up-to-date information to training participants. This is, for example, reflected in a trainer's acknowledgement that "people now can get information much more easily from various sources. [Therefore], the training participants are able to access the latest information. ... You don't want to lose credibility by presenting out-of-date information". Thus, informal learning serves as an adaptation mechanism for them to cope with their fast changing environments.

Thirdly, acknowledging that training participants have years of experience and a wealth of knowledge and practical skills in their own areas, the trainers feel that it is important to learn continuously in order to present a positive self-image in the eyes of the training participants. As a junior trainer in the GTC indicates,

> We teach adults who are knowledgeable and already possess much experience in their fields. Today, many already have had doctoral degrees. They come to the classroom with a variety of problems, questions and interests; some are unexpected, and some others are just for testing the trainers. It is important to recognise their ability, but as trainers, we must

maintain our reputation. [Question: How do you maintain your reputation?] ... demonstrating our competence by having the best possible preparation to ensure best performance, by having up-to-date materials and appropriate techniques for conducting the class. It is also important to have background knowledge of the training participants. This may seem trivial, but for me it is extremely important. (Trainer 6)

Fourthly, some GTC trainers reported engaging in continuous learning so that they can prove themselves capable of being trainers and dispel a negative stereotype that public service trainers have limited ability. This assumption originates from the fact that the public service trainer position is a relatively new career in the Indonesian public service. It was not established until 1985 (GOI, 1985). Before a better recruitment system was developed, it was widely believed that many public servants entered the training profession without a genuine interest in, or capabilities to be in the training career.

There have been two stereotypical reasons given to explain public servants changing to a training career. First, public servants become trainers because they lose their managerial positions due to reorganisations or other reasons. The Indonesian public service system does not recognise demotion, except when a public servant is found guilty of a serious violation. Therefore, transferring such public servants to the training profession is a popular solution. Formally, it is regarded a lateral promotion, but to the public servants concerned, it is seen as a consolation prize or even a demotion. Such a case was, and to some extent is still, widely dubbed by the public servants themselves *'diwidyaiswarakan'* (forced to become a trainer). The term has the connotation that one becomes a trainer not as a result of their own choice but rather because of a lack of better career options. At the same time, this reflects the reality that the training position has not been, and to some extent is still not, a first choice career in the public service.

The second reported stereotypical reason for becoming a trainer is when a public servant wants to postpone his or her retirement, and has additional grade promotions before retiring. In the training profession, the trainers can work until the age of 65, instead of having to retire at 56, as is the case for public servants in general (GOI, 1986). Consequently, many public servants shift to training careers when nearing their retirement age. An extra nine years, during which a public servant receives his or her full salary, is quite attractive for many public servants. In addition, an additional tenure of nine years is sufficient for the public servant to be promoted at least once more before retiring, which allows him or her to receive a higher retirement salary. Given these benefits, it is easy for people to assume that these are the reasons senior public servants become trainers, although many may be in fact genuinely interested in a training career, and have more than adequate abilities to be trainers.

Early in the preliminary stage of this research, a trainer indicated that one of the problems in attracting young public servants to training is the image of the training career as a "retirement village". Coupled with incentives such as the possibility of extending public service tenure and even achieving further promotions, it is not surprising that older trainers find this career option especially attractive. The younger and more energetic public servants, in contrast, do not normally contemplate an early career in the training field but are more interested in the managerial positions. Nevertheless, for older trainers in general, this is a challenge that encourages them to develop themselves so that they can disprove this assumption. As indicated by a senior trainer in the GTC:

> There is a prejudice against senior public servants moving into the training position. They thought we became trainers because we only wanted to extend our tenures in the public service, which I do not deny. But, I can also prove that I am fit for the job. Although I did not have a background in training, I can manage by learning independently [that is, informally]. (Trainer 13)

Somewhat related to the above is the pressure to learn because of having no previous experience in the training practices. In the GTC, 93 percent of the trainers were previously from managerial positions, and the rest were recruited directly from staff positions. None of these trainers had qualifications in education and training before starting their training careers. The relevant regulations, strictly speaking, do not require them to have formal qualifications in training or education to become trainers. Virtually any public servant who has at least an undergraduate degree in any discipline, is in grade III/a (starting grade for public servant with an undergraduate degree) or higher in the Indonesian public service, scores at least "good" in his or her performance assessment result in the previous year, and has passed the prerequisite training programs (GOI, 2001a) can be appointed as trainers.

In the CTU, some trainers did have qualifications in education before becoming trainers. The majority of them, however, were recruited from various units of the CTU's parent company and only took formal university courses on education and training after they had been appointed trainers. Nevertheless, the trainers indicate that there were still many knowledge and skill gaps that they needed to fill in to be able to perform well in their professional duties.

Therefore, the trainers generally start learning the real craft of the training profession after they have already become trainers. This puts pressure on the trainers to learn and to expose themselves to as many learning opportunities as possible. Some of the trainers clearly indicate that they need much more than what their own training programs provide. Therefore, many trainers rely on informal learning to develop their capabilities. A senior trainer in the CTU said,

> The training profession is a challenging job. During my early training career, I found it difficult to cope because it was then an entirely new area for me. The training programs were generally fine, but I needed more practical tools that I could apply directly. I used to rely much on practical tips from some colleagues who had been in the training profession longer. It was their support that actually helped me to start, and developed further from there. (Trainer 1)

Implicit in the trainer's description above is the inherent problem of training transfer associated with a formal training program, that is, the difficulty of applying what the learner had learned in formal programs of instruction in the context of his or her day-to-day work. The issue of learning transfer is inherent in the formal training programs and constitutes a body of research in its own right in the formal training literature (see, for example, Richman-Hirsch, 2001; Yamnill and McLean, 2001).

There are a number of different ways that the trainers express this issue. For example, some trainers think that training materials are inconsistent with reality in the field, some speak of the inadequacies of training material in covering the complex aspects of their work, and some others attribute this problem to the different levels at which formal and informal learning operate.

For the GTC trainers, the need to stay competitive is another factor that stimulates them to learn continuously. Although these trainers do not explicitly use the word 'competition', their accounts and their work structure clearly indicate that there is competition among the trainers. For example, there is a high degree of subject overlap, with more than one trainer specialising in the same subject (see Figure 4.1 earlier in Chapter Four). The competition is mainly related to securing teaching opportunities. Teaching activities bring multiple benefits, such as financial rewards, prestige and credit points for promotion. Credit points are values associated with trainers' activities (see Appendix 5). Public service trainers should accumulate a certain number of credit points for their promotion to a higher rank (See also the subsection Learning Local Issues in this chapter).

However, the number of teaching opportunities in the GTC has become more scarce. The trainers indicate that the GTC cannot provide their trainers with enough activities to fulfil their mandatory workload. Consequently, the trainers – many of whom specialise in the same subjects – have to compete for teaching opportunities. The trainers believe that by learning they can improve their capabilities, and hence their competitive advantage in securing teaching assignments. In addition, teaching honoraria paid per hour on top of their basic salary is additional income for trainers. This further contributes to the competitiveness of their teaching activities.

Opportunities to train are reduced further by part time trainers, who also take part in teaching activities. They are referred to as *'widyaiswara luar biasa'* (exclusive trainers) (GOI, 2001c), or *'tenaga kediklatan lainnya'* (supplementary training personnel) (GOI, 2001b). They include managers or other people whose expertise and capabilities are needed to achieve the objectives of a training program. Others who also compete for teaching opportunities are retired bureaucrats or retired trainers, and trainers or non-trainers from other institutions.

A common competitive strategy that trainers adopt is to develop their ability to teach many subjects. This involves learning either through attending training programs or through informal learning, or both. A number of trainers also indicate using less conventional strategies, for example, specialising in areas that are of less interest to others. Therefore, they have relatively little competition for the programs they are prepared to offer.

Finally, the trainers often find themselves having to take unscheduled teaching assignments. Such assignments generally come from other training centres on short notice. They can also occur in situations in which the trainer scheduled to teach cannot make it for some reason. Although incidental, trainers see these as strategic opportunities because such assignments often lead to additional teaching assignments in the future. Therefore, when they arise, trainers take these opportunities seriously and try to perform well. In fact, these opportunities might be regarded as a feature of the trainers' work organisation, especially in the GTC. Hence, engaging in informal learning continuously prepares them for assignments that can come on short notice. As one female middle rank trainer in the GTC expresses it:

> It is important to fulfil any requests [to teach]. If you don't take such an opportunity you lose a lot: money, opportunities to establish new and hopefully lasting working relationship, credit points, reputation, and many more. So, it's good to be prepared all the time. (Trainer 31)

The diverse informal learning drives above are relevant to Clardy's (2000) categories of induced, voluntary and synergistic learning trigger. For example, issues that trainers encounter in their daily activities, changes in their subjects of teaching specialisation and their frequent unscheduled tasks may be classified as induced learning. The need to maintain positive self-image, to fill in knowledge and skills gaps and to stay competitive are examples of the voluntary learning triggers. The synergistic category, which is the interaction between organisationally generated opportunity and personal motivation, has no specific example in this study, but it is implied in the other two categories of learning drive. It is also important to note that among the induced learning drives identified above, none of them was deliberately introduced through a policy. Rather, they were induced by the natural contextual features of the trainers' work.

It is clear that the training profession, by its nature, compels trainers to learn continuously. Constant access to information and knowledge repositories is, therefore, vital for the trainers' success in carrying out their professional duties. As formal training programs are time and space dependent, trainers often have to fulfil such need through informal learning.

In addition, although formal learning processes provide the trainers with a useful theoretical and formalised body of knowledge, these fail to address some of the specific problems that trainers encounter in the course of their day-to-day activities. The trainers feel that theories only provide broad guidelines about what to do in typical situations. However, the messy reality of workplace situations such as teaching often requires them to try out something beyond what has been prescribed by formal theory. Thus, there is an implicit informal learning need in areas that the formal training programs cannot provide. These circumstances virtually force trainers to engage in continuous learning through informal means if they are to survive in their career.

Informal Learning and Consciousness

When the trainers are asked about the kind of knowledge and skills they needed to learn and develop in order to perform their tasks successfully, however, their responses are somewhat perplexing. That is, these included among other categories, analysis of training needs, designing training curricula, module and evaluation, oral presentation, mastery of subject matters, using teaching aid, academic writing and communication. All of these are basic knowledge and skills that a trainer must have by default, and this is explicitly stated in relevant regulations, manuals and performance assessment criteria for the training profession (see, for example, GOI, 2001a; c). When they are further asked to specify how they developed knowledge and skills in those areas, their responses include attending training programs, seminars, taking university courses or other such formally organised learning events.

This does not suggest, however, that the trainers only learn through formal means. It suggests, rather, that in response to this question the participants may be giving a normative response, namely responding in a way that repeats their organisation's job descriptions, rather than what they acknowledge elsewhere as actually occurring in practice. It is only due to lack of awareness that informal learning is overlooked. Low awareness has been a characteristic of informal learning. Referring to workplace learning, which is essentially informal learning, Hager (1998) argues that such learning is often implicit and even the learners themselves are commonly unaware of the extent of their learning.

Before exploring what the trainers learn informally, it is useful to discuss why such learning is only tacitly recognised by the trainers. This is necessary to support the argument that the trainers do learn informally, and the assumption that learning is not necessarily a conscious process.

The low awareness is attributable to several factors. Some are general characteristics of informal learning, but some others are peculiar to the research participants. These factors include the nature of knowledge involved in informal learning, the characteristics of the informal learning process, the features of the systems under which the trainers work, and the type of activities the trainers do.

The nature of knowledge involved in the trainers' activities is tacit, difficult to codify or explicate and is often taken for granted. Such characteristics have been observed in a study on "know-how on the job" conducted by Kusterer (1978). In the study, Kusterer noticed a tendency for the respondent to overlook or underestimate their knowledge. A typical response from his respondents at the beginning of every interview is "I don't know why you want to interview me. You don't have to know anything to do my job" (p. 187).

In addition, apart from containing tacit knowledge, the informal learning process is itself implicit, and does not normally constitute a separate activity that the trainers specifically plan to undertake. Rather, it is embedded as a natural accompaniment to the trainers' other activities. Some trainers describe how they are often unaware of what they have learned until they apply the knowledge. Such phenomena have been reported by researchers. For example, Livingstone (2001) indicates that many informal learning activities are accidentally initiated, occur in irregular time and space patterns and are only consciously recognised after the fact, and therefore most people do not recognise much of the informal learning they do until they have a chance to reflect on it. Similarly, Schugurensky (2000) notes that tacit learning is an internalisation of values, attitudes, behaviours, and skills that occur during everyday life, and not only do we have no *a priori* intention of acquiring them, but we are not aware that we learned something. This is in marked contrast to the formal training programs which are highly organised with a set of specific objectives, clear timeframe and venues.

Furthermore, the system governing the development of trainers is biased towards formal mechanisms. The formal system only recognises 'measurable' learning, which is clearly characteristic of the formal training. Informal learning is not officially recognised nor rewarded; an important factor that shapes the trainers' awareness. Formal training, on the other hand, is clearly associated with rewards such as formal recognition of competence to teach certain subjects, prerequisites to attending more advanced training programs, credit points for promotion, honoraria and other entitlements. This contributes further to enhancing awareness of formal training and overlooking informal learning.

A further effect of the official system bias is that the system is heavily based on the traditional cognitivist conception of learning. It assumes that learning is the reception of factual knowledge. In general, learning is conceived of as a process of transferring knowledge from a more knowledgeable source to less knowledgeable targets, which is a characteristic of a formal training program. The cognitivist character of the systems can be seen, for instance, in the separation between learning and working. The current conceptualisations assume that learning occurs in certain places at certain times, which is again a feature of formal training programs. Another indication of the cognitivist bias of the system is its assumption that learning is an individual activity. Importantly, the trainers' own job, which involves teaching other people in the formal setting, may also contribute to them overlooking informal learning.

Thus, trying to obtain information on tacit learning processes was one of the challenges faced in this research. Additional probing was required to reveal the informal dimension of learning. Through in-depth interviews, some indications of how trainers undertake informal learning process can be revealed. When they are asked what kind of problems they normally encounter in performing their tasks, the more complex aspects of their activities – which have important informal learning implications – started to emerge. It appears that there are some areas of knowledge and skills that the trainers need to learn informally, and which are crucial factors for their performance.

Developing Rapport

The trainers find that establishing initial relationships with the training participants and setting up the mood in a new class is challenging, but extremely important for their teaching. The trainers report various techniques that they use as ice breakers, ranging from a simple self-introduction, using jokes, discussing current affairs, presenting interesting statistical facts or challenging participants with relevant quizzes, to very unconventional techniques such as breathing exercises.

A simple introduction at the beginning of a session is not considered sufficient. Trainers regard this as a defining moment for the success of the whole teaching session. As a senior trainer in the GTC expresses it: "If you get this [rapport] right you've won the battle; the rest will take care of itself" (Trainer 35). No one best technique for establishing initial connections with the training participants is identified. They indicate that the techniques for accomplishing this are highly situational and dependent on personal styles. A technique that worked well in the past might not work for a current class. A technique that works best for one trainer might not work for others. Even a technique that worked well in a morning session might not be useful in an afternoon session. The trainers generally find it easier to become acquainted with training participants if they had a successful session with the same group before, which further underscores the importance of knowing how to start a session properly.

Motivating Participants

Motivation plays an important part in trainers work, yet they think that it gets little coverage in the training programs. Many GTC trainers indicate that participants in their classes are generally older and not very motivated. Some attend a training program because they were directed to by their bosses, not because of personal needs or interests. Some other trainers talk about the difficulty of shifting the trainees' mood, mind and behaviour into training mode. This is especially true of the participants in advanced managerial training programs. As another senior trainer in the GTC puts it: "They are bosses in their organisations, and some try to behave like one here too" (Trainer 33). Some other trainers also report that many training participants are nervous because they have not attended any formal training programs for a long time.

The trainers report using different techniques to tackle such issues. Some report using more or less the same techniques for establishing rapport, such as telling relevant jokes or doing some quizzes. Some others say they use group work. Although the trainers can normally make preparations based on information from their colleagues who have taught a class, the actual interactions with the training participants in the class are highly situational. Often, the trainers need to learn or figure out how to solve instructional problems on the spot. The varying characteristics of the training participants constitute an on-going challenge that the trainers face in relation to getting training participants to focus on learning.

Handling Conflict in Teamwork

Many of the trainers' activities involve teamwork. On the one hand, they enjoy the benefits of working with other people because they have the opportunity to share responsibilities and learn from each other while performing their tasks. However, teamwork can also be problematic if not well managed. For example, a trainer indicated having not much left to say in a two-hour session because her teaching partner who had previously presented his material had covered most of what she was supposed to present. This can happen because teams are not always composed of trainers who have been working together for a long time.

Another problem that the trainers often experience relates to inconsistencies between their explanation and that of their collaborating partners. Sometimes this represents a genuine difference of opinion; at other times, it is just a matter of different interpretations. Such a situation constitutes a dilemma for many trainers. "We do not want to undermine our colleague or our team, but we do not want to lose credibility either" is the way one middle rank trainer articulates this. If no solution can be found, one way out is for a trainer to ask for time to discuss the matter with the previous trainer and get back to the participants later.

In short, teamwork is another challenge that the trainers have to deal with, for example, how to manage task distribution, share or divide responsibilities, synchronise understandings, and handle unanticipated circumstances.

Self-Promotion

In the GTC, the distribution of jobs, especially teaching assignments, seems to operate as a market mechanism, where theoretically the trainers have equal opportunities. Yet, the actual distribution of teaching assignments is not balanced. Parenthetically, in the CTU, this is not the case as these trainers do not gain extra benefits by being involved in more teaching.

Many GTC trainers complain, for example, about certain people getting more opportunities than the others. In one informal gathering of trainers in

March 2003, various problems that they had been facing were raised. One problem that they found still existed was favouritism, "*siapa dekat dia dapat*", meaning whoever was close to decision makers would get better opportunities.

Collectively, the trainers have been asking for a management intervention to balance the distribution of teaching opportunities. However, individually, as the interviews revealed, trainers try to improve their own visibility within the training community. Some do this by learning to teach many subjects, others try to establish contacts in other training institutions, and yet others form alliances and divide their opportunities equally among the members of the informal alliance. As indicated earlier, a less conventional strategy is to develop mastery of subject areas that are not popular (some trainers call it a "trademark") in order to avoid competition.

Due to this "covert" competition, some trainers feel the need to learn how to market their expertise. This seems paradoxical as the idea emerged in the GTC, which is a public organisation. The trainers feel the need to learn to build personal, group and organisational profiles for promotion and teaching opportunities. Although many of the trainers talk about it, there has not been a systematic collective effort to design strategies. The only sign of this, although still in an early stage, is the idea among some GTC trainers to have one or two of their well known colleagues accept all teaching requests and then redistribute them among their colleagues. This idea was inspired by what the trainers in another institution had done. This seems to be an on-going process that is likely to entail informal learning at individual and at group levels.

Learning Local Issues

The trainers need to know what is going on with regard to their profession, including the local procedures in their own institution and those in the other institutions. For example, knowledge about credit point administration for the GTC trainers is very important. The trainers must collect a certain number of points for promotion to a higher grade. For consideration for promotion, trainers are required to calculate their own credit points and submit the total to the committee of credit point assessment for consideration.

Although there is a national guideline on calculating credit points, the details of various activities can be ambiguous. Thus, trainers may claim a different number of credit points for exactly the same activity. Some trainers report comparing their point accounts with their colleagues before submitting them to the committee of credit point assessment in order to make sure that they did not miss any points.

In addition, the trainers also find it important to have a general idea of the culture and norms of other training institutions. This includes knowledge of their formal authority structure, informal systems and the general characteristics of their training participants. This is important as a basis for them to design strategies for dealing with these issues. The importance of such knowledge is reflected in the fact that some trainers have an in-depth knowledge about the general characteristics of training participants in many of the other government training institutions and have developed strategies to deal with them.

> When teaching in [name of a training institution], we have to be really prepared because most of their participants have high educational qualifications. They only attended the training because it is a prerequisite for their promotions. They are famous for intimidating trainers. In [name of another training institution], you must use a lot of anecdotes and motivating tactics because the participants are generally unmotivated. (Trainer 17)

In response to the difficulties of getting information about various local issues, some trainers indicate the need to have a newsletter covering various activities related to the training profession. At the time of the interviews, the distribution of such information was still dependent on direct interpersonal exchanges.

It is obvious that some of the areas that the trainers indicate they need to learn informally are general subjects normally covered in formal training programs. The trainers, however, indicate that the actual practice is much more complex and unpredictable than is prescribed by the basic theories and concepts that they learn through formal training programs. This is an indication that the trainers actually need to supplement the insufficient explicit knowledge with tacit knowledge. In studying learning and knowledge transfer in market setting, Uzzi and Lancaster (2003) also demonstrate that distinctive forms of knowledge complement each other in the organisational learning process. Although they use the "private" and "public" knowledge distinction, and claim that this distinction is more encompassing than that of tacit and explicit knowledge dimensions, they nevertheless show that the learning process involves different types of knowledge, which are complementary to each other.

Thus far it is evident that the trainers are pressured to learn continuously by various factors that are inherent in their role and work environment. More specifically, the trainers are induced to learn by the less structured nature of their work, the constant changes affecting their areas of teaching specialisation, the need to maintain an image of competence, the need to fill in knowledge and skill gaps, the need to stay competitive and the need to be ready for unanticipated teaching assignments.

Relationship between Formal and Informal Learning

Even after probing, however, some trainers still do not seem to recognise the merits of informal learning. This lack of appreciation seems to stem from the fact that these trainers view learning from a narrow perspective, limiting their conception of learning to the process of knowledge transfer from the trainer to the trainees. This is quite reasonable, as indicated, because as trainers that is how they themselves help other people learn. Learning other aspects such as cultural awareness, intra- and interpersonal skills, which Day (1998) indicates are part of informal learning, was not considered. For example, a trainer indicates that one of the advantages of formal training programs is that the course objectives are clearly stated so participants know exactly if they had succeeded or failed in absorbing the training materials.

Another trainer points out an advantage of the formal training programs, stressing that apart from learning the subjects presented, the participants can also learn from one another. The possibility of each learning mode being embedded in the context of the other has been reported by Boekaerts and Minnaert (1999) who note that numerous informal learning processes may occur in formal learning contexts; likewise, formal learning episodes may take place outside a school context. However, rather than showing the superiority of formal training programs over informal learning, this trainer actually shows implicitly the complementarity of the two learning modes, recognising the possibility that learning can occur outside the context of formal instructions through social interactions among training participants. The only difference with purely informal learning is that, in the example given, the trainers' informal learning is embedded in and takes place in tandem with the formal programs of instruction.

However, despite working in the same environment, some other trainers are able to indicate the benefits they obtain from informal learning. They feel that – as trivial as it might seem – informal learning brings real and readily applicable results. The competing perceptions between those favouring the different learning modes made it possible to explore the characteristics of each, based on the trainers' perspective, as summarised in Table 5.1.

Table 5.1. Comparison between formal and informal learning

Formal	Informal
Contents are general and cover a wide range of topics, thus trainees have opportunities to obtain extra knowledge	Allow in-depth understanding because things are learned while doing them
Unobstructed because it is carried out at specific time and place	Comprehension is enhanced because what is learnt can be practiced immediately
Able to get answers of questions quickly because trainees could help one another	Flexible, may be carried out at any time and at any place
Able to get the theories which help systematic understanding	Efficient and effective as it is relevant to specific needs of the learners
Formally recognised or certified which is important for career promotion	Learners are mentally prepared to learn because they are in control
Although contents not always immediately applicable, it is good for future reference	No formal recognition, it is the learners themselves who know that they have learned something
Able to transfer knowledge to a large number of participants simultaneously	Incremental process
	Problem based and action oriented
	Facilitative for the development of know-how

Although the characteristics of formal and informal learning above are generated from contrasting views of the trainers, these characteristics actually reflect the mutually complementary nature of formal and informal learning as the trainers experience it. The way the trainers express their perceptions about the differences between formal and informal learning is not exactly similar to the contrasting characteristics of these two learning modes that have been discussed in the literature as presented in Chapter 2. However, each of the characteristics that the trainers identify may fall into one of the informal learning features suggested in the literature.

As illustrated in Figure 5.1, when combined, the weaknesses of one learning mode are offset by the strengths of the other. Hence, an organisational strategy that combines both modes of learning could result in an improved opportunity for the trainers to develop work-related knowledge and skills.

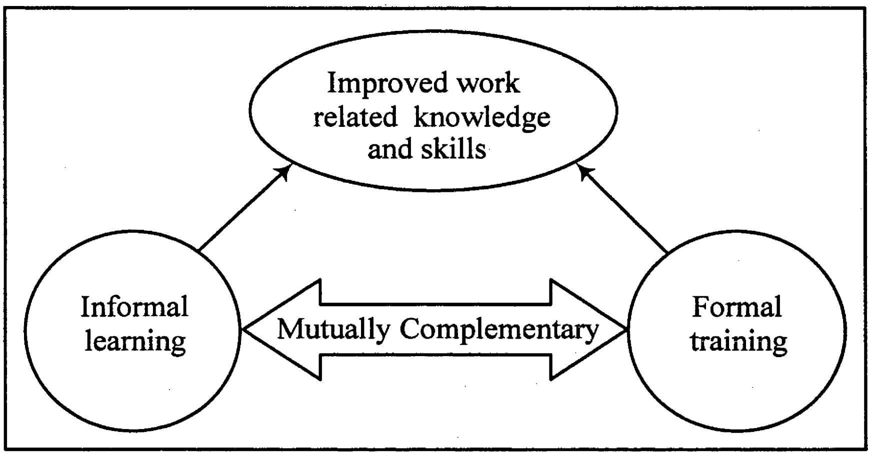


Figure 5.1. Relationship between formal and informal learning

In terms of contents, for instance, the trainers can learn basic theoretical foundations from the formal training programs and complement this with informal learning in order to be able to deal with context specific issues they encounter in their day-to-day professional practices. In addition, trainers can acquire knowledge incrementally through informal learning, and occasionally attend formal training programs to update, refresh or reaffirm their existing knowledge. In fact, informal learning may take place inside the framework of a formal training program (Van der Krogt, 1998). Furthermore, informal learning can fill in personalised individual learning needs, which is not achievable in formal training programs. Another important characteristic of formal training that the trainers indicate is the capacity of formal training programs to get people together, which enables them to cross fertilise ideas. The formal exchange of ideas that takes place during the training programs may extend beyond the duration of the training programs to facilitate further learning in informal ways.

In general, the trainers use both formal and informal learning to develop their capabilities. They engage in informal learning activities to develop their knowledge and skills in areas that are not covered by the formal programs of instruction that they have attended. These areas are personal, problem-oriented, and context-specific. Further, the trainers use informal learning to extend and to refine what they have already learned through formal training programs. Some trainers indicate a need to pursue further learning (*'belajar mandiri'*) after attending a training program to "fine tune" and to "give a personal touch" to what they learned through the formal program. Some report doing this through class observations; that is, watching an experienced trainer teaching or performing. Conversely, the trainers can also use formal training programs to reaffirm what they have learned informally.

The Process of Informal Learning

Having discussed what trainers learn informally, it is now useful to examine how such learning processes actually take place. From in-depth interviews with the trainers, it was found that there are a number of ways in which the trainers learn informally. The kinds of learning resources they use also vary, including 'self-access' learning resources such as books, magazine, laws, regulator material, manuals and similar written information. Also indicated here are mass media such as radio, television, newspapers and magazines. The Internet has also become a popular source of knowledge for some trainers, especially those in the CTU.

Independent Learning Using Self-access Learning Resources

The trainers find leisure reading on their own to be a flexible yet effective way to learn because it can be done at any time and virtually anywhere. The major impediment to this is limited access to the latest books. This limited access to books is, however, balanced by relatively easy access to mass media resources.

These trainers report that mass media provides a wealth of learning materials. Access to the media is flexible and relatively affordable to most trainers. There are around fifteen free-to-air television stations broadcasting various information every day. The trainers find that what they watch on television often leads into interesting and relevant discussions with their colleagues or with training participants. The radio is also seen as a rich source of information for the trainers. One of the advantages of radio is its perceived flexibility and its accessibility. As one senior trainer in the CTU says,

> Even in the traffic jam, you can tune in to one of the radio stations and listen to the news or talks shows. You could learn a lot while queuing on the road. You could hear various views and perspectives, problems and solutions which often become relevant illustrations in teaching. (Trainer 19)

Access to mass media such as magazines and newspapers is also quite good. Besides being available in their organisations' libraries, most of the trainers subscribe to at least one newspaper or magazine.

The Internet is becoming a popular alternative source of knowledge and information for trainers, especially those in the CTU. All CTU trainers have Internet access at work and some also have access at home. All of the trainers also have corporate and private email addresses that they use quite frequently as an alternative means of communication. The trainers find the Internet a very useful source of knowledge and tool of communication. The CTU trainers, for instance, use Internet applications such as mailing lists or discussion forums to obtain up-to-date information in their areas of specialisation. They also use the Internet to check current international regulations and standards relating to the training programs that they provide. Some trainers also report using the Internet to communicate with trainers overseas who specialise in the same areas of expertise.

However, Internet connections are not yet widely available to the trainers in the GTC. Only ten out of the 44 trainers in the GTC report using the Internet, either at home or from internet cafes. The reasons for not using the Internet vary. Most of the trainers provide more than one reason. The 99 total reasons given could be classified into "have not learned how to use the Internet" (42%), "do not know how to use a computer" (23%), "too costly" (21%), "currently not needed" (14%).

The use of cell phones is also commonplace among trainers. Every interviewed trainer in the two training centres uses a mobile phone as a means of daily communication. Although the trainers do not associate the use of mobile phones directly with learning benefits, their stories indicate that this technology has a potential to expand social ties and be a catalyst for informal learning. At the present stage, however, the trainers use mobile telephones only for short conversations, as they are too expensive to use for extended discussions.

The availability of access to information, nevertheless, does not replace interpersonal exchanges of information. The involvement of other people is inevitable. Even activities usually thought of as individual are often also likely to involve other people. For example, learning through reading books or other written documents might be undertaken because of other people's recommendations, influences or pressures. This leads to a consideration of the importance of social relations in informal learning.

Knowledge Sharing and Construction through Social Relations

The trainers' networks are informal, emerging, self-organising, and their existence is not immediately apparent to external observers, or often even to the trainers themselves, despite the fact that the network might affect them, in a positive or negative way. Trainers' awareness of their interconnections seems to be limited to their direct personal relations. They do not appear to be fully conscious that beyond their direct personal contacts they are also enmeshed in a larger network (or networks) through their indirect personal ties.

Various types of informal social relations and interactions with people also constitute important methods of informal learning for the trainers. In fact, social network analysts have demonstrated the importance of social relations and interactions in knowledge acquisitions (see, for example, Granovetter, 1973; Burt, 1992), in innovation (Valente, 1995; Valente and Saba, 1998), and in many other areas.

In the interviews, the trainers were asked if there were people who specifically contributed to their opportunity to improve their work-related knowledge and skills, who these people were, and what was the nature of their relations with each of these people. Their answers were categorised. It was found that there are four salient relations that the trainers feel contribute to their learning and development. These are communication, collaboration, advice-seeking and advice-giving relations.

Communication Relations

Communication exchanges among the trainers occur in many places. The places that the trainers indicate as frequent communication locations for small discussions include their own offices, the (communal) trainers' halls used before classes start and during breaks, the library and the cafeteria. Some report an increased frequency of conversation by telephone prior to undertaking collaborative activities such as team teaching. Others indicate gaining much useful knowledge from informal conversations with other trainers during attendance at formal training programs.

The trainers find communication relations beneficial for exchanging learning resources, ranging from information that seems to be trivial such as jokes or anecdotes to that which is more related to their work such as information about new books, teaching assignment opportunities, and training or seminar events. In general, these exchanges of information are unplanned and occur at virtually any place and through diverse means or channels. Overall, communication relations seem very flexible, yet useful for learning by facilitating the distribution of information or ideas. For example, a middle rank trainer from the first phase of the study indicated,

> I use a lot of anecdotes in my classes. They help me get the participants motivated; they [training participants] enjoy them very much. [Q: Where do you get the anecdotes from?] ... from everywhere. It is not clear where they originated from, ... but some colleagues seem to have a good stock of them. (Trainer 9)

The knowledge that they acquire from communication exchanges is general in nature, and the trainers report that often they are unaware of having such knowledge until later when they are confronted with problems, or relevant situations, that require them to apply the knowledge.

Some trainers, however, are rather pessimistic about informal communication, indicating that when people get together they tend to gossip and there is nothing useful to learn from such exchanges. Such a comment does not, however, negate the learning benefits of much of the communication which trainers are involved in.

Communication relations expose the trainers to various information, ideas or knowledge of others. For many, the benefits from communication are not limited to the information per se that they get from others, but also include the perspective into which the information is placed. As one middle rank trainer in the GTC puts it, "I can easily get new knowledge by reading books, but talking about it with other people makes the knowledge alive and more meaningful to me" (Trainer 3). This is relevant to Zemke's (2001, p. 14) idea that "people hold conversations and expose one another to the possibility of becoming not just different, but better and more capable as a result".

Advice-seeking Relations

For more specific issues, especially ones directly related to the trainers' activities, seeking advice from people who are expert in the relevant fields is beneficial. For example, the following account provided by a junior trainer during the first phase of the study is a representative of many trainers' views.

> For me, the quickest way to learn is to go to someone who is an expert in the area in which I have a problem. If I have a problem related to my subjects, I usually go to my teammates. For problems concerning government policies, I normally go to [name of a person]. He has a Masters degree in public policy and he is very good in this area. For computer related problems, [name of another person] is the expert that I go to. I also like to test any crazy ideas that I have with Mr. [name of a trainer]. He is very open-minded and helpful. (Trainer 5)

Seeking advice is not always triggered by a problem. Some trainers report seeking advice just to get other people's opinions about work that they have in progress, for example, getting advice for draft article, training material design, or a research proposal.

The benefits of advice-seeking relations have been recognised by researchers in other areas of learning. For example, Athanassiou and Nigh (1999) report that the density of advice networks involving top management teams of multinational companies in the US affected the level of internationalisation. Cross, Borgatti and Parker (2001a) have also identified five benefits obtained from consulting other people, including solutions, meta-knowledge (pointers to sources of knowledge), problem reformulation, validation and legitimation.

However, the trainers also indicate that it is not easy to get work-related advice. They feel that some of the trainers refrain from giving advice related to their areas of expertise. Some junior trainers think that their senior colleagues do not want other trainers to take over teaching opportunities in subject areas that they are teaching. Some trainers even warn about seeking advice. For example, a junior trainer in the GTC believes that some of his colleagues do not appreciate ownership of ideas.

> You need to be careful who you go to [for advice]. I had an experience of asking a colleague what he thought of my idea. He claimed the idea and proposed it to the management without my knowledge. [Question: what kind of idea?] It was a design of a training program. There is no way I can prove that it was originally my idea, so I chose to be just quiet about it. The training program had been implemented but I was not even involved in it. (Trainer 9)

Advice-giving Relations

Learning benefits from giving advice have not received adequate empirical scrutiny. Generally, studies of advice networks look at the advice-seeking side rather than advice-giving, or both (see, for example, Haythornthwaite, 2001). However, it was found here that giving advice to others entails learning benefits because it can sharpen or even reshape the previous understanding of the advice giver. This view is supported by some accounts of giving advice to others. As a junior trainer from the first phase of the study reported,

> He is more senior than I am. I do not see myself as a better trainer than him, but he often comes to me with problems, personal or about work. ... perhaps not real problems but he just wants to know what I think. For me, being able to help other people makes me more confident and feel appreciated, and I think I also learn from helping other people because it makes me aware of the issues and have better understanding about them. (Trainer 8)

In another trainer's account, "the more I give, the more I get" summed up the learning rewards that the trainers acquire from giving advice.

Collaboration Relations

Collaboration networks can expose learners to the tacit knowledge of their collaboration partners. As tacit knowledge is difficult to explicate, some of the tacit knowledge may be passed on through working together. In addition, working together may also reduce any effects of competitive behaviour that cause people to be unwilling to share their tacit knowledge.

The trainers, especially those in the GTC, have many opportunities to collaborate. The subjects, especially those in the managerial training programs, are grouped under themes, and each is presented by teams. Team membership is not fixed because there are many possible combinations of trainers, including those who are from other training centres, who could make up a team. Each component in a theme session is presented by a trainer. A theme session could last for a few days.

The trainers generally believe that this way of presenting programs offers learning opportunities to them. Those belonging to a team normally have intensive discussions and intensive meetings before, during and after theme sessions are presented. The whole series of activities from the preparation stage to the concluding presentation involves intensive information and knowledge exchange. In addition, in these close working relationships, the trainers not only exchange textual or verbal messages, but also implicit knowledge embedded in their practices. Using a metaphor, the account of a senior trainer from CTU clearly reflects the richness of collaborative activities as a learning medium.

> If you want to learn how to drive a car, you cannot rely on the theories only. You need to go out with someone who can drive and give it a try. Our work [as trainers] is a little bit more complex than driving a car, so we need to work in teams and learn from one another. (Trainer 8)

Collaborative activities that the trainers report include team-teaching, co-authoring training materials, designing training curriculum, conducting research, and the joint presentation of a paper at a seminar. In the CTU, the trainers are divided into units based on their areas of expertise. Therefore, they consider almost all of their activities as collaborations with their colleagues who are assigned under the same unit. Inter-unit collaboration also takes place, especially in the design of training programs.

Thus, social relations, play an important role in the trainers' informal learning. From their accounts, it becomes evident that social relations provide the trainers with access to rich learning resources which are relevant to their personal learning needs. The strength of social relations has been demonstrated by Valente and Saba (1998) in their study of adoption of contraception, where learning new contraceptive practices from non-person sources such as mass media only contributes to the first four of six steps in the adoption process. Social networks, on the other hand, contribute to all six steps.

The trainers appear to have quite diversified learning relations. Their interactions with people are not limited to their colleagues, but extend to others outside their organisations or profession. In fact, the trainers have learning interactions with a large number of external actors. In both organisations (GTC and CTU), of all the people who the trainers name as learning associates, 77 percent are from outside their organisation, profession or both.

In addition, almost all trainers indicate that they learn from the people who they train during their interactions in the classroom. They especially praise the contribution of training participants in supplying information on the practical dimension of the theories and concepts they present. In the CTU, the trainers are more proactive as they interact with their current or prospective clients by visiting them at their workplaces. Through observation and interviews with them they learn the problems and issues that require training support. They then use the information to improve their material or in some cases to design new training programs.

The Instrumental Role of Social Relations for Informal Learning

The trainers' social relations are instrumental for learning processes because they facilitate access to and sharing of learning resources. The structure of social relations in which the trainers are embedded provides them with pathways through which they can search for and obtain learning resources, either from those directly connected to them or from others more distant through indirect links. This is relevant to the argument made by Podolny and Page (1998) that social networks preserve a greater diversity of search routines and convey richer, as well as more complex information.

The trainers constantly emphasise the importance of staying current and relevant by tapping into learning resources, which include any information about various aspects of their work. For example, they need information about matters related to their profession, areas of specialisation, teaching opportunities, and training or seminar events which are relevant to their interests. To be able to find such information, a trainer indicates that they needed to have "eyes and ears everywhere"; that is, having reliable sources to supply them with such information.

Along the lines of the above, a middle rank trainer in the GTC describes the importance of maintaining informal social connections with people around them using a radio broadcasting metaphor.

> You have to tune into the [training profession] 'frequency' through having contacts everywhere. It helps you keep up with what is going on around, [such as] what training programs are going to be conducted in what training centre, [or] what training programs are likely to need your expertise. (Trainer 2)

It is implicit in the trainer's account that informal contacts help in finding teaching opportunities. Since working, such as teaching, is essentially a learning process, social relations are, therefore, facilitative for the trainers in finding learning opportunities.

Another example of the facilitative role of social relations in informal learning is an attempt by the GTC trainers to adopt a technique of securing teaching opportunities. This is an illustration of learning at a group level, rather than an individual level. The GTC trainers discovered how trainers from another training centre managed to get many teaching assignments. From their contacts they found that a number of senior trainers in the centre who had been well known acted as brokers. They accepted all requests to teach even if they had been fully booked. They then redistributed some of the teaching opportunities to their colleagues.

Irrespective of whether this distributed work technique that the trainers attempted to adopt was a good or a bad practice, the point was that social relations facilitated access to knowledge or practices located elsewhere. The success or failure in actually adopting the technique will depend on the way they are related, especially the position of the trainers who are expected to play the brokerage role in the structure of relations. For example, if these trainers are marginal players, or if they all belong to an exclusive cohesive subgroup, the technique will not be expected to be successful.

Whether or not trainers are successful in adopting the technique of distributing work, a process of learning has taken place. In a number of interviews, as part of the data collection, this issue came up, indicating that although the GTC trainers have not adopted the technique, they have started to discuss it among themselves. This in itself constitutes a learning process which could lead to adopting the technique as is, modifying it, or abandoning it and creating an entirely different approach. Other kinds of innovation adoptions at individual, group or organisational level may take place in the same manner as this example.

Another case exemplifies how social relations can provide the trainers with opportunities to learn. A member of a subject-based group of trainers established relationships with colleagues of his wife from a private institution who specialised in the same subjects as he did. In the course of frequent family outings, the trainer picked up new ideas from his private sector colleagues and successfully adopted some of these. That is, they became part of the training in the public service. Although this is the only example of how the public service trainers learn from their private counterparts, it nevertheless points to the role of social relations of various kinds in learning.

Virtually every aspect of the trainers' activities offers learning opportunities. However, the trainers differ in their ability to recognise an opportunity. Differences can be seen from the fact that some trainers report more learning benefits from their social relations than the others did. Some trainers are able to learn from a seemingly trivial event that others do not see as a learning opportunity. For example, in the previous section it was indicated that some of the trainers feel that they benefit from listening to jokes and anecdotes. The trainers also believe that their social relations stimulated learning by providing cues as to what is relevant to learn.

In addition, social relations constitute a medium through which trainers can get inspiration leading to further meaningful learning. The attempt to adopt a technique in managing teaching assignments, discussed earlier, by appointing some high profile colleagues to broker teaching opportunities is a case in point. Language seems to play an important role, because it is implicit in a GTC senior trainer's account, "The terminologies, phrases, metaphors that people use provide clues to what should be learned and where to find the learning source for it". Similarly, another trainer indicates,

> Keeping in touch with people makes me aware of what is going on around my area [of specialisation]. From communicating with them I am able to pick up clues of what is current or what needs to be integrated into my teaching material. People help in opening up your horizons so that you are able to anticipate what needs to be learned. (Trainer 35)

Besides facilitating access to and sharing of knowledge, social relations are also instrumental in the construction of knowledge. Construction of purely new knowledge is a breakthrough, a very complex process, and rarely takes place. Nevertheless, knowledge construction does not have to result in entirely new knowledge. In this study, an incremental process of enhancing the existing knowledge is regarded as knowledge creation.

Many examples of knowledge construction at this level are identified in this study. Such process might take place through the synthesis of different ideas. For example, a female middle rank trainer in the GTC indicates that her knowledge and skills emerged out of subtle fusion processes in which what she heard and saw from people around her, as well as what she learned from formal training programs, were combined together:

> It is difficult to attribute a piece of knowledge or skill as the contribution of a particular person or group of persons. For example, I am aware that my teaching style is influenced by many people, but I cannot identify the specific persons from who I got it. I guess I obtain different pieces of ideas and tips from here and there and these are all combined together to make me the kind of trainer I am now. (Trainer 17)

In conclusion, the results of the present analysis unequivocally suggest that a considerable part of trainers' learning takes place informally, and that social relations play important roles in the informal learning process. The trainers' need to learn informally is driven by the nature of their work as well as by their need to maintain a positive self-image and to stay competitive. Such learning is embedded in the social relations in which the trainers are involved, including those of communication, collaboration, advice-seeking and advice-giving. These social relations facilitate informal learning by providing access to, and a medium for, sharing knowledge, supporting construction of knowledge and enhancing the application of knowledge.

CHAPTER SIX. THE OVERALL CHARACTERISTICS OF THE TRAINERS' SOCIAL NETWORKS

In the previous chapter, the way the trainers learn and the type of social relations that are facilitative for their process of learning were explored. This chapter examines the structure of these facilitative social relations using a formal social network approach. Social networks are complex social phenomena and social network analysis is a complex research method, encompassing various concepts and formal measures for characterising the structure of social relations. Therefore, before dissecting the internal structure of the relevant networks and applying more complex network concepts, it is useful to start with examining the overall characteristics of the networks using basic social network concepts and measures.

The purpose of this chapter, therefore, is to explore the general characteristics of the networks in which the trainers from a Government Training Centre (GTC) and a Company Training Unit (CTU) are embedded. More precisely, the chapter examines the shape and the characteristics of the networks as a whole and evaluates their potential implications for the process of learning and knowledge sharing among the trainers involved.

The chapter is organised into three main sections. The first section examines the characteristics of the networks for the GTC trainers, consisting of a knowledge network (in which the four uniplex networks are combined) and then four networks of uniplex relations (which are the constituent parts of the knowledge network). It addresses the broad framework of these networks, highlighting their important features and characteristics, such as size, density of the interconnections, distances between actors, the extent to which actors can reach one another, and the extent to which the networks are structured around one or a few focal actors. The comprehensive descriptions of these network concepts are presented alongside the discussion of the data for the knowledge networks of the GTC trainers. Therefore, in examining the other networks in the GTC and all the networks in the CTU, the discussion can focus more on the data, while the network concepts are only described briefly. The second section examines the networks in the CTU, along the same lines. The third section addresses the significance of the various network features for the two groups of trainers, highlighting their potential strengths and weaknesses in fostering learning and knowledge sharing.

The Knowledge Network in the Government Training Centre (GTC)

This section examines the overall characteristics of the networks in which the four different relations pertaining to learning and knowledge sharing are combined. As this network combines relations in which different types of knowledge and learning resources are embedded, it is also referred to as a "knowledge network". In this network, a tie between a pair of actors exists if the two actors are connected by at least one of the four relations of concern here: communication, collaboration, advice-seeking or advice-giving. Substantively, a tie from actor A to actor B means actor A was able to access or receive learning resources from actor B; or simply, actor A had an opportunity to learn from actor B.

Network Size, Memberships and Density

The first basic feature of the network is its size which reflects the expansiveness of the actors in building and maintaining their interconnections. The size of a network is indexed by the number of actors in it (Monge and

Contractor, 2003). The size of the GTC trainers' network was 44, the number of trainers targeted as study participants. Three of the trainers neither nominated nor were being nominated (isolates). Therefore, the inclusiveness, that is, the ratio of connected actors to the total number of actors (Scott, 1991b; Monge and Contractor, 2003) is 93 percent. Because GTC trainers (internal actors) were allowed to nominate associates from outside this group (external actors), the size of the network including the external actors is 192, and the inclusiveness is 98 percent.

The network membership is quite diversified, extending beyond functional, organisational and professional boundaries of the trainers to include external actors. Of all 192 actors, only 44 (23%) are internal actors and the remaining 148 (77%) are external actors who had varying organisational and professional affiliations. These external network associates can be classified into organisationally external actors (trainers, but who do not work for the GTC), professionally external actors (public servants who work for the GTC, but not as trainers), or organisationally and professionally external actors (those who are neither trainers nor working for the GTC). To illustrate, organisationally external actors can include trainers from all the other government training centres, or even those from private training institutions. Professionally external actors might include anyone who worked for the GTC or its parent organisation but not as trainers, such as managers, administrative staff, and holders of other functional positions such as researchers, librarians, auditors and information technology experts. Organisationally and professionally external actors include retired trainers whose expertise is still needed as well as managers from other government institutions.

As can be seen in Figure 6.1, the proportion of the different types of external actors is fairly balanced, where "organisationally external" actors account for 21 percent (40), and both the "professionally external" as well as "organisationally and professionally external" actors account for 28 percent (55).

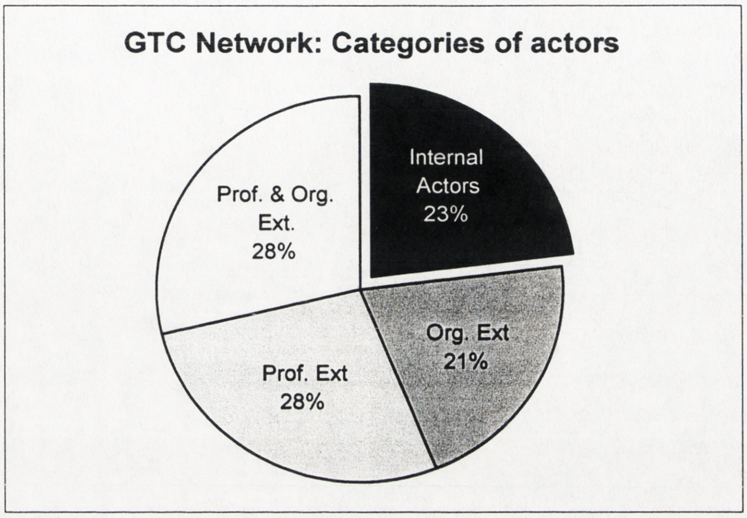


Figure 6.1. The category of actors making up the GTC trainers' networks

Apart from having a large number of external actors in their network, the actual number of ties connecting the trainers to these external actors is also substantially large. As Table 6.1 shows, of the total 382 ties originating from the GTC trainers, the majority (59%) are directed towards their external associates, as compared to only 41 percent to their own colleagues (other trainers within the GTC).

The extensiveness of the external actors' involvement is also evident from the average number of ties to external actors within the GTC trainers' network neighbourhoods. As can be seen in Table 6.1, on average each trainer has about six ties to external actors compared to only four to their own colleagues. In addition, the trainers have up to 19 ties to external associates and only a maximum of 11 to their internal associates. Furthermore, three of the GTC trainers do not have any ties to their own colleagues, compared to only one who does not have any ties to external actors.

Table 6.1. Ties from the GTC trainers to internal and external actors

Number of ties from internal actors	To internal actors	To external actors
Total within the network	158 (41.4%)	224 (58.6%)
Average within neighbourhood	4.27	6.05
Standard deviation	3.56	3.40
Range	0-11	0-19
None ties reported	3	1

Thus, the extent to which external actors are involved in this knowledge network is evident from their dominant position in terms of the total number of actors in the network, the total number of ties in the network and the average number of actors in the trainers' network neighbourhoods.

In a network, there can be up to $n(n\text{-}1)$ unique ties if the direction of ties is considered, or up to $[n(n\text{-}1)/2]$ if the direction of ties is disregarded, where n is the number of actors in the network. Thus, a linear increase in the number of actors is followed by an exponential increase in the number of possible ties. For a small network containing only a few actors, it is possible for all ties to be present and this can be easily verified by interviewing all actors. However, for a network with a reasonably large number of actors, such as the one under investigation, it is virtually impossible for everyone to establish or to maintain ties with everybody else. For the 192 actors in the GTC, there can be up to 36,672 unique ties, or 18,336 if the direction of ties is not considered. Here, the network is quite sparse and far from approaching its maximum number of ties; the number of observed ties was only 1,051.

The density of a directional network equals the proportion of ordered pairs of actors that are present in the network. If the directional network is represented by a directed graph (digraph), the density is simply $\Delta = L \mathbin{/} g(g - 1)$, where L is the number of arcs and g is the number of nodes (Wasserman and Faust, 1994, p. 129).

As can be seen in Table 6.2, the density of interconnections for all 192 actors is 0.029. This suggests that only about 3 percent of all theoretically possible personal relations were observed to exist. Thus, the knowledge network of the GTC trainers is very sparse.

Table 6.2. The density of the GTC trainers' network

Type of Actors	Asymmetric	Symmetric
Internal actors only	0.084	0.128
External actors only[1]	0.030	0.031
Internal & external actors	0.029	0.038

[1]The interconnections among the external actors are based on interviewed actors' perceptions

Alternatively, the density of the network can be measured by taking into consideration the possibility that some study participants might forget to name some of their network associates. Although efforts were made to ensure that the participants accurately nominated all their important associates, for instance, by not limiting the number and the kind of persons they could nominate, the possibility that the participants forgot to name some of their associates cannot be ruled out totally. By symmetrising the ties in the network, at least some missing ties due to memory lapses and other causes might be recovered. Symmetrising the ties is also reasonable since in reality it is possible that network resources, especially those embedded in the communication and collaboration relations, flow in both directions. As can be seen in Table 6.2, however, the density of the network with ties symmetrised is 0.038, which is only slightly higher than the original density index. It should be noted that in order to provide alternative views of the network, subsequent analyses consider both asymmetric and symmetric ties.

It is also important to recognise that the density index above might have underestimated the real extent to which GTC trainers are interconnected, as only 37 of the 192 actors were able to be interviewed (See Chapter 3). These 37 actors are part of the 44 trainers in the GTC who were targeted as the study participants (internal actors). The remaining 155 actors were not interviewed, of whom seven were internal and 148 external actors. As indicated in Chapter 3, the ties among them were recorded very prudently based on the GTC trainers' perceptions. Thus, another possible way to measure the density of the network is to make an adjustment by taking into account the fact that some actors did not have an opportunity to make nominations. The adjusted density is 0.035, indicating that only about 3.5 percent of possible ties have been actually observed to exist. Obviously, this adjusted index still represents a sparse network.

Another possible way to compensate for the non-interviewees is to exclude the external actors and measure the density only on the interconnections among internal actors. As indicated in Chapter 3, none of these external actors were interviewed, and they were not originally targeted as study participants. Their inclusion in the dataset is due to the fact that a relation is not an individual but a shared property. Therefore, if an internal actor indicates having a relationship with someone outside the targeted participants, these persons must be included as actors in the dataset. Nevertheless, most of the analyses, especially ones which are structural, focus on the interconnections among the internal actors. In such analyses, the external actors are included to provide an alternative perspective to the trainers' networks.

Thus, by calculating only the density of ties among the GTC trainers (internal actors), the fact that external actors did not make nominations no longer affects the density calculation. As the number of internal actors is considerably lower than the total number of actors, it was expected that the density of their interconnections would be much higher. However, as it turned out, the density of ties among the 44 GTC trainers is not much higher than that for all 192 actors. As was seen in Table 6.2 earlier, when taking into account the internal actors only, the density increases just slightly to 0.084, or to 0.128 if their interconnections are regarded as undirected.

The knowledge network is sparse; its density is consistently low despite being measured in different ways and taking into account different factors. This has implications for the capacity of the network to support knowledge sharing and learning.

Reachability, Components and Distance

Reachability and *distance* are important measures as they can indicate whether a network has the potential capacity to spread information despite being sparse. The concept of reachability, as the term suggests, indicates whether there is a path of some length through which a piece of information can travel between a pair of actors in a network. It takes into account both direct and indirect ties. Thus, it captures the intuitive notion of getting information, help or supports from a "friend of a friend". However, it is important to note that as the path increases in length, its capacity to relay information may weaken, and the information it carries may be subjected to an increased level of noise and distortion. Therefore, it is useful to consider the distances that separate reachable pairs. Distance, or more specifically *geodesic distance*, is the number of steps on the shortest path between a pair of actors. It can be used to indicate the likelihood of information dissemination by taking into account the minimum number of steps required for information to travel between a pair of reachable actors. Both measures are, therefore, useful for characterising a network pertaining to learning and knowledge exchange.

The data indicates that not all actors are reachable by others in this GTC network. The reachability index for all actors is 0.31 if the ties are considered asymmetric, that is, A $\rightarrow$ B and/or B $\rightarrow$ A are two unique pairs. This suggests that considering all 36,672 possible unique pairs for 192 actors, there is a path of some length between about 31 percent of them. Alternatively, if the ties are considered symmetric, that is A $\rightarrow$ B, B $\rightarrow$ A and A $\leftrightarrow$ B are pairs of actor A and B, the reachability is 0.78, indicating that 78 percent of a possible 18,336 pairs of actors can reach each other via a path of some length.

A reachability index of less than 1.00 indicates that the network is not connected. The extent of disconnection can be observed by examining the number and the size of the components that exist in the network. A component or subgraph is a connected subset of network nodes and links (Wasserman and Faust, 1994; Monge and Contractor, 2003). All nodes in a subgraph are reachable through direct or indirect links and there is no path between a node in the subgraph to nodes outside the subgraph (Wasserman and Faust, 1994).

Components can be strong or weak. For a strong component, the direction of lines is considered. In this case, tracing the connected actors for a strong component follows the direction of ties, and direction should not change during the tracing process. For a weak component, the direction of ties is disregarded (Scott, 1991b). Using a more formal definition, "two vertices are in the same weak component if there is a semi-path connecting them. Two vertices x and y are in the same strong component if there is a path connecting x to y and a path connecting y to x" (Borgatti *et al.*, 2002).

As an illustration, consider the hypothetical graph given in Figure 6.2. The graph contains five strong components: {A, B, C}, {D, E, F}, {G} and {H}, and two weak components: {A, B, C, D, E, F}, {G, H}. Note that G and H together only qualify for a weak component because although there is a path connecting G to H, there is no path connecting H back to G.

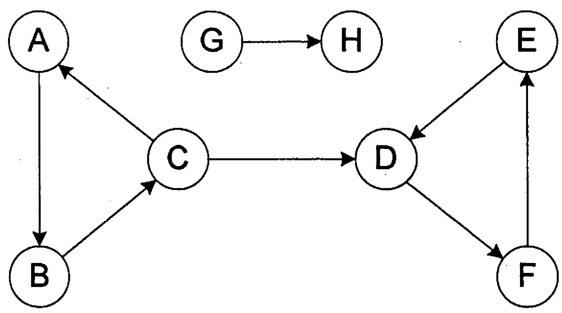


Figure 6.2. Strong and weak components

Components were detected using UCINET 6 (Borgatti *et al.*, 2002). As can be seen in Table 6.3, the knowledge network is divided into four strong components, containing clusters of 77, 28, 15 and 8 actors, as well as a *triad* and six *dyads*. Forty-nine actors have no connections, forming isolated single-actor components.

Table 6.3. The strong network components in the GTC knowledge network

		Type of actors		
Type of Components	Components	Internal Actors	External Actors	Total Actors
Main component	1	0	77	77
Secondary component	1	28	0	28
15-cluster	1	0	15	15
8-cluster	1	0	8	8
Triad	1	0	3	3
Dyad	6	2	10	12
No connections observed	49	14	35	49
Total	60	44	148	192

It is interesting to note that the internal and external actors are separated into disparate strong components. This can be seen from the fact that none of the components contain both types of actors. Instead, the external actors are clustered among themselves, forming a main connected region of 77 actors, a 15-cluster, an 8-cluster, a triad, and five dyads. The remaining 35 external actors constitute isolated single-actor components. The internal actors also form clusters among themselves, including a secondary component of 28 actors and a *dyad*. The remaining 14 trainers constitute single-actor components.

If the direction of ties is ignored, the network is clustered into only two weak components, and a mixture of internal and external actors is found to exist within each of these components. As can be seen in Table 6.4, the primary weak component consists of 168 (88%) actors, of whom 36 are GTC trainers and 132 are external actors. The secondary weak component consists of 21 (11%) actors, five of whom are GTC trainers and 16 are external actors. The remaining three (2%) actors who have no connections are all GTC trainers. As the direction of ties is disregarded for the weak component, the reachability in the primary and secondary weak components is 1.00, confirming that everybody is able to reach all the others within the observed components, which is the definition of a connected network.

Table 6.4. The weak network components in the GTC knowledge network

		Type of actors		
Type of Components	Components	Internal Actors	External Actors	Total Actors
Main component	1	36	132	168
Secondary component	1	5	16	21
No connections observed	3	3	0	3
Total	5	44	148	192

The density index of the weak primary component is 0.033, or 0.041 adjusted, indicating that this component is itself sparse and in it only about 4 percent of possible direct connections are actually present. The secondary weak cluster consists of 21 actors, 5 of whom are internal actors (GTC trainers) and 16 are external. The density of the secondary cluster is 0.025 or 0.028

adjusted. This suggests that only about 3 percent of the possible ties exist, which is also quite sparse for a network cluster of only 21 actors. The low density of the whole network discussed in the earlier part of this section and the low density of the connected components found here further confirm that the knowledge network of GTC trainers is indeed part of a loosely-bounded system.

As indicated earlier the whole network is not a single component, but consists of various components. Although a component is by definition connected and actors are reachable, various factors may constrain or prevent resources from flowing among reachable actors. One such factor is the distance between reachable actors. It can be assumed that resources will be likely to flow more freely and faster between actors who are closer to one another; that is, those who are separated by fewer steps, than among those who are more distant. Therefore, it is useful to examine the average distance between those reachable pairs.

The distance measure indicates how far, at minimum, network resources have to travel from one actor to reach the other. The measurement is based on *geodesic distance*, that is, the number of steps in the shortest path from one actor to another. Although in practice various factors may cause people to choose longer paths despite a shorter path being available, it is useful to consider geodesic distance because it does have advantageous characteristics. Theoretically, a geodesic path can be the most efficient and fastest connection between two actors because it does not have to depend on more than the minimum necessary number of actors. In addition, information that travels shorter distances is not prone to distortion, thus is likely to be more accurate.

As can be seen in Table 6.5, the average geodesic distance among reachable pairs is 3.154 (range, 1 - 8; standard deviation, 1.340). Assuming that actors actually use geodesic paths, the data suggested that an actor can reach another actor in about three steps on average. Although the diameter or the longest (geodesic) path in the network is up to 8 steps, the low standard deviation suggests that the geodesic distances values do not disperse too far away from the average of three steps. In fact, as clearly shown in the table, about 30 percent of the reachable pairs only require three steps to reach each other, compared to only 0.24 percent actors who require the maximum of eight steps.

Table 6.5. The distribution of geodesic distance in the GTC trainers' network

Distance	n	Percentage
1-step	1051	9.18
2-step	2817	24.61
3-step	3472	30.33
4-step	2319	20.26
5-step	1182	10.32
6-step	458	4.00
7-step	122	1.07
8-step	27	0.24
Total Reachable	11448	100.00

Mean distance, 3.154; Std. Dev., 1.340; Range, 1-8

It is also important to note that some actors have alternative geodesic paths that they can utilise. Considering reachable pairs only, the average number of geodesic paths between reachable pairs is 2.36 (standard deviation 2.54; range 1 to 39). In other words, there are about 2 shortest paths available for an actor to reach another actor.

The GTC Networks Centralisation

Another important feature worth considering is the extent to which a network is an equal or unequal social system. This notion is related to the concept of *centralisation* in social network analysis. Centralisation is based on the individual level concept of *centrality* which describes the position of individuals in terms of how close they are to the "centre of the action" in a network. Centrality measures indicate relative positional advantages or disadvantages of actors in terms of being a source or a destination of direct ties (*degree*), being closely connected to or from all the other actors (*closeness*), or being in the pathways between pairs of other actors (*betweenness*) in a network. Centralisation, which is of concern here, is an overall network measure, which considers the variability of individuals' centrality scores.

The concept of centrality, on which the centralisation measure is based, has been a subject of investigation for a long time. Bavelas was one of the earlier pioneers who introduced this concept for studying human communication (Freeman, 1977; Scott, 1991b). Freeman (1979), developed a family of centrality measures: degree, closeness and betweenness, which have been widely used in social network research.

Network analysts generally believe that the different aspects of central positions can be translated into power by virtue of more opportunities, fewer constraints, more choices, more autonomy and greater independence. Krebs (1998) points out that research has shown that employees who are central in key networks learn faster, perform better, and are more committed to the organisation. Network centralisation indicates how equal or unequal the manifestation of those centrality measures are distributed across all actors in the network.

A network is highly centralised to the extent that a few, or maybe just one, actors have much higher centrality than most of the other actors within the same network. In other words, network centralisation measures how centralised or unequal the distribution of degree, closeness, or betweenness across actors in a population is. It essentially measures the overall cohesion or integration of a network (Scott, 1991b). The network centralisation is measured as a ratio to the perfectly centralised star network of the same size. A star network is the most centralised; hence, the most unequal type of network.

The centralisation level of a knowledge network is important as it can reflect the distribution of knowledge or other learning resources. For example, a highly centralised network may impede the flow of knowledge resources. The different centralisation indices of the GTC network can be found in Table 6.6. The centralisation indices are expressed as percentages, where 100 percent indicates that the network is fully centralised and zero means the network is fully decentralised.

Table 6.6. GTC Trainers' overall knowledge network centralisation

Centralisation	Internal Actors	All Actors
Out-degree	17.63	8.70
Closeness[1]	25.94	22.83
Betweenness	7.05	7.60

[1]Closeness centralisation for the network representing all actors was measured on the weak primary component; for the internal actors only, closeness centralisation was measured on interconnections among GTC trainers who are part of the weak primary component

Degree

The degree of an actor is simply the number of other actors to whom he or she is directly connected; hence, it can also be used to indicate the actor's network neighbourhood size. An actor is central to the extent that he or she becomes the source or the destination of many ties, or being "in the thick of things" (Scott, 1991b). The degree of an actor may indicate his or her position's potential for activity in the network (Freeman, Roeder *et al.*, 1980). As a central actor in this regard has many alternative associates to go to, he or she has a better opportunity of receiving whatever is flowing through the network (Borgatti, 1995). Thus, degree centralisation indicates whether such opportunity is available to a few privileged actors (high centralisation) or accessible to most of the actors in general (low centralisation).

The focus here is on the *out-degree* centralisation because it indicates the extent to which the network provides the actors with equal opportunities to go to other actors and to access learning resources from them.

As can be seen in Table 6.6, if only the ties among the GTC trainers are considered, the out-degree centralisation is 17.63 percent, which is quite low. This suggests that the knowledge network constitutes a relatively equal system in terms of providing the trainers with direct access to learning resources possessed by their associates. The out-degree centralisation of 8.70 percent, when all actors are considered, indicates that the GTC trainers are part of a large but quite equal system of knowledge exchange. The low centralisation suggests that the number of direct ties among actors is more or less equal. In other words, none of the trainers have a network neighbourhood disproportionately larger than his or her colleagues. The network provided about equal chances for the trainers to receive learning resources through direct links.

Closeness

Unlike the *degree*, which only takes into account direct ties, the closeness centrality explains the structural position of an actor beyond his or her local neighbourhood by taking into consideration both direct and indirect ties that connect the actor to the rest of the network. Thus, closeness is a measure of global centrality. An actor is central in this regard to the extent that he or she has the smallest sum of geodesics to all other actors in the network (Freeman, 1979).

Closeness is useful in assessing the probability of actors being able to access information either directly or indirectly. It is a measure of independence from control (Freeman *et al.*, 1980). In addition, in the context of network diffusion, Borgatti (1995) interprets closeness as an index of the expected time until arrival at a given node of something flowing through the network. Thus, the overall network closeness centralisation indicates whether or not actors are equally or unequally close to one another. In the context of learning and knowledge dissemination, closeness centralisation indicates the extent to which the system provides the actors with efficient and timely access on an equal or unequal basis.

As noted earlier, the GTC network is not connected. Hence, closeness centralisation cannot be computed because distance between unconnected nodes was undefined or infinite. Therefore, closeness centralisations are measured on the main connected region of the knowledge network identified earlier (in Table 6.4). This approach is reasonable because the primary component contains 168 (88%) of all 192 actors. In addition, 78 percent of the internal actors, who are the main focus in this study, are represented in this component. Thus, the component is highly representative of the network as a whole. It is important to note that ties among actors within the primary component are symmetrised so that the component becomes connected, a condition for applying the closeness measure.

As can be seen in Table 6.6, the primary component is not highly centralised in terms of closeness as indicated by centralisation indices of only 26 percent for ties among the internal actors, or 23 percent for the ties involving both internal and external actors in this main component. The relatively low closeness centralisation indices suggest that the distribution of closeness centrality in the primary component, and perhaps in the GTC knowledge network as a whole, is quite balanced. The implication for knowledge distribution is that the trainers can access knowledge and other learning resources at more or less the same speed. If a new idea is introduced into the system, from a structural point of view the trainers should be able to hear about or adopt it at about the same time, provided that the idea strictly travels only through geodesic paths.

Betweenness

The idea of betweenness has been interpreted in different ways. Freeman (1977) noted three distinct interpretations of this concept. First, an actor central in terms of betweenness has power to control the communication of other people (Bavelas, 1948 and Shaw, 1954). Second, betweenness centrality incurs liability that puts stress on the central actor because he or she is responsible for the communication of other people (Shimbel, 1953). Third, a central person plays a unifying role because he or she can coordinate the activity of others (Cohn and Marriott, 1958). Borgatti (1995) seems to support the third view, noting that "betweenness indexes the extent to which a node's presence facilitates the flow of that-which-diffuses". Freeman is more inclined to the original idea of Bavelas, arguing that the importance of betweenness is in the potential to control information flow in the network. Thus, a central person in this respect can broker relationships or control the contacts of those requiring to pass through him or her to reach other people.

An actor is central in this regard to the extent that he or she falls on the *geodesic* communication paths of other pairs of actors. The more instances an actor falls on such *geodesic* paths the more central the actor is in terms of *betweenness*.

In the GTC networks considered here, betweenness across actors is quite homogenous as indicated by low centralisation indices of 7 percent for internal actors only, or 8 percent for all actors (`see Table 6.6). This suggests that a few privileged trainers do not have disproportionately higher control over the flow of learning resources than the others do.

Various measures have been applied to characterise the knowledge network of the GTC trainers. In general, the network is quite large, consisting of 44 trainers and 148 external associates. Because some trainers are isolates, the inclusiveness of the network is 93 percent. The knowledge network appears to be quite sparse. The network is also unconnected and a large proportion of trainers form isolated single-actor components. Although the trainers have extensive connection to external associates, they appear to be separated into different components in a strong sense. On average, reachable pairs are three geodesics apart from each other, and there are about two such paths for each pair of actors. As indicated by relatively low centralisation measures, the knowledge network is a quite balanced system, providing about equal opportunities or constraints to the network members in general in terms of degree, closeness and betweenness.

The Instrumental Relations for the GTC Trainers

Characteristics of the knowledge network, which combines four relations, have been examined in the previous section. The present section is concerned with each of the four relations making up the knowledge network, including communication, collaboration, advice-seeking and advice-giving relations. Each of these relations is treated as a network in its own right and is discussed along the same lines as the knowledge network in the previous section. As the concepts used have been explained alongside the discussion of the data for the knowledge network, the discussion here can focus primarily on the data for each of the uniplex networks.

It will be recalled from the discussion of the knowledge network that ties among external actors are constructed based on the perceptions of the internal actors. Because these ties are not specifically indicated as communication, advice exchange or collaboration, they cannot be included in each of the four separate networks. Although technically possible, it was not practical from data collection point of view to ask each and every respondent to indicate specifically the nature of each of the relations among their external associates along the four dimensions. In addition, it was not clear how accurate information of this kind would have been. A detailed discussion on this issue is given in Chapter 3. Thus, each individual network only contains connections among internal actors, and between internal actors and their external associates. Ties among these external associates are not included.

Each of these networks is a conduit for channelling a different type of learning resource. The communication network facilitates the distribution of general information and knowledge. Such learning resources may be directly or indirectly related to what the trainers need to know to execute their tasks, and may or may not be useful immediately. The collaboration network facilitates the development and exchange of more personal or tacit knowledge. Trainers pass on such knowledge to each other through joint involvement in concrete professional activities. These collaboration activities can be deliberately initiated or organised, but the learning processes embedded in them can take place consciously or otherwise. As Cross and Borgatti (2001a) suggest, tacit knowledge is obtained over time through repeated interactions. The advice-seeking network is a medium for obtaining expert knowledge or know-how from competent others. Results of the qualitative analysis suggest that advice-giving networks also support learning by providing opportunities for the advice givers to reaffirm and to enhance their own knowledge and understanding. Many trainers report that they can actually gain a better understanding of certain work-related matters after having a chance to give advice to their colleagues on an issue.

Theoretically, one might expect that these four different networks are the same size as they are drawn from the same set of 192 actors. However, some actors are part of one network but not others. Therefore, each network has a different level of inclusiveness, defined as the proportion of connected actors to the total number of actors in the dataset. As can be seen in Figure 6.3, the communication network is the most inclusive, in which more than 80 percent actors are connected, followed in descending order by the collaboration, the advice-seeking and the advice-giving networks. The advice-giving network has a particularly low inclusiveness with more than a half of the total number of actors not included in it.

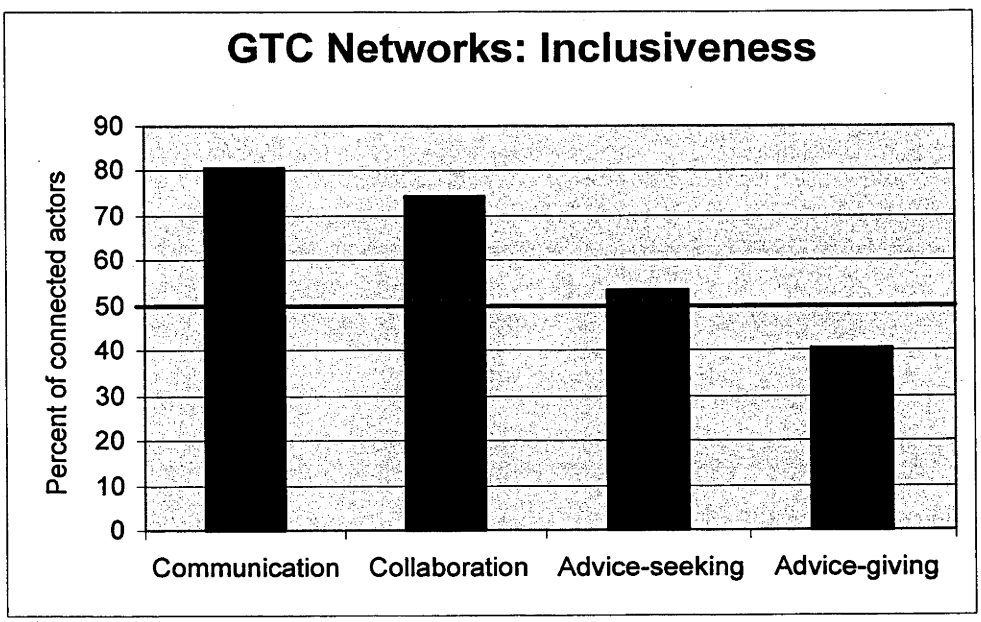


Figure 6.3. The inclusiveness of the networks in the GTC

The different degrees of actor inclusiveness across the networks seem to be influenced by the nature of resources circulating within each of the networks, or to reflect the value that the trainers attached to the resources. Thus, to some extent, the level of inclusiveness reflects the relative strategic importance of each network to the trainers. Communication exchanges normally take place serendipitously with a variety of people and involve mainly transmission of general information, some of which might not be very valuable or relevant to the trainers' learning needs. Thus, the trainers might feel more free to exchange such resources. In contrast, advice is a special type of resource and is presumably exchanged among people who have closer or stronger relations. In other words, the trainers seem to be more selective in choosing their advice-exchange partners than they are in determining information exchange or collaboration associates. This is consistent with Tough's (1971) finding, as noted by Cross (1981), where it is reported that locating competent help is one of the major problems in self-directed learning projects.

It is important to note that although there is no underlying continuum, measurements for the different networks are presented in line graphs. This is because the indices across the different networks appear to demonstrate a consistent pattern whereby the communication network is at the upper end and the advice-giving network is at the lower end of the measurement scales. Line graphs are used to highlight this trend, rather than imply a continuum.

The capacity of each network to spread learning resources embedded in it depends very much on its tie density. Figure 6.4 shows that all of the networks are quite sparse. When all actors are considered and the direction of ties is preserved, none of the networks reaches a density of one percent. Relaxing the criteria by disregarding the direction of ties results in only a slightly higher density. The density of the communication and the collaboration networks are above one percent. The density of the advice-seeking and giving networks, however, remains below one percent.

From Figure 6.4, it is noteworthy that the density across the different networks follows a consistent trend whereby the communication network is the densest, followed in descending order by the collaboration, the advice-seeking and the advice-giving networks. The decrease in density in that order is magnified when only interconnections among the GTC trainers are considered.

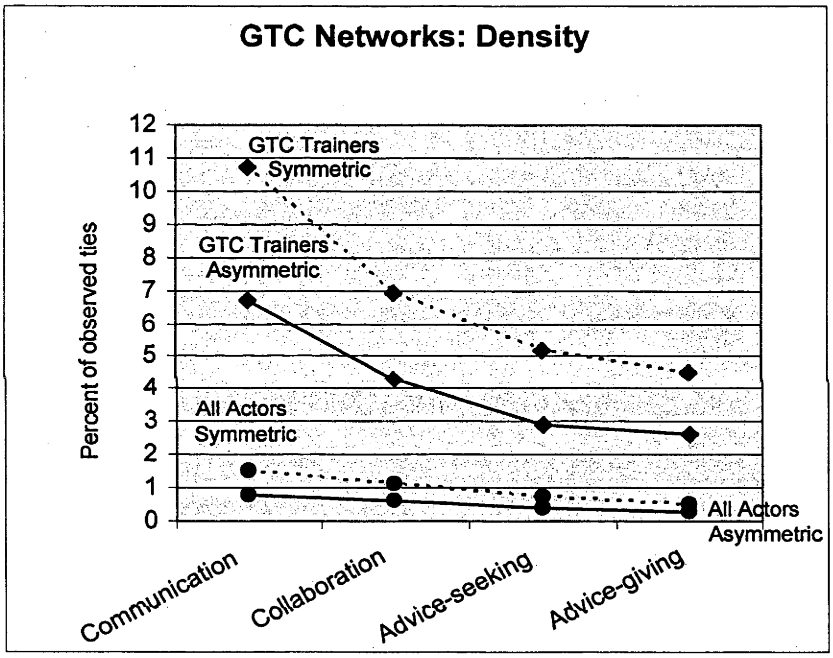


Figure 6.4. The density of the networks in the GTC

The interconnection among the GTC trainers (excluding external associates) was higher, where the communication network had a density of about 6.7 percent in asymmetric mode. The densities of the other networks are below five percent. The order and the trend remains the same, where the advice-seeking and the advice-giving remain the lowest. In symmetric mode, the density of the communication network is above 10 percent. The trend in density across the different networks is the same as that in the asymmetric mode.

As different networks carry different types of knowledge or learning resources, the density "trend" suggests that some learning resources flow more easily than other resources do. More specifically, the potential distribution of general information which is embedded in the communication network, and tacit knowledge in the collaboration network, are relatively better as there is a higher number of ties through which such resources can be transmitted. By the same token, technical know-how, commonly transmitted through advice-seeking and advice-giving networks, may be more difficult or slower to diffuse.

Sparse networks, however, may still be capable of disseminating learning resources to all members for as long as there are pathways of any length connecting all pairs of actors. Thus, the proportion of reachable pairs to all possible pairs of actors is important to examine. As can be seen in Figure 6.5, the reachability of all networks appears to also be low. It also follows the same trend as that associated with the density measure, where the communication and the collaboration networks appear to be the most reachable, while the advice-giving network is the least reachable. The reachability among GTC trainers is also higher than that among all actors.

When all actors and the direction of ties are considered, only the communication network has a reachability of 10 percent. All the other networks have less than 5 percent reachability. Disregarding tie direction indicates much higher reachability among all actors, accounting for over 50 percent for the communication network, about 40 percent for the collaboration network, about 20 percent for the advice-seeking network and just over 12 percent for the advice-giving network.

When only GTC trainers are considered and the direction of ties is asymmetric, reachability reaches 45 percent for the communication network, 21 percent for the collaboration network, 11 percent for the advice-seeking network and 5 percent for the advice-giving network. When the direction of ties is not considered, the percentage of reachable pairs among the internal actors is much higher, reaching 60 percent for the communication network, 47 percent for the collaboration network, 38 percent for the advice-seeking network and 35 percent for the advice-giving network.

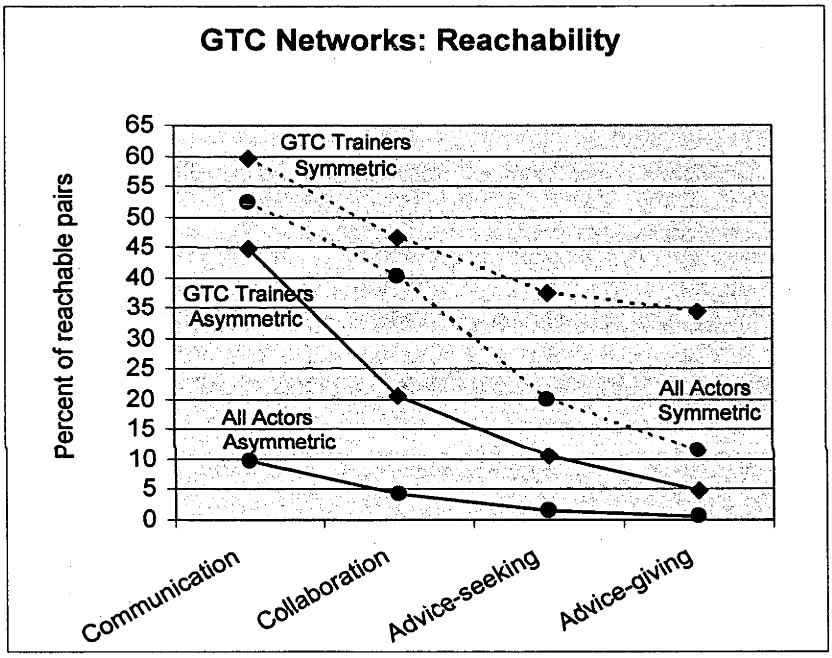


Figure 6.5. The reachability of networks in the GTC

These characteristics suggest that general information which could flow via communication relations has a higher possibility of diffusing through the communication network than the specific know-how in the advice networks (both advice-seeking and advice-giving). This applies to both internal actors' interconnections and to the ties among all actors.

The average distance among reachable actors across the four different networks demonstrates a contrasting pattern from those associated with the size, inclusiveness, density and reachability measures earlier, where advice exchange networks are at the lower ends of the measurements. As can be seen in Figure 6.6, when the ties are asymmetric, actors are closer to one another in the advice-seeking and advice-giving networks than they are in the communication and collaboration networks. For all actors, the average distances between reachable pairs in the advice-giving and advice-seeking networks are two and three respectively, compared to three steps in the collaboration network or four steps in the communication network. This trend also applies to ties among internal actors only. However, if the direction of ties is disregarded, the communication and collaboration networks indicate shorter average distances for the network members. Apparently, treating ties as symmetric reveals many shortcuts through which actors in the more dense networks, such as the collaboration and the communication networks, can be connected.

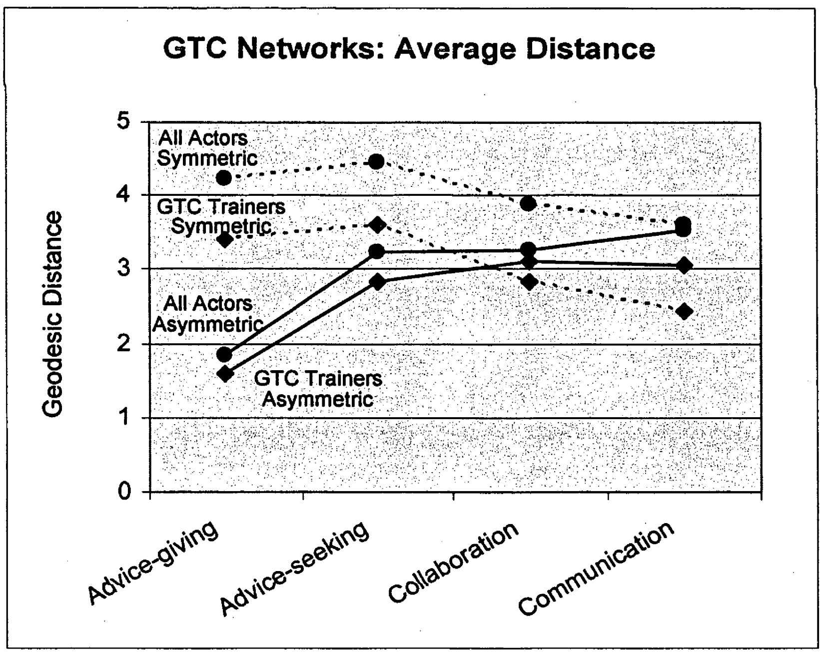


Figure 6.6. Average distance among reachable pairs in the GTC

The data seem to suggest that general information in the communication network tends to travel far and reach many people, while technical know-how in the advice-seeking and advice-giving networks travels shorter distances to reach a limited number of people. This could indicate the value that the trainers attach to different types of network resources. Technical expertise appears to be regarded by the trainers as a valuable asset; therefore, advice exchanges only occur among trainers whose ties possess specific characteristics, for instance, those that are stronger or more durable. General information, on the other hand, is not considered to be as highly valuable and, therefore, tends to be distributed more widely and more freely.

The number of geodesic paths connecting actors is another important feature to consider. Having more than one geodesic path can increase the likelihood of learning resources being distributed quickly. Figure 6.7 shows the familiar trend where communication and collaboration networks are at the higher end of the measurement scale and the advice exchange networks are at the lower end.

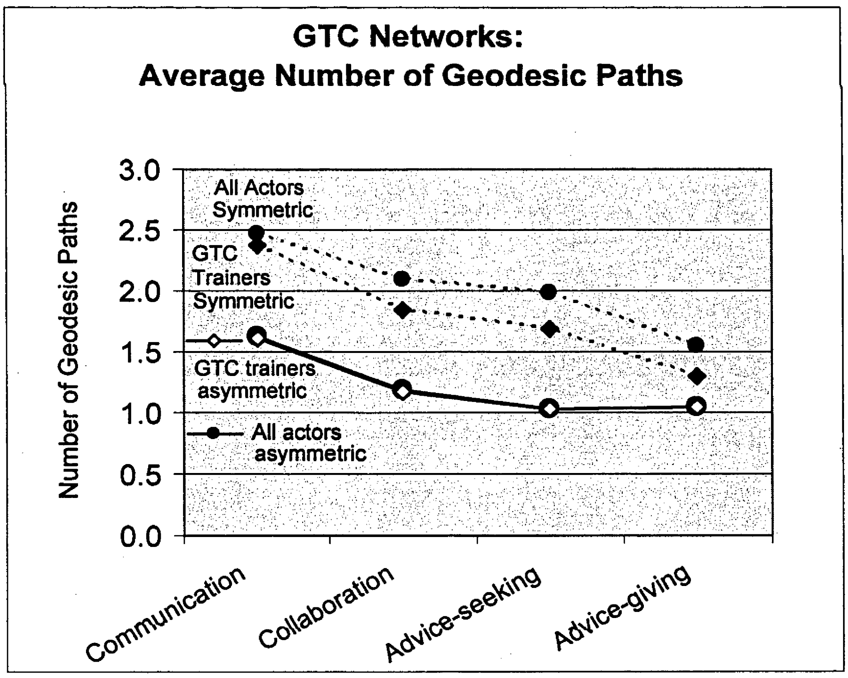


Figure 6.7. The average number of geodesic path in the GTC networks

It can be seen in the Figure 6.7 that if the direction of ties is considered, the average number of geodesic paths for internal actors and for all actors is almost identical, and this applies to all of the networks. It can also be seen that the communication network is the only one that provides an average of two geodesic paths among reachable pairs. The other three networks provide only one geodesic path on average.

If the direction of ties is not considered, the average number of geodesic paths between reachable pairs is not much higher. For the ties among internal actors, there is an average of two geodesic distances connecting reachable pairs, except in the advice-giving network where there is only one. For the ties among all actors, the average number of geodesic paths connecting actors can be rounded up to three for the communication network and two for the other three networks.

Earlier, it was found that none of the networks is fully traversable, indicating that the networks are not connected. The extent to which the networks are partitioned into components is shown in Table 6.7 and Table 6.8. In general, all networks are divided into several strong and weak components. Isolated single-actor components were dominant in all networks, especially when the strong component criterion is applied. The advice-seeking and the advice-giving networks have a higher number of isolated components and smaller component sizes compared to the communication and collaboration networks.

In Table 6.7, it can be seen that the communication network is the only one that has a strong component which might be regarded as a main connected region. However, this main connected region is quite small, containing only 26 (14%) of all actors. In addition, internal and external actors do not blend in the strong components. In all networks, the internal actors are clustered among themselves, while all the external actors form isolated single-actor components.

Table 6.7. GTC networks fragmentation into strong components

Network	Size and type	n	Internal Actors	External Actor	Total actors
Communication	26-cluster	1	26	0	26
	Dyad	1	2	0	2
	Isolated	164	16	148	164
Collaboration	11-cluster	1	11	0	11
	Triads	2	6	0	6
	Dyads	2	4	0	4
	Isolated	171	23	148	171
Advice-seeking	7-cluster	1	7	0	7
	Triad	1	3	0	3
	Dyads	2	4	0	4
	Isolated	178	30	148	178
Advice-giving	4-cluster	1	4	0	4
	Dyads	2	4	0	4
	Isolated	184	36	148	184

However, as Table 6.8 shows, if weak components are considered, all networks appear to have reasonably large components that can be regarded as main connected regions, and several smaller clusters, triads or dyads.

Table 6.8. GTC networks fragmentation into weak components

Network	Size and type	n	Internal Actors	External Actor	Total Actors
Communication	131-cluster	1	35	103	138
	16-cluster	1	4	12	16
	Isolated	38	5	33	38
Collaboration	121-cluster	1	33	88	121
	15-cluster	1	5	10	15
	7-cluster	1	2	5	7
	Isolated	49	4	45	49
Advice-seeking	86-cluster	1	33	53	86
	7-cluster	1	2	5	7
	4-clusters	2	2	6	8
	Dyad	1	1	1	2
	Isolated	89	6	83	89
Advice-giving	65-cluster	1	26	39	65
	5-clusters	2	4	6	10
	Triad	1	1	2	3
	Isolated	114	13	101	114

As can be seen in Table 6.8, the communication network has the largest main region, containing 138 actors, followed by the collaboration network with

121 actors in its main region. The advice-seeking and advice-giving networks consistently have much smaller components. In addition, in this weak definition of component, internal and external actors are mixed together.

The last network feature to consider is centralisation. As shown in Table 6.9, the highest centralisation index is only 29.98, corresponding to the closeness centralisation for the advice-giving network involving GTC trainers only. This indicates that advice from some GTC trainers has a higher likelihood of reaching their colleagues faster compared to the advice from the rest of the trainers in the network. However, the difference is too small for the closeness centralisation of the advice-giving network to be considered unique from the other centralisation measures for the other networks. Thus, in general, these networks constitute quite even relational systems.

Table 6.9. Centralisation of the uniplex networks in the GTC

	Internal Actors			All actors		
Network	Outdegree	Closeness	Betweenness	Outdegree	Closeness	Betweenness
Communication	16.93	26.19	10.58	8.13	26.13	2.52
Collaboration	19.36	22.73	7.84	9.92	26.45	1.63
Advice-seeking	13.74	23.37	3.08	8.58	19.37	0.44
Advice-giving	21.15	29.98	1.38	9.19	27.28	0.18

Note: Centralisation indices are expressed in percentage, and the higher the values the more centralised (unequal) the corresponding networks are

The four uniplex networks have been examined along several basic network concepts. The communication and collaboration networks on the one hand, and the advice-seeing and advice-giving on the other, occupy opposite ends of the measurement results continuum. The communication and collaboration networks are more inclusive, denser, more reachable and more integrated. On the contrary, the advice exchange networks, especially the advice-giving network, have lower scores for all these measurements. The only exception to this is in the average distance between reachable actors when the direction of ties is considered.

These structural features suggest that general information, which is exchanged mainly within a communication network, has the best chance to diffuse faster and more widely in the system. Such a learning resource should be easily accessible to the trainers as well as to all the other members of the communication network. In contrast, specific work-related technical know-how, which travels within the advice-seeking and the advice-giving networks, is constrained by these structural characteristics; hence, its distribution seems to be restricted to a small section of these networks.

Overall, the structure and the characteristics of the four networks provide information on the types of resources that are likely to disseminate more effectively than others. On the one hand, the communication network possesses characteristics that are more facilitative in supporting the flow of learning resources. On the other hand, the characteristics of the advice-seeking and advice-giving networks seem to have features that are likely to impede the flow of learning resources embedded in them.

The Knowledge Network in the Company Training Unit (CTU)

The trainers' networks in the Company Training Unit (CTU) will be analysed along the same lines as those in the Government Training Centre (GTC). The network concepts were explained alongside the data analysis for the trainers' network in the GTC. Therefore, this section now concentrates specifically on the characteristics of the trainers' networks.

Network Size and Density

There are 135 actors in the knowledge network of CTU trainers, which constitutes the size of the network. There are three isolates, all of whom are CTU trainers. Therefore, the inclusiveness of the network is 98 percent.

External actors seem to play an important role in this network. Of the 135 actors, only 31 (23%) are CTU trainers, the remaining 104 (77%) are external actors, that is, network associates other than the CTU trainers themselves.

These external actors are highly diversified, consisting of business clients who have been trained by the CTU trainers, managers and administrative as well as technical staff within the CTU, engineers and technicians from various private companies and some public servants from central as well as from local government agencies, and trainers from other training institutions. A small proportion of external actors are family members of the CTU trainers. Figure 6.8 shows the proportion of these external actor categories.

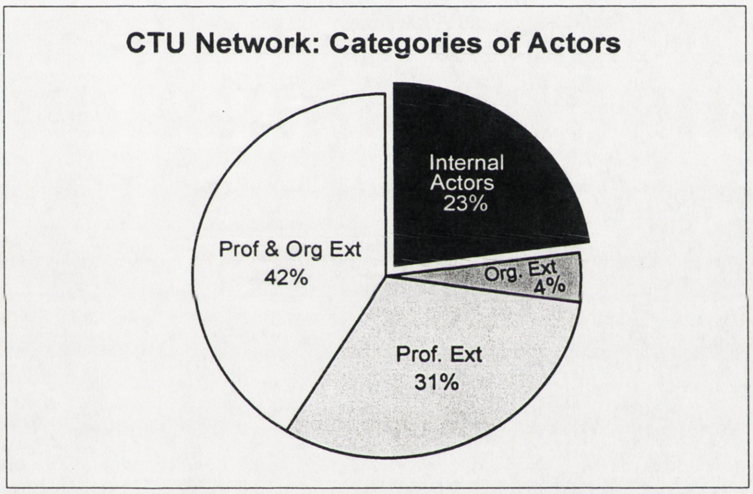


Figure 6.8. The category of actors making up the CTU trainers' networks

Of all the external actors, only 4 percent are organisationally external, 31 percent professionally external and 42 percent organisationally and professionally external. The data suggest that the CTU trainers tend to associate mainly with people who are the most remote from them; that is, those who are organisationally and professionally external. In contrast, the number of contacts with trainers from other organisations is very limited.

The importance of external actors can also be seen in the number of ties that the CTU trainers have to their external associates. As can be seen in Table

6.10, although the difference is small, the total number of ties connecting the trainers with their external associates is higher (52%) than those connecting them to their own colleagues (48%). At neighbourhood level, individual trainers appear to have a slightly higher average number of ties to external actors than to internal actors.

Table 6.10. Ties from the CTU trainers to internal and external actors

Number of ties from internal actors	To internal actors	To external actors
Within the network	154 (48.28%)	165 (51.72%)
Average within neighbourhood	4.97	5.32
Standard deviation	3.38	3.34
Range	0-14	0-11
None ties reported	3	4

It is also implied from the table that there are some cases where one external actor is named by more than one internal actor. In other words, some CTU trainers are connected to the same external associates. This is indicated by the fact that the number of ties the external actors receive (165) from the internal actors is higher than the number of external actors themselves (104).

For all 135 actors, there are 18,090 possible unique ties (ordered pairs), or 9,045 unordered pairs. As can be seen in Table 6.11, however, if the ties are asymmetric and all actors are considered, only 557 (3.1%) of these are actually observed to exist. The network remains sparser with a density index of 0.044 even when the ties are symmetrised. Taking into account the fact that 107 actors (all the 104 external actors and 3 internal actors) did not make nominations yields an adjusted density of 0.038, indicating that 3.8 percent of possible ties are actually present. This obviously still constitutes a quite sparse network. The density of interconnections among CTU trainers (internal actors only) appears to be higher with an index of 0.166, when ties are asymmetric and 0.230 when they are symmetric.

Table 6.11. The density of the CTU trainers' network

Type of Actors	Asymmetric	Symmetric
Internal actors only	0.166	0.230
External actors only[1]	0.022	0.023
Internal & external actors	0.031	0.044

[1]The interconnections among the external actors are based on interviewed actors' perception

In general, the CTU trainers' network is quite sparse, and hence not a very good medium for spreading knowledge. However, there are other characteristics which might compensate for the lack of cohesion, such as the reachability and the distance between actors.

Reachability, Network Components and Distance

If the direction of ties is taken into account, only about 21 percent of all possible pairs from the 135 actors can reach each other through a path of some length, which is a quite small proportion. The extent of the disconnection is reflected in the number of and the size of components that the network contains, as can be seen in Table 6.12.

The network is partitioned into 79 strong components, 72 of which are isolated single-actor components. Of the 135 actors, 53 percent form isolated single-actor components; and of the 31 CTU trainers, 23 percent constitute isolated single-actor components. The largest connected region is populated by 24 CTU trainers. No external actor belongs to this main region. The second largest component contains 19 external actors. No internal actor belongs to this secondary region. The external actors are further divided into a cluster of 11, a triad and 3 dyads. Thus, the CTU trainers and their external associates are separated into disparate components. The identified components contain either all CTU trainers or all external actors. Though CTU trainers may benefit from having associations with external actors, the benefits may not be maximised because they do not belong to the same strong components, within which learning resources can flow more freely and easily (see Scott, 1991a).

Table 6.12. The strong network components in the CTU knowledge network

		Type of actors		
Type of Components	Components	Internal Actors	External Actors	Total Actors
Main component	1	24	0	24
Secondary component	1	0	19	19
11-cluster	1	0	11	11
Triad	1	0	3	3
Dyad	3	0	6	6
No connections observed	72	7	65	72
Total	79	31	104	135

If the direction of ties is disregarded, all actors are reachable as indicated by a reachability index value of 1.00. This reachability, however, does not necessarily guarantee that network resources automatically disseminate to all actors. Reachability simply indicates that there is a path between a pair of actors, irrespective of how many other actors may fall on it. The actual use of such paths to access resources depends on many other factors, one of which is the distance between reachable actors. Actors who are directly connected to each other are more likely to be involved in exchanges of information than those who are several steps apart. This also implies that the speed of resource exchange within a network might be faster when actors are closer to one another. It is, therefore, beneficial to consider the distance between reachable actors in the CTU knowledge network.

The distance between two actors is indexed by the geodesic, that is, the shortest path or the fewest number of steps separating a pair of actors. As can be seen in Table 6.13, the average distance between reachable pairs is 2.727 (standard deviation, 1.128; range, 1 to 7). This indicates that the CTU trainers are able to reach the others in about three steps on average. In fact, the modal distance is 3-steps (32%). The next most common is 2-steps (29%). There is one instance of 7-step distance. Thus, the CTU trainers are not very far from one another. In a real social situation, people could still access information from others three steps away, although it may take longer for the information to get across this distance.

Table 6.13. The distribution of geodesic distance in the CTU trainers' network

Distance	n	Percentage
1-step	557	14.67
2-step	1106	29.14
3-step	1213	31.95
4-step	687	18.10
5-step	202	5.32
6-step	30	0.79
7-step	1	0.03
Total Reachable	3796	100.00

Mean distance, 2.727; Std. dev., 1.128; Range, 1-7

The average number of geodesic paths connecting reachable pairs is 2.23. This indicates that CTU trainers have a spare geodesic path that they can utilise to reach their network partners if one of them breaks down.

The CTU Network Centralisation

As shown in Table 6.14, the out-degree centralisation of the network when only the CTU trainers are considered is 31 percent. If all actors are taken into account, the degree centralisation is quite low (12%). This suggests that there are only a few central actors who have access to slightly larger numbers of actors in their network neighbourhoods than others do. This applies to interconnections among CTU trainers only as well as to interconnections among all actors. In other words, the CTU trainers' network can still be regarded a fairly equal system of relations from the degree centrality point of view.

Technically, closeness centralisation cannot be computed for the unconnected network, as there are infinite distances. However, if the ties are assumed symmetric, the knowledge network is connected. Therefore, closeness centralisation is computed from the knowledge network with ties symmetrised.

Closeness centralisation for interconnections among the CTU trainers is only 33 percent. If their external associates are included, closeness centralisation is slightly lower (29%). Although the closeness centralisation indices are larger than those of the other centralisation measures, they are still not large enough for the network to be regarded as highly centralised in terms of closeness. Thus, the network in the CTU may still be considered a fairly equal social structure from the closeness point of view. This suggests that all actors have a relatively similar potential speed of access to learning resources in the network (provided that these resources strictly travel only through geodesic paths).

Table 6.14. CTU trainers' overall knowledge network centralisation

Centralisation	Internal Actors	All Actors
Out-degree	31.11	11.94
Closeness[1]	32.87	28.87
Betweenness	14.87	3.75

[1]Closeness centralisation is measured on the symmetrised CTU trainers' network

It can be seen in Table 6.14 that the betweenness centralisation indices are also quite low. The betweenness centralisation for the interconnections among CTU trainers is only 15 percent. The index is much lower (4%) when their external associates are included. These centralisation indices still reflect a balanced social network structure from the point of view of betweenness, suggesting that none of the trainers are much more powerful than the others in controlling the flow of learning resources.

Overall, the knowledge network of the CTU trainers involves a quite substantial proportion of external actors who come from various organisational and professional affiliations. The network is quite sparse. If the direction of ties is considered, only 21 percent of all possible pairs of actors are reachable. The disconnection seems to be defined by actor types, where 24 CTU trainers form the primary component among themselves, and 19 external actors form the secondary component among themselves. However, if the direction of ties is disregarded, the knowledge network is fully traversable. For the reachable pairs of actors, there are three steps on average separating them, and they have about two such paths. The knowledge network constitutes an even system in terms of degree, closeness and betweenness centralisations.

The Instrumental Relations for the CTU Trainers

The description of each of the four networks has been given as part of analysing the GTC trainers' networks. Therefore, this section should be brief and concentrates mainly on discussing the data.

The networks in the CTU contain 135 actors. Every actor is connected by at least one of these social relations: communication, advice-seeking, advice-giving or collaboration. When each of these relations is regarded as a social network in its own right, not all of the actors belong to every one of these separate networks. Thus, each network has a different degree of inclusiveness. As can be seen in Figure 6.9, the collaboration network is the most inclusive, in which about 79 percent of all actors are connected, followed in descending order by the advice-giving network (76%), the communication network (68%) and the advice-seeking network (62%). It is evident from the diagram that the differences in levels of inclusiveness across the four networks are not great.

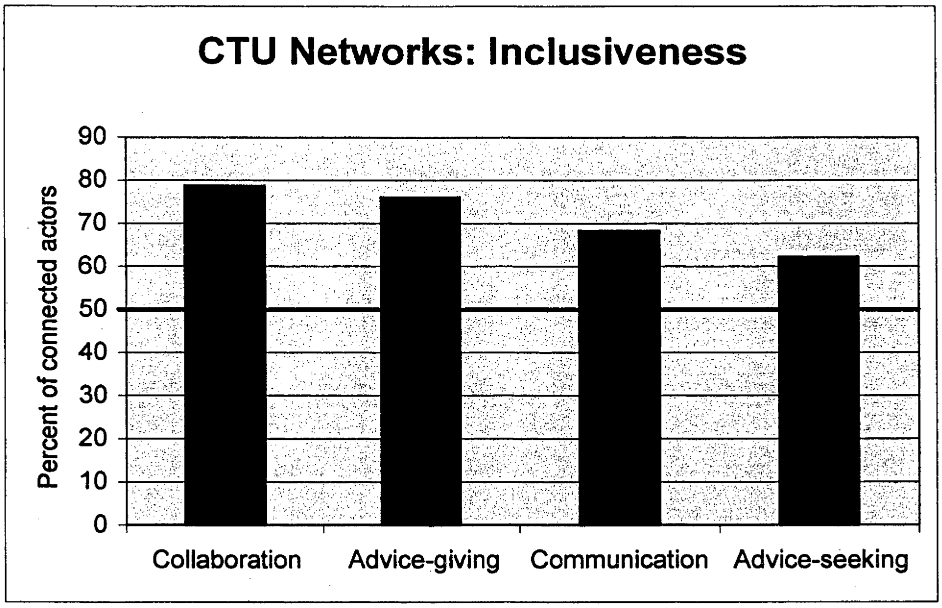


Figure 6.9. The inclusiveness of the network in the CTU

It is important to note that the different measurements across the networks for the CTU also demonstrate a consistent trend where the collaboration network is at the upper end and the advice-giving network is at the lower end of the measurement scales. Therefore, line graphs are also used to highlight this trend, but not to imply an underlying continuum.

Size seems to always correlate negatively with density. As can be seen in Figure 6.10, there is a high discrepancy in the density between the interconnections among all 135 actors and the interconnections among the 31 CTU trainers. When all actors are considered, the density is only about 1 percent and 2 percent for asymmetric and symmetric relations respectively for all of the networks. However, when only interconnections among the CTU trainers are examined, the density indices range from 8 to 13 percent if ties are asymmetric, or up to 14 to 20 percent if ties are symmetrised.

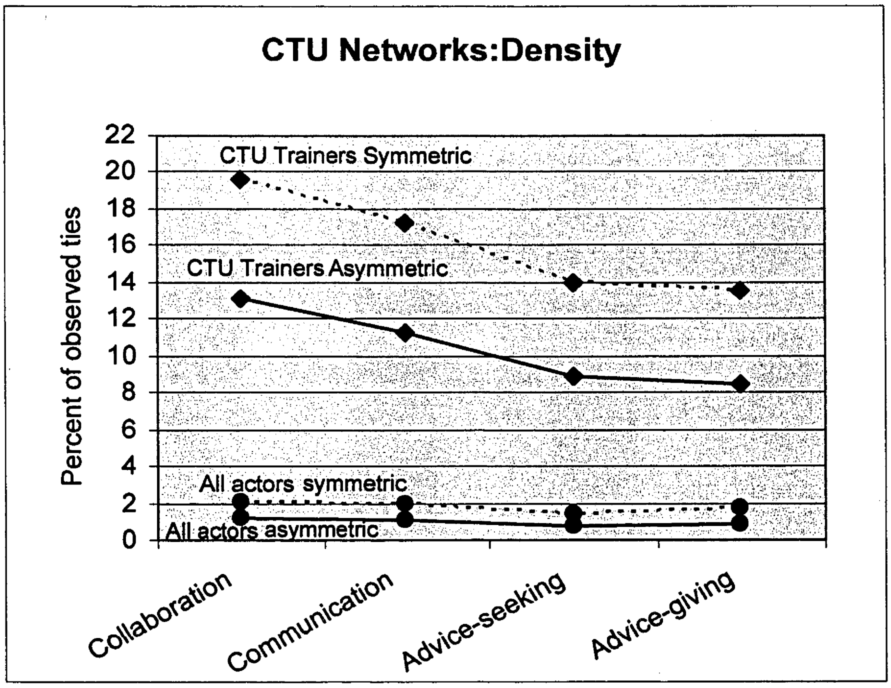


Figure 6.10. The density of the networks in the CTU

It is worth noting that the collaboration network appears to be the densest, followed in descending order by the communication, advice-seeking and advice-giving networks. Having the collaboration network as the densest network suggests that the CTU trainers potentially benefit from being able to access not only each others' explicit but also implicit knowledge, in which collaboration networks are rich.

Besides being the most inclusive and the densest, the collaboration network also contains the highest proportion of reachable pairs of actors. As shown in Figure 6.11, although only about 17 percent of all pairs among the 135 actors in it are reachable if ties are asymmetric, the proportion is considerably higher, reaching 73 percent, when only ties among internal actors are considered. If collaboration relations are considered symmetric, every CTU trainer is able to reach all the others as indicated by a reachability index of 100 percent. However, advice exchange networks are the lowest in terms of reachability.

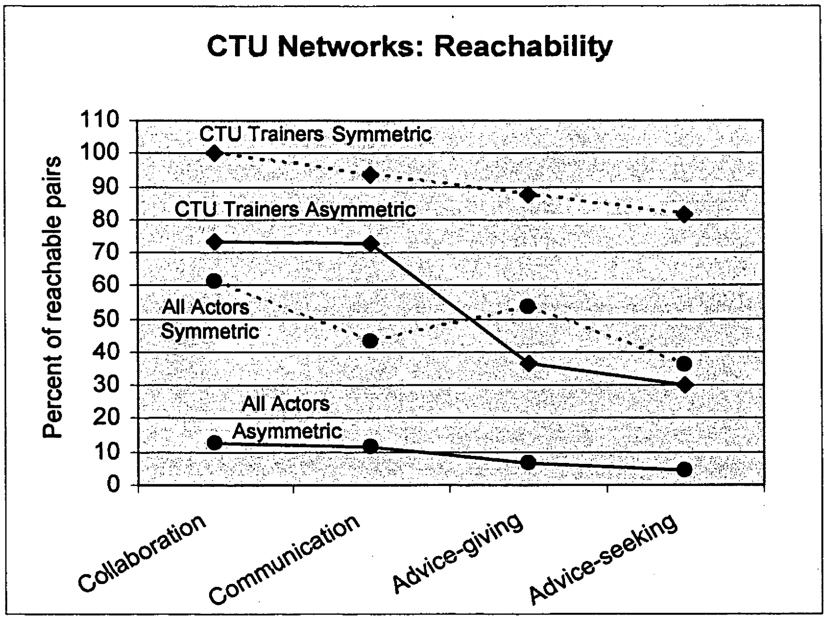


Figure 6.11. The reachability of the networks in the CTU

If ties are considered asymmetric, the distance tends to increase steadily from advice-seeking and advice-giving networks towards the collaboration and communication networks. As can be seen in Figure 6.12, unlike the other measures where collaboration and communication networks show more advantageous characteristics, for distance measure advice-seeking and advice-giving networks appear to be stronger as indicated by shorter distances among the actors in them. Reachable actors in the advice-seeking network are only separated by an average of two steps, compared to about three steps in the other networks. However, if the ties are symmetrised, the collaboration and communication networks tend to have the shortest distance separating the actors. This is because in symmetrised form, where it is assumed that information and/or resources can flow in both directions even if only one of a pair of actors names the other, there are more shortcuts, especially in the denser networks such as the collaboration and the communication networks.

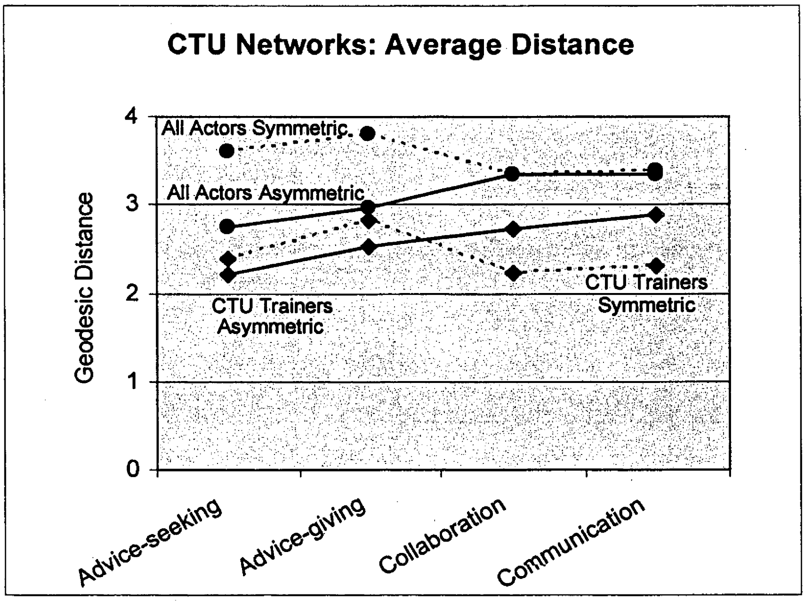


Figure 6.12. Average distance among reachable pairs in the CTU

However, being overly precise here is not very meaningful because there is no half geodesic distance as such. Therefore, although the graph shows an increasing or a decreasing trend, rounding the figures results in similar distances, or at most a difference in distance by one step. Nevertheless, with a larger network this trend may represent an important difference across the various networks.

Except in the advice-seeking network, there are two geodesic paths, on average, connecting reachable actors in the networks, as can be seen in Figure 6.13. There is an obvious trend for the number of geodesic paths to decrease from the collaboration network towards communication, advice-giving and advice-seeking networks. However, rounding the figures renders the difference in geodesic counts small. Again, with larger and denser networks the difference may become more pronounced.

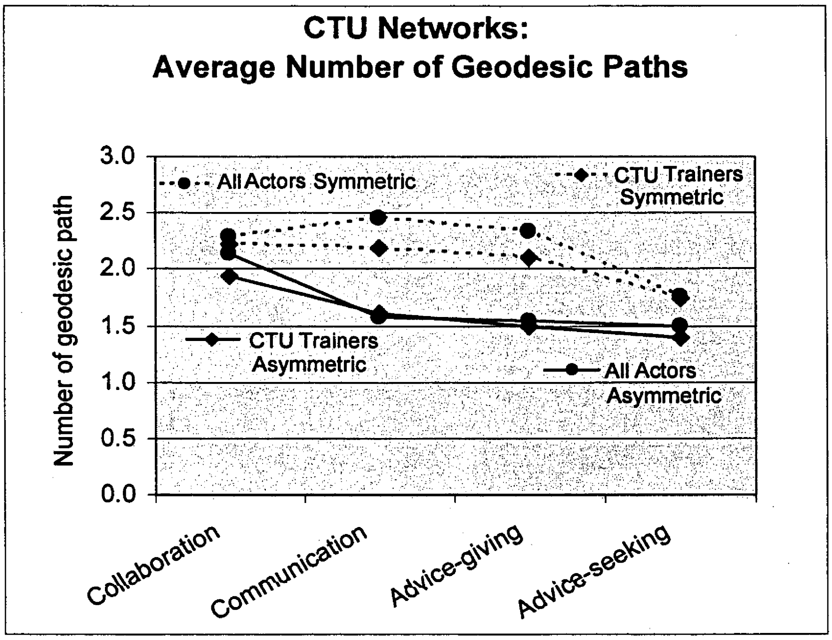


Figure 6.13. The average number of geodesic path in the CTU networks

The extent to which reachability is reflected in network partitioning can be seen in Table 6.15 and Table 6.16. In general, these networks are fragmented into many small components. In fact, isolated single-actor components are dominant in terms of strong and weak components.

Table 6.15. CTU networks fragmentation into strong components

Network	Size and type	n	Internal Actors	External Actor	Total actors
Communication	23-cluster	1	23	0	23
	Isolated	112	8	104	112
Collaboration	22-cluster	1	22	0	22
	Isolated	113	9	104	113
Advice-seeking	8-cluster	1	8	0	8
	Triad	1	3	0	3
	Dyads	3	6	0	6
	Isolated	118	14	104	118
Advice-giving	10-cluster	1	10	0	10
	7-cluster	1	7	0	7
	Dyad	1	2	0	2
	Isolated	116	12	104	116

As can be seen in Table 6.15, the strong components are generally small. The largest one is found in the communication network, containing 23 actors, and in the collaboration network containing 22 actors. For the advice-giving and advice-seeking networks, the largest strong components contain only ten and eight actors respectively. CTU trainers also cluster among themselves, separate from their external associates. All of their external associates form isolated single-actor components.

However, as shown in Table 6.16, when weak components are considered, all of the networks contain quite large primary components. CTU trainers and their external associates mix together in these components. It is interesting to note that none of the CTU trainers form isolated component, except the one in the advice-seeking network.

Table 6.16. CTU networks fragmentation into weak components

Network	Size and type	n	Internal Actors	External Actor	Total actors
Collaboration	106-cluster	1	31	75	106
	Isolated	29	0	29	29
Advice-giving	99-cluster	1	30	69	99
	4-cluster	1	1	3	4
	Isolated	32	0	32	32
Communication	89-cluster	1	30	59	89
	Triad	1	1	2	3
	Isolated	43	0	43	43
Advice-seeking	81-cluster	1	29	52	81
	Triad	1	1	2	3
	Isolated	51	1	50	51

Weak components are generally larger, with the collaboration network having the largest connected region, linking 106 actors. Surprisingly, the advice-giving network has the second largest connected region, linking 99 actors. The collaboration network seems to be better connected. This implies that the CTU trainers have better access to each others' hidden or tacit knowledge than to other learning resources.

As can be seen in Table 6.17, the relatively low centralisation indices for the uniplex networks demonstrate that these networks constitute quite even structures. The highest centralisation index is 33.49, corresponding to the closeness centralisation for the advice-giving network involving internal actors only. This indicates that advice from some CTU trainers has a higher likelihood of reaching others faster compared to that of their colleagues. Nevertheless, the difference is too small for the closeness centralisation of the advice-giving network to be considered unique from the other centralisation measures for the other networks.

Table 6.17. Centralisation of the uniplex networks in the CTU

	Internal Actors			All actors		
Network	Outdegree	Closeness	Betweenness	Outdegree	Closeness	Betweenness
Communication	33.11	34.21	29.21	10.96	28.96	5.53
Collaboration	34.67	34.79	15.73	13.80	32.42	3.23
Advice-seeking	28.67	28.74	4.98	10.45	28.26	1.00
Advice-giving	18.89	33.49	10.85	11.09	28.46	2.28

Overall, the collaboration and the communication networks appear to have higher indices in almost all of the measures used. Compared to the advice-seeking and advice-giving, they are more inclusive, denser, and they contain a higher proportion of reachable pairs of actors, higher average number of geodesic paths connecting reachable pairs, and are less fragmented. However, there is no major difference in terms of centralisations. All of the networks can be regarded as equal or balanced relational systems.

Implications of the Network Features

The results of the data analysis have revealed characteristics of the networks in which the trainers from the two training institutions are embedded. The two groups of trainers have some similar characteristics, but they also exhibit some differences. Some of these characteristics reflect strengths of the networks, but some others may be regarded as weaknesses.

Although the CTU trainers form slightly denser networks, both groups of trainers can be regarded as part of loosely bounded learning systems. This is indicated by the fact that their networks have low densities despite being measured in different ways and taking into account various factors. Some would argue a sparse network cannot effectively support informal learning processes because there are too few pathways through which learning resources may disseminate. Such a condition might cause some regions to prosper while the others are resource-poor.

Although such an assumption is reasonable, some social scientists have demonstrated that sparse networks can be beneficial (see, for example, Granovetter, 1973; Burt, 1992; Krackhardt and Hanson, 1993; Krebs, 1998). One of the main arguments for the benefits of a sparse network is that it contains many missing links which leaves 'vacancies' in the network structure, thus giving rise to "structural holes" (Burt, 1992); a strategic network position on which diverse knowledge and ideas intersect. The principal argument emanating from this theory is that actors who span network chasms are exposed to non-redundant information. Consequently, they are likely to adopt or develop alternative ways of thinking and behaving, and are at higher risk of having good ideas (Burt, 2004). Likewise, Krebs (1998) believes that innovative products and services can be created from such an advantageous position because a node spanning the right structural holes may receive a diverse combination of information and knowledge available to no one else in the network.

It can also be argued that networks have the potential to become vibrant loci for learning and knowledge sharing, despite being sparse, on the basis of the characteristics of the ties linking the actors. These sparse networks may be more efficient, perhaps, in the sense that there are fewer redundant links (though this can give rise to other kinds of weaknesses). This assumption arises from Granovetter's (1973) seminal work on the "strength of weak ties", suggesting that weak ties are more likely than strong ties to be bridges to more distant regions of a network and, therefore, capable of passing new or competitive information. In a dense network, members tend to be confined to local norms, knowledge, and "provincial news and views of close friends" (Granovetter, 1982, p. 106). Subsequent studies on the importance of weak ties have demonstrate that weak ties can be instrumental in finding jobs (Granovetter, 1982), in closing deals in banking (Mizruchi and Stearns, 2001), and for individual advancement (Burt, 1992; 1997; 2000). In addition, Valente (1995) argues that Granovetter's (1973) theory of "Strength of Weak Ties" is essentially a diffusion model, and that weak ties facilitate the diffusion of innovation by connecting otherwise unconnected groups, and accelerate the diffusion of innovation by providing short ties between actors.

The extensive connections to external actors constitute another important characteristic that is worth highlighting. The trainers seem to rely a great deal on their external associates in learning and in accessing learning resources. This is evident from the fact that the number of external actors is far greater than the number of internal actors. Also, the total number of ties to external actors is larger than the number to internal actors, and the average number of external actors in the trainers' network neighbourhoods is also larger than ties to internal actors.

Despite the general similarity, the extent to which external actors are involved is more pronounced in the GTC trainers' networks. In addition, the two groups of trainers differ in terms of the proportion of each external actor category. The GTC trainers associate with the three external actor categories (organisationally external, professionally external as well as both organisationally and professionally external) in balanced proportions. The CTU trainers, however, have very limited contact with organisationally external actors, who are trainers from other training organisations.

The difference is attributable to the different needs and priorities of the trainers, their organisational arrangements, and their work organisations. Such differences expose the each group of trainers to potentially different types of learning resources. For the CTU trainers, they have access to the knowledge of what their customers or potential customers need because they interact mostly with those who are professionally and/or organisationally external, consisting of people who had or would use their services. This is essentially a reflection of the customer-oriented nature of the CTU as a commercial organisation. The GTC, as a public organisation, on the other hand, is not subjected to the same level of pressure to satisfy customers as a means of survival. Consequently, the trainers are not stimulated to associate with certain groups of people, resulting in associations with a more balanced proportion of external actor categories. This suggests that that the GTC trainers are exposed to more diverse learning resources than their counterparts in the CTU.

Despite the differences and the possible exposure to different kinds of learning resources, the fact that both groups of trainers have extensive connections to external entities constitutes a strength, which could offset the weakness of having sparse network structures. Connections to these external associates can be regarded as weak ties as these external actors are organisationally, professionally, and physically remote from the trainers. Thus, they have access to more diverse knowledge and learning resources than they would otherwise have if they only interacted internally with their own colleagues.

Apart from the structural advantages of having weak ties with external associates, the characteristics of the external associates themselves can also bring learning benefits. As these external actors come from diverse organisational and professional backgrounds, they can help to form a vibrant learning environment, and provide trainers with rich learning resources, which may be different from those already circulating within the trainers' immediate work environment.

As Araujo (1998) argues, informal relationships between individuals belonging to different organisations provide not only opportunities to exchange ideas, information, favours and other resources, but also help learning and provide opportunities to search for new knowledge. The importance of external associates is also reported by Liebeskind, Oliver, Zucker and Brewer (1996) in their study of organisational learning in two new biotechnology firms, in which they find that scientists in the two firms use a very wide external-scientists collaborators to access scientific knowledge at numerous institutions. Similarly, Powell (1998) argues that organisations that are positioned in a network of external relations adopt more administrative innovations earlier.

The networks of the CTU trainers are slightly more reachable than are those of the GTC trainers. None of the networks in the GTC is fully traversable irrespective of whether the ties are symmetric or asymmetric, or whether all or only internal actors are considered. In contrast, the networks in the CTU contain a higher proportion of reachable pairs of actors, except for the knowledge network in asymmetric mode. In fact, the knowledge network in the CTU is fully reachable in symmetric mode, and that applies to the interconnections among the internal actors as well as interconnections among all actors. The symmetric communication network involving internal actors only is also fully reachable. This could imply that there is a higher possibility of learning resources in the CTU being disseminated to all actors, compared to the GTC. As will be discussed later in Chapter 8, the difference in reachability as well as in some other network measures has something to do with the physical and non-physical organisational arrangements. It is sufficient to indicate here that the GTC trainers are physically distributed in several places, whereas the CTU trainers are all located in one area.

Despite the difference above, the networks are equal in that none of them are reachable in a strong sense (if the direction of ties is considered). In addition, in the strong components, the internal and external actors are not mixed. Scott (1991b) argues that strong components indicate the sets of actors among whom resources such as knowledge, ideas and information may flow easily and freely. Therefore, although the two groups of trainers have a large number of connections to the external actors who could bring alternative views, ideas and knowledge into their internal communities, they cannot get maximum learning benefits as the learning resources are rather restricted by structural features.

Another important feature of these networks is the distance of paths connecting reachable pairs of actors. Of all the networks in both organisations, the greatest average distance is four steps, indicating that there are three intermediaries on average between pairs of actors. Although this seems to be a large number, it is important to stress that geodesic distance is a very strict type of path. For knowledge or other learning resources that the trainers exchange, their diffusion might not depend entirely on geodesic paths. In fact, according to

Stephenson and Zelen (1989), actors may not use geodesic paths, despite them being available, due to random communication patterns or deliberate efforts by actors to conceal information. In addition, Borgatti (2005a) notes that informational resources such as gossip or email messages do not necessarily travel through geodesics; but rather, they can spread by parallel or serial duplications through paths. Thus, the four geodesics is a worst case scenario. Assuming that the learning resources strictly travel through the shortest paths, they require a maximum of four steps. Therefore, there is a possibility that the maximum of four steps is not a major impediment to the dissemination of knowledge and other learning resources, as even longer paths may be used.

An interesting pattern also emerges from the characteristics of the four uniplex networks. The communication and collaboration networks, on the one hand, and advice-seeking and advice-giving on the other, seem to display contrasting features. The communication and collaboration networks are generally at the higher end of the measurement scales. For example, these two networks are more inclusive, denser and more reachable, and less fragmented. Advice-seeking and advice-giving networks, in contrast, are less inclusive, sparser, less reachable, and more fragmented. The only measurement where the advice-seeking and the advice-giving networks are stronger is in the average distance between reachable actors with asymmetric ties. This suggests that general work-related knowledge, information, and tacit knowledge may be widely circulated and may come from distant sources. However, personal advice, tips or tricks may only flow within a limited circle in which actors can reach each other fairly quickly. This seems to reflect the value of advice which may constitute an important – perhaps strategic – resource that people exchange only primarily with their close associates.

The networks in both organisations constitute fairly even structures, as indicated by low centralisation indices, providing the trainers with more equal opportunities to access different types of learning resources. Although not highly different from the other centralisation measures, the advice-giving networks involving internal actors in both organisations appear to be the most centralised. This seems to suggest that there are some influential actors in both organisations, whose advice is more highly accessible compared to others.

There are, however, some characteristics which might be regarded as weaknesses for both networks. That is, the networks are unconnected, having low overall reachability, and a large number of isolated single-actor components. This may present obstacles to the transfer of learning resources. In addition, the unconnected actors, as individuals or isolated single-actor components, cannot benefit from the network, nor can the network benefit from them. Furthermore, as indicated earlier, the trainers in both organisations are separated from their external associates into different strong components, within which learning resources are expected to flow more freely and more easily. This applies to the four uniplex networks and to the knowledge networks which combine these four uniplex networks.

To conclude, the analyses reveal some basic characteristics of the networks of informal social relations pertaining to learning and knowledge exchange, in which the trainers from two different training institutions are embedded. Some of the characteristics constitute potential advantages, such as the potential for the networks to support innovation and access to diverse ideas from outside the trainers' immediate environments. However, there are also some features which could potentially impede the flow of learning resources, such as the high degree of fragmentation, especially for the networks in the GTC, and the existence of single-actor components in large number.

Obviously, there seems to be a need for bridge-building in order to integrate the different parts of the networks, so that cross fertilisation of diversified knowledge and ideas from disparate parts of the systems can be facilitated. Nevertheless, combined with positive features such as the extensive and diverse external connections as well as the relatively short distance between actors, the networks can still constitute rich learning environments.

CHAPTER SEVEN. EXPLORING SUBSTRUCTURES IN THE TRAINERS' NETWORKS

The basic features of the networks have been discussed in the previous chapter. The present chapter is concerned with the internal substructures of the networks by examining cohesive subgroups contained in each of the networks. More specifically, the chapter investigates whether the networks contain cohesive subgroups, and if so, what the characteristics of these subgroups are and what implications they have for informal learning and knowledge exchange among the actors involved.

The concept of a group is important in sociology. In social network studies, examining subgroups that make up a network has been one of the important goals of social network analysts. This interest dates back to as early as Moreno's (1934) pioneering work on *sociometry* (Seidman, 1983; Frank, 1995). According to Freeman (1992), one of the forms of human groups that has been continually of interest among investigators is one which is relatively small, informal, and involves close personal ties.

It is important to note, however, that this chapter concentrates on cohesive or proximity based analysis of subgroups. It is a basic method and a good starting point to explore complex network structures such as the ones under investigation. It is different from the relatively more recent equivalence-based method of defining clusters used in the next chapter, which aggregate actors who exhibit similarity in their patterns of relations.

The rest of this chapter is organised into several sections. The first section discusses the conceptual background of cohesive-based subgroup analysis. In particular, it outlines some of the concepts, definitions and tools for identifying subgroups in a network. The second section addresses the specific procedures and techniques used in analysing subgroups in this study. The third part focuses on actually identifying and examining subgroups in the networks in the two organisations: the Government Training Centre (GTC) and the Company Training Unit (CTU). This analysis focuses specifically on the number and size of subgroups, their level of separation or integration and the roles played by certain network actors. Finally, the characteristics of subgroups in the two organisations are compared and contrasted.

The Concepts of Cohesive Subgroups

Decomposing a social network into its constituent subgroups may provide a better understanding of its structure. Of particular interest here are cohesive subgroups, groups of actors whose choices of one another are greater in both number and intensity than the choices between them and non-members (Fershtman, 1997). More generally, cohesive subgroups are "subsets of actors among whom there are relatively strong, direct, intense, frequent, or positive ties" (Wasserman and Faust, 1994, p. 249).

Various intuitive ideas about cohesive subgroups have generated a number of different theoretical conceptualisations such as cliques, clusters, components, cores and circles (Scott, 1991b). In general, these different models can be divided into two main categories; those based on distance and those based on tie density (Everett and Borgatti, 1999). Wasserman and Faust (1994) divide them more specifically into subgroups based on *reachability* or *diameter*, and those based on nodal *degree*.

Analysis of distance-based subgroups or "maximal strong component[s]" (Burt, 1982, p. 39) attempts to identify subsets in the network, where actors in each subset are closer to one another than to those outside the subset.

Distance or reachability based subgroups according to Erickson (1988) are suitable for processes that require intermediaries such as diffusion (cited in Wasserman and Faust, 1994). As this study deals with such processes; that is, dissemination of learning resources, the subgroup concepts which fall within this category will be discussed in more detail. These include *cliques* (Luce and Perry, 1949; Luce, 1950), *n-cliques* (Luce and Perry, 1949; Alba, 1973), *n-clans*, and *n-clubs* (Mokken, 1979).

As for the density category of cohesive subgroups, the main objective is to find subsets of actors within which the network connections are denser than between subsets (Newman and Girvan, 2003). Density-based subgroups include *k-cores*, *k-plexes*, *ls-sets* (Luccio and Sami, 1969; Lawler 1973; Seidman 1983; (Borgatti, Everett *et al.*, 1990)), *lambda sets* (Borgatti *et al.*, 1990) and *components*.

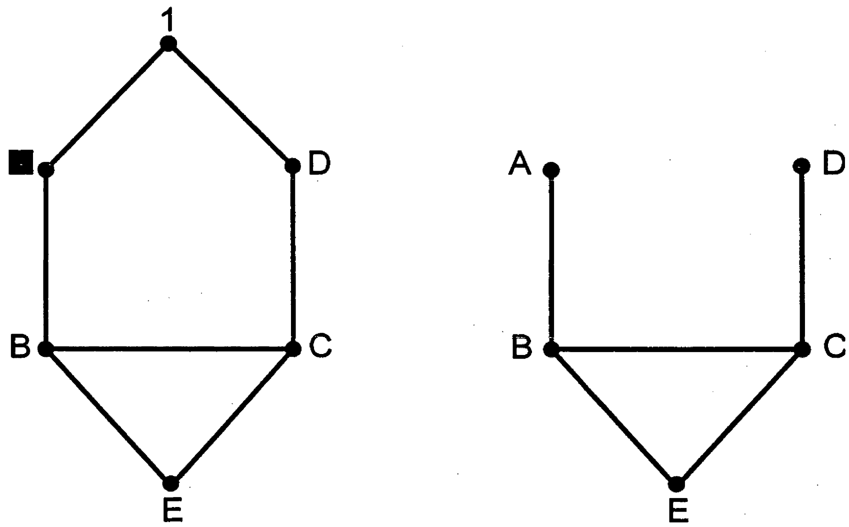
"The clique is the foundational idea for studying cohesive subgroups in social networks" (Wasserman and Faust, 1994, p. 254). It is the most restrictive definition of a subgroup. A clique is a subset of at least three symmetrically related members, with no other element(s) outside the subset symmetrically related to any of the member of the subset (Luce and Perry, 1949). In other words, it is a set of actors all of whom are connected to one another by mutual or strong relations (Burt, 1982). In the language of graph theory, it is essentially a maximal complete subgraph. It is maximal and complete because its density equals one and adding more actors to the subgraph violates the maximality and the completeness conditions.

Although the concept of a clique does capture the idea of a cohesive subgroup, it can be less useful for some real world network data. Actors who are not directly connected to all the other members of a clique, despite being relatively close in the intuitive sense of social proximity, do not belong to the same cohesive subgroup by clique definition. Due to its requirements, real networks, especially ones that are sparse, may not form a clique in this strict sense. Conversely, for a dense network there may be too many overlapping cliques, which makes interpretation difficult. As an example, Everett (n.d.) notes that Kapferer's "sociational" data matrix of only 39 actors contains as many as 118 cliques. In addition, a clique can also ignore peripheral actors who are relevant.

The n-clique (Luce, 1950; Alba, 1973) concept was designed to relax the criterion of the clique definition by allowing the group members to be *n* geodesic distance from one another. However, in many cases, this definition has been found to be too relaxed, allowing actors who are not strictly *n* geodesic distance apart to be assigned to the same subgroup. Due to the weaknesses of the *n*-clique, some researchers find the original concept of clique more appropriate. Alba and Moore (1978, p. 178), for example, note that "clique concept is not as severe a standard as it first appears".

Other weaknesses associated with the concept of n-clique are well known. First, Scott (1991b) argues that a value of *n* greater than 2 is difficult to interpret sociologically in the context of cohesive subgroups. The second major limitation of the n-clique idea is that it allows members of a subgroup to be connected by an actor who is not part of the subgroup (Luce, 1950; Spilerman, 1966; Alba and Moore, 1978). In other words, some cliques will not be fully connected by paths internal to them (Alba and Moore, 1978; Scott, 1991b; Wasserman and Faust, 1994). This leads further to violation of the n-clique principle, that is, a clique member can actually be further than n geodesic from the other members. As an illustration, consider the graph in Figure 7.1.

Although the subgraph in (b) is a connected 2-clique extracted from the graph in (a), it does not satisfy the 2-clique definition because its diameter is three (A, B, C, D). In (a), it satisfies the 2-clique definition (distance ≤ 2) through node 1, but node 1 is not a member of the 2-clique. Thus, the n-clique does not necessarily represent the ideas of tightness or connectedness of groups (Mokken, 1979).



(a) Source: Alba (1973: 119) (b)

Figure 7.1. n-cliques

Due to these undesirable properties of the n-clique, Alba (1973) restricted his definition of a subgroup to an n-clique where every pair of members is connected by a geodesic composed of subgroup members. Mokken (1979) formalised this idea as an n-clan which requires that the distance connecting all unique pairs of actors in an n-clan of a network is no more than *n*, and that the distance connecting members of different n-clans of the network is more than *n*. Therefore, a group member's geodesic cannot pass through actors who are not members of the group.

Essentially, an n-clan is an n-clique that must satisfy the condition that every pair of actors in it must be connected by a geodesic composed of actors within the n-clan itself. Mokken (1979) introduced the related concept of an n-club, which is a maximal subgraph of diameter *n*. All actors within a 2-club are more than 2 steps from all actors outside the 2-club. Mokken demonstrated the interrelationships of the clique, clan and club, proposing that all n-clubs are contained within n-cliques and that all n-clans are also n-cliques (Mokken, 1979). To illustrate this, consider graph (a) in Figure 7.1 The set of nodes {B, C, D, E} is not a 2-clique; hence, not a 2-clan, but it is a 2-club contained in a 2-clique {A, B, C, D, E}. The 2-clan {1, A, B, C, D} is also a 2-clique, and a 2-club.

All these distance-based subgroups have an additional characteristic, that is, they all allow overlapping subgroups. Thus, an actor may belong to more than one subgroups, a pair of actors may be in one or more subgroups, and subgroups may share one or more members.

Procedures for Identifying Cohesive Subgroups

In identifying subgroups in this study, it is important to consider which subgroup definitions to use, how to treat isolates, and the direction of ties.

In terms of subgroup definition, there are in particular two competing perspectives for finding cohesive subgroups in the network. On the one hand, there are bottom-up or agglomerative approaches which conceptualise a whole network as an aggregate of smaller structures such as dyads, triads and smaller clusters. Cliques, n-cliques, n-clans, k-plexes, k-cores and *f-groups* are examples of the subgroup definitions that look at the network structure from a bottom-up view. On the other hand, there is a top-down view consisting of approaches that identify subgroups by dividing the network along weak links. These approaches look at the whole network first and then divide it into locally dense areas which are separated from the rest of the network. Examples of these top-down approaches include *components*, *blocks and cut-points*, *lambda sets*, *factions* and the relatively new *Newman-Girvan* approach.

One of the main differences between the two perspectives is that the agglomerative approaches tend to focus on the dense part of the network and generally identify overlapping subgroups. Peripheral players are often neglected. The divisive approaches, in contrast, take every actor into account and assign them to a subgroup. Thus, the agglomerative approaches are better for identifying the core of a network, and the divisive approaches are more suitable for simply dividing the network into subgroups in which within density is greater than between density.

In this study, both are relevant. It is important to identify the core of the network where ties are cohesive, and where knowledge and other learning resources flow more freely and more intensively. However, peripheral players also need to be taken into account, as they may play an important bridging role. Freeman (1992) has argued that a good method that can reflect the sociological intuition of social group is one which can show the internal structure of the network while being able to identify non-overlapping subgroups. As there is no single tool (especially one which has been implemented in a computer program) that simultaneously takes both perspectives into consideration, this study employs a combination of subgroup detection tools and methods.

Because the main aim is to find cohesive subgroups, rather than just subgroups, it is important to use the strictest possible definition of a subgroup so that the cohesiveness of the identified subgroups can be assured. For this reason, the concept of clique is used as a starting point. As will become clear later, the main concern is the amount of clique overlap, rather than the structure of the cliques themselves. Some of the drawbacks of the clique concept include its strictness and the difficulty in interpreting any overlapping subgroups. In this study however, these are regarded important features and are required to ensure that the identified subgroups are indeed cohesive.

In addition, the overlapping subgroups are relevant to the substance of network resources under investigation. The level of clique overlap can indicate the gradation of cohesiveness of the subgroups in the network. In addition, the overlap in group membership carries important information and should not be eliminated. In networks involving the exchange of information and learning resources, the overlapping cliques may be important in understanding how these resources are distributed. It is expected that resources diffuse more freely and more quickly where cliques overlap. Rather than eliminating any overlapping cliques, they can be disentangled through a systematic simplification in which cliques are aggregated based on the criterion of the amount of overlap they have.

Although the clique concept is powerful in identifying the cohesive part(s) of a network, it has one limitation. As indicated earlier, clique and other distance-based subgroup concepts generally focus on internal connections and ignore connections between subgroups (Burt, 1982; Seidman, 1983). Due to this, some peripheral actors may not be considered (Newman and Girvan, 2003).

In this study, when the clique concept left out some peripheral actors, one of the divisive subgroup approaches was employed to assign these peripheral actors to the identified cohesive subgroups. It is important to note that the peripheral actors were not those who were at the periphery of the network as a whole, but rather, at the periphery of the cohesive subgroups. The Faction and Newman-Girvan concepts give rise to two powerful divisive methods that are employed here. Besides being powerful, these two methods have been implemented in network analysis software such as UCINET 6 (Borgatti *et al.*, 2002). Furthermore, these two methods do not conflict with the detection of cohesive subgroups using the simplification of overlapping cliques.

In order to ensure that the methods employed captured cohesive subgroups, the ties in each of the networks were symmetrised using the strongest possible criterion that the data allow. In this case, the matrices of relations were symmetrised by keeping mutual ties only. That is, a tie between x and y is symmetric if x and y each actually nominated the other. Keeping strongly connected actors is necessary as the objective was to identify cohesive subgroups in the network. In cases where the strong symmetrising criterion was not possible, the underlying graphs were used. In other words, a tie between a pair of actors is considered to exist if at least one of them nominated the other.

Isolates, by definition, are not part of any cohesive subgroup; hence, they were not included in the subgroup analysis. Therefore, the cohesive subgroup analyses were performed on the main connected region of each network.

The procedure for identifying subgroups, which form the cohesive part of the networks, was carried out in several steps. First, cliques in the main connected regions of the networks were identified. The second step involved a systematic aggregation of cliques at different levels of overlap. The higher the level of clique overlap the more cohesive the resulting subgroups are. The process of aggregation followed the technique proposed by Everett and Borgatti (1998), in which the amount of overlap between a pair of cliques is used as a criterion to determine if the two cliques are considered adjacent. This was represented as an intersection graph for each network, where the nodes were cliques and the thickness of the edges connecting cliques was proportional to the number of actors that a pair of cliques shared. Actors who belonged to adjacent cliques formed a cohesive subgroup, and the amount of overlap on which clique adjacency was defined reflects the level of cohesiveness of the subgroup. The identified subgroups were then described in terms of their numbers, their size and their degree of overlap. Actors who played particular roles, such as being leaders, peripheral players, or bridges, were also described. In addition, relevant actor attributes such as age, tenure, rank, education, work unit, and gender were also used to describe the identified subgroups in terms of which of these attributes constituted unifying factors.

Cohesive Subgroups in the GTC Trainers' Networks

Knowledge Network

The main connected region of the GTC trainers' knowledge exchange network contains 31 actors. These actors are linked by 57 mutual ties with a density of 0.12. Thus, only 12 percent of possible ties among them are present. As can be seen in Figure 7.2, the main region of the network includes 14 cliques. The largest clique has five members; there is only one clique of this size. Another clique has four members, and the remaining 12 cliques contain three members which is the minimum size allowed by the clique definition. As can be seen on the left panel of Figure 7.2, the cliques are generally small and highly overlapping. As they are generally of size three, some of these overlapping cliques only differ by a single actor.

The clique-by-clique co-membership matrix on the right panel of Figure 7.2 shows more clearly the degree of overlap among the 14 cliques. The diagonal entries indicate the size of each clique and the off-diagonal entries give the number of actors that each pair of cliques have in common. It can be seen that the pairs of cliques overlap by at most two actors in common (2-overlap level).

Cliques 1 and 3, for example, overlap by two actors, sharing actors 31 and 32. Actors 8 and 31 are particularly highly prominent. Actor 8 belongs to six different cliques (cliques 6, 7, 8, 10, 11 and 12); while actor 31 is a member of five different cliques (cliques 1, 2, 3, 4 and 5).

14 cliques found

1:	27 30 31 32 34
2:	16 31 32
3:	31 32 41
4:	7 31 41
5:	6 16 25 31
6:	2 8 9
7:	1 2 8
8:	3 8 18
9:	4 27 30
10:	5 8 10
11:	5 8 15
12:	8 10 18
13:	6 25 28
14:	27 30 40

[redacted]

Co-membership matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	5	2	2	1	1	0	0	0	2	0	0	0	0	2
2	2	3	2	1	2	0	0	0	0	0	0	0	0	0
3	2	2	3	2	1	0	0	0	0	0	0	0	0	0
4	1	1	2	3	1	0	0	0	0	0	0	0	0	0
5	1	2	1	1	4	0	0	0	0	0	0	0	2	0
6	0	0	0	0	0	3	2	1	0	1	1	1	0	0
7	0	0	0	0	0	2	3	1	0	1	1	1	0	0
8	0	0	0	0	0	1	1	3	0	1	1	2	0	0
9	2	0	0	0	0	0	0	0	3	0	0	0	0	2
10	0	0	0	0	0	1	1	1	0	3	2	2	0	0
11	0	0	0	0	0	1	1	1	0	2	3	1	0	0
12	0	0	0	0	0	1	1	2	0	2	1	3	0	0
13	0	0	0	0	2	0	0	0	0	0	0	0	3	0
14	2	0	0	0	0	0	0	0	2	0	0	0	0	3

Figure 7.2. Clique overlap in the GTC trainers' knowledge network

A highly redundant clique structure such as this one is quite perplexing and makes the interpretation of cohesive subgroups rather difficult. However, group overlap is an important sociological phenomenon. It is one of the natural and desirable features of concrete social groups (Everett and Borgatti, 1998). Alba (1982) proposed that overlap should be recognised (in Scott, 1991b), Arguing that "the density of overlap among cliques may be more significant than the composition of the cliques themselves" (Scott, 1991b, p. 122), which was the case in this study.

The overlapping subgroup structure provides important information regarding the cohesiveness of the relations which the analysis here aims to discover. At a network level, overlaps indicate the overall degree of integration of a whole system. At individual level, they show the closeness among people who belong to many subgroups simultaneously. Rather than ignoring them, the clique overlap itself should be made an object of examination in an attempt to uncover the internal cohesive subgroups of the trainers' networks.

Everett and Borgatti (1998) have argued that methods which put an artificial constraint on the groupings so that actors can be divided into mutually exclusive groups may be viewed as odd, and they recommended a method for simplifying overlapping structures by reducing, rather than eliminating the amount of overlap considered. Their method involves building an *intersection graph* based on the degree of subgroup (clique or any other subgroup concept) overlap. An intersection graph uses subgroups, instead of individual actors, as vertices. Two subgroups are adjacent if and only if they have a vertex in common. If an intersection graph forms a clique, it is called a *clique graph*. However, a clique graph is not very informative because it simply shows that all cliques are overlapping.

Everett and Borgatti (1998) later suggested that increasing the amount of overlap included between two cliques before they were considered to be adjacent (k-overlap clique graph or intersection graph) could further enhance clique graphs, by revealing actors in them who form stronger relationships. Thus, in this study the level of cohesiveness of subgroups is defined at k-overlap(s), or also referred to as k-overlap level. Highly overlapping or strongly connected cliques then become surrogates for actors who form cohesive parts of a network. Aggregating highly overlapping cliques has been used by Alba and Moore (1978) for identifying elite social circles in the United States.

Figure 7.3 shows the intersection graph of the cliques in the GTC trainers' knowledge network. The thickness of the edges is proportional to the amount of overlap between the cliques that they connect. It appears that even if 1-overlap criterion (pairs of cliques have one actor in common) is applied for connecting cliques, the cliques are already divided into two mutually exclusive groups labelled I and II. Each group is highly cohesive, as indicated by the density of connections in it. In fact, group I constitutes a complete graph where all cliques are adjacent to one another. Group I contains cliques 6, 7, 8, 10, 11 and 12; while group II contains cliques 1, 2, 3, 4, 5, 9, 13 and 14. At 2-overlap level, as indicated by the thick edges, group I is divided further into two subgroups, where cliques 6 and 7 spin off from their original group to form a separate group of more strongly related cliques. Group II, however, remains connected as one group at this level of overlap.

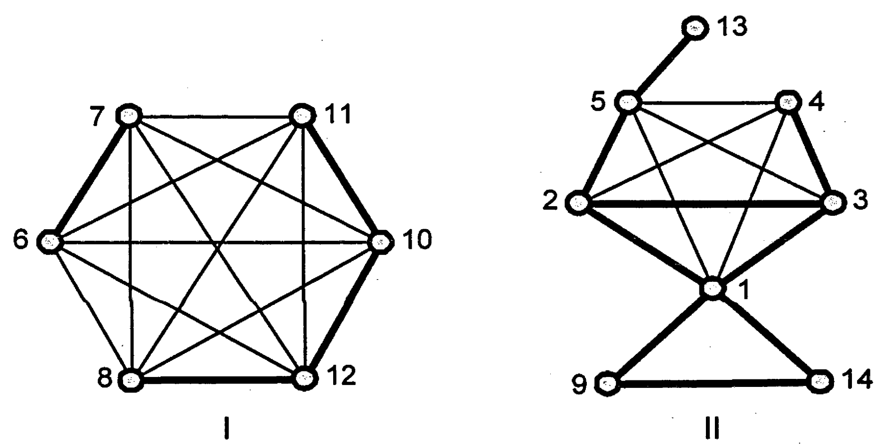


Figure 7.3. Intersection graph of for the GTC trainers' knowledge network

Based on the simplified structure of clique overlap above, actors who form the cohesive part of the network can be identified, as shown in Figure 7.4. It is important to note that the intersection graphs and the network diagrams in this section were plotted using Netdraw (Borgatti, 2002) with spring embedding graph-theoretic layout. Some of the nodes were slightly moved manually to reduce the number of cross lines.

At the 1-overlap level, the actors are divided into two subgroups, as indicated by the perforated boundary lines in Figure 7.4. The first subgroup is labelled A; it contains actors 1, 2, 3, 5, 8, 9, 10, 15 and 18, with a density of 0.39. The other subgroup is labelled B and contains the actors 4, 6, 7, 16, 25, 27, 28, 30, 31, 32, 34, 40 and 41, with a density of 0.35. At 2-overlap level, the main region of the knowledge network is divided into three subgroups C, D and E, as indicated by the solid boundary lines. Subgroup C {3, 5, 8, 10, 18} and subgroup D {1, 2, 8, 9} are part of subgroup A. The densities of these more cohesive subgroups C and D consequently increase to 0.60 and 0.83 respectively. It is important to note that subgroups C and D are overlapping as a result of sharing actor 8. At level 2-overlaps, subgroup B does not split further into more cohesive subgroups; but, at this level of overlap, it is labelled E. Thus, subgroup E has the same set of members and density as subgroup B.

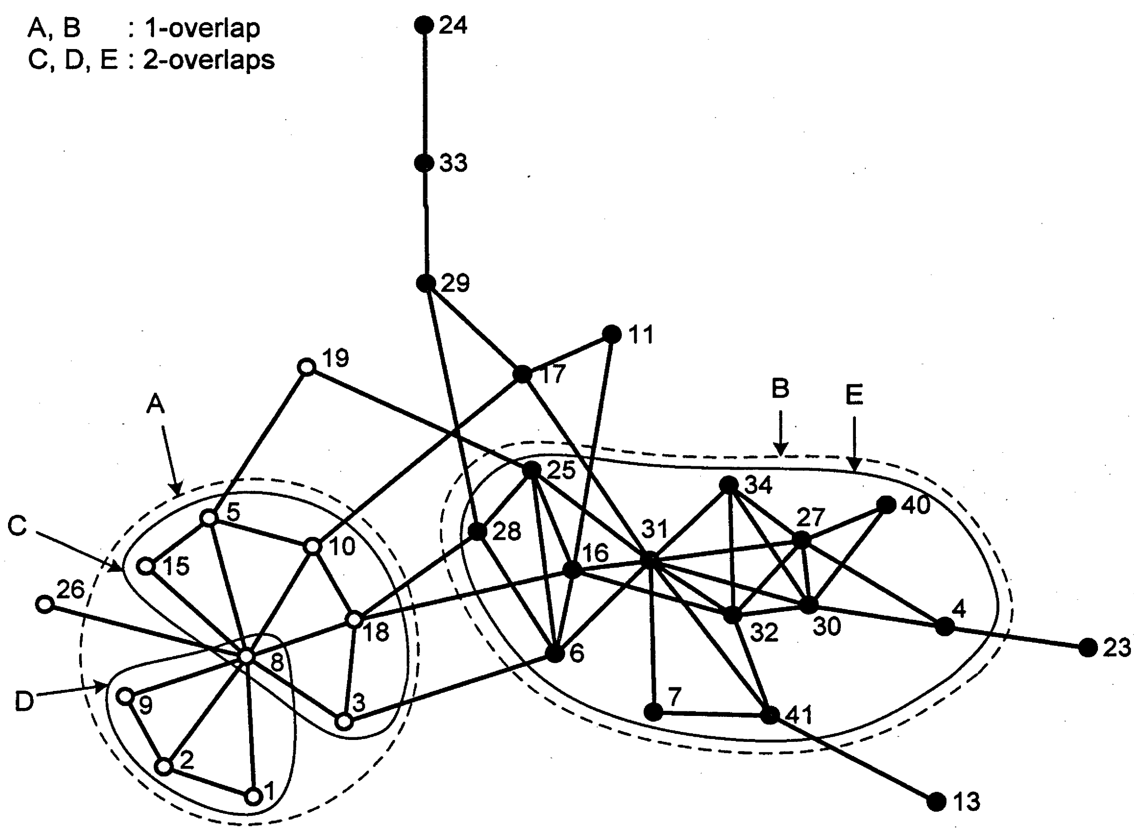


Figure 7.4. The cohesive subgroups in the GTC trainers' knowledge network

The overlapping cliques have been simplified based on the amount of overlap itself to reveal the cohesive parts of the knowledge network. Of the 31 actors in the main region of the knowledge network, 22 (71%) are integrated into these cohesive subgroups. Any actors who are not part of any subgroups are referred to as peripheral actors. Thus, the remaining nine actors are peripheral to the cohesive subgroups in the knowledge network. Some of these peripheral actors can be assigned to the subgroups identified just by using visual inspection. However, rather than use such a heuristic approach, it is important to ensure that the assignment of actors into subgroups takes advantage of one of the formal methods already developed. In this case, the *Faction* procedure implemented in UCINET 6 (Borgatti *et al.*, 2002) and Netdraw (Borgatti, 2002) was used here. Based on the *Faction* procedure, actors 19 and 26 were assigned to subgroup A; and actors 11, 13, 17, 23, 24, 33 and 29 were assigned to subgroup B.

The division of actors into mutually exclusive subgroups using *Faction* did not alter the groupings that had already been established based on the degree of clique overlap. Rather, it simply assigned the peripheral actors to the already identified subgroups as indicated by white and dark nodes in Figure 7.4. Although, the *Newman-Girvan* community structure algorithm also produces mutually exhaustive non-overlapping subgroups, *Faction* produced more consistent results with the existing groupings.

The division of actors into cohesive subgroups above is consistent with the multidimensional scaling (MDS) of geodesic distance between actors, as can be seen in Figure 7.5. The dashed boundary lines reflect the division of actors into two groups, A and B, at 1-overlap level. The solid boundary lines designate the set of actors who are more cohesive because the cliques to which they belong have two actors in common. Indeed, the MDS procedure captures the groupings quite vividly, placing actors 8 and 31, who are key players, at the centre of their respective subgroups. Moreover, peripheral actors are shown scattered around the identified cohesive subgroups. The stress value of 0.148 is still within an acceptable range, indicating that the positions of actors in the two dimensional space are not highly distorted. According to Borgatti *et al.* (2002), stress values below 0.1 are excellent, but those above 0.2 are less desirable.

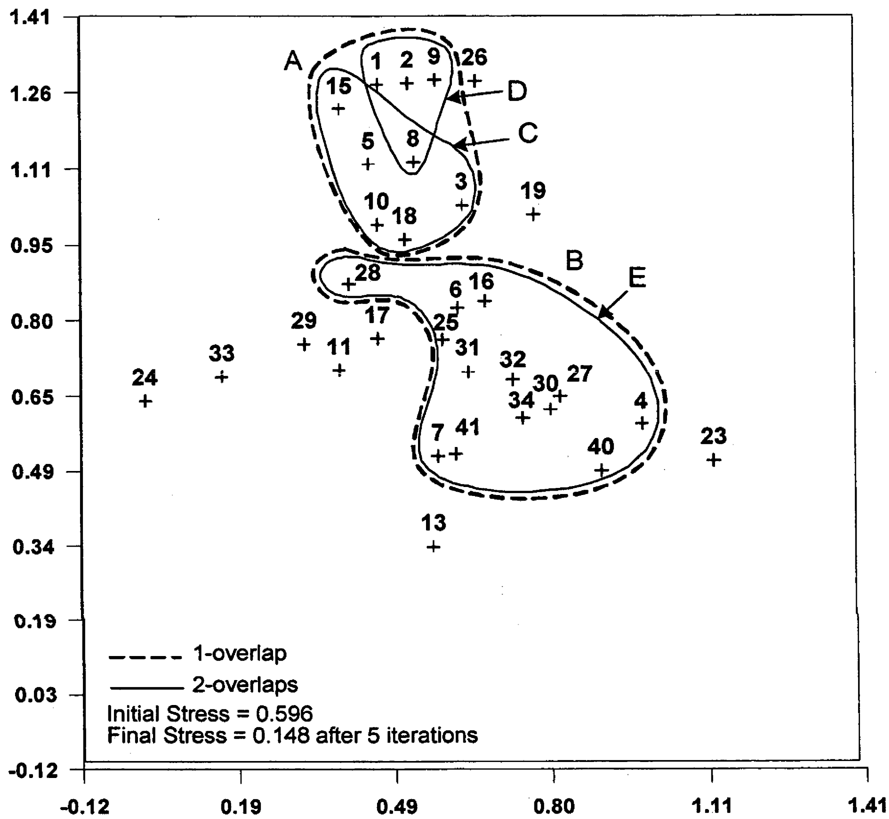


Figure 7.5. MDS of distance in the GTC knowledge network

From the different graph representations, especially Figure 7.4, it is evident that actors 8 and 31 are leaders in their respective groups. However, the position of actor 8 is more critical as this actor constitutes a cut point. That is, if removed, actor 8 would cause the most disruption to the main region of the knowledge network; the removal of actor 8 would cause four other actors (1, 2, 9 and 26) to be disconnected, three of whom are part of subgroup D, the most cohesive part of the network. Thus, the subgroup structure which forms the cohesive part of the knowledge network is not very solid.

Actor 31, despite being at the centre of subgroup B, would not cause the network or subgroup B to be disconnected if removed. The other cut points are actors 4, 29, 33 and 41. However, these actors are peripheral players and would not cause a major disruption to the network if removed. They would only potentially cause one or two other peripheral actors to be detached from the main region of the network if they left the network.

The analysis so far shows the division of actors into more comprehensible groupings based on cohesion as indicated by the level of clique overlap. The sets of actors occupying the core of each group have also been uncovered. Furthermore, the leading actors at the centre of each group have also been identified. It is useful to further examine whether the identified subgroups constitute sociologically meaningful groups. In other words, it is important to try to find out whether those who belong to the same subgroups are homogeneous in terms of their sociologically relevant characteristics, such as age, tenure, rank, work unit and other such attributes. Table 7.1 shows the subgroup memberships by actor attributes.

In order to ensure that the maximum possible number of actors are taken into account, the analysis of the nature of subgroup memberships using actor attributes here, and in the subsequent networks is performed at a sufficient level of cohesiveness that produces more than one subgroups.

For the knowledge network, a level 1-overlap is sufficient to capture the cohesive parts because subgroups in this network are identified from strongly symmetrised relations. At this level of cohesiveness, two subgroups emerge, A and B. These subgroups seem to consist of trainers who are homogeneous in terms of rank and level of educational qualifications. Members of subgroup A are relatively more junior trainers, while those of subgroup B are more senior.

The members of subgroup A are 33 percent junior trainers, and 67 percent middle rank trainers. There are no senior trainers in this subgroup. Four of six trainers in subgroup A are still in the lower grades of middle rank. Thus, together with the junior trainers, they can be considered lower rank trainers. In contrast, subgroup B contains only one junior trainer (8%) but as many as eight (62%) middle rank trainers and four (31%) senior trainers. Half of the middle rank trainers in subgroup B are already in the top grade of middle rank and will become senior trainers in their next promotion. Therefore, together with the senior trainers they may be regarded higher rank trainers.

Table 7.1. Subgroups by actor attributes for GTC knowledge network

Attribute	Subgroup A n	Subgroup A (%)	Subgroup B n	Subgroup B (%)
Rank				
Junior	3	(33.3)	1	(7.7)
Middle	6	(66.7)	8	(61.5)
Senior	0	(0.0)	4	(30.8)
Education				
Undergrad	7	(77.8)	3	(23.1)
Masters	2	(22.2)	9	(69.2)
Doctoral	0	(0.0)	1	(7.7)
Work Unit				
A	5	(55.6)	1	(7.7)
B	3	(33.3)	5	(38.6)
C	0	(0.0)	3	(23.1)
D	1	(11.1)	4	(30.8)
Gender				
Male	8	(88.9)	8	(61.5)
Female	1	(11.1)	5	(38.5)
Age*	49	(9.8)	56	(4.3)
Tenure*	4	(0.9)	5	(2.5)

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

The level of education of subgroup A members is also quite distinct from that of subgroup B members. Subgroup A is made up of trainers with relatively lower levels of education than those in subgroup B. The majority of trainers making up subgroup A have obtained undergraduate degrees, accounting for

78 percent, and only 22 percent of members have Masters degrees. In comparison, the majority of trainers in subgroup B have Masters degrees, accounting for 69 percent, and 23 percent only have undergraduate degrees.

The actors in each of the two subgroups do not seem to be homogeneous in terms of work unit, gender, age and tenure. In each subgroup, the members are drawn from different work units, and no single work unit is represented in a substantial proportion. This especially applies to subgroup B. Although subgroup A has 56 percent of its members from unit A, there are also as many as 33 percent and 11 percent from units B and D respectively.

In terms of gender, male trainers appear to be dominant in all subgroups. However, it is interesting to see that the female trainers are more strongly represented in subgroup B. As can be seen in Table 7.1, five out of the six female trainers (83%) in the main region of the knowledge network belong to subgroup B. In addition, the five trainers in subgroup B account for 50 percent of the 10 female trainers in the GTC networks, compared to only 24 percent for the 34 male trainers. Therefore, despite male trainers being dominant in the two subgroups, it cannot be concluded that the male and female trainers are partitioned into (these) two subgroups.

Subgroup A seems to contain relatively younger trainers with an average age of 49 years old, compared to 56 years old for those in subgroup B. Thus, there is a seven year difference. However, the high standard deviations of about 10 years in subgroup A and 4 years in subgroup B suggest that the ages of the subgroup members vary considerably from these average values. Finally, the members of subgroups A and B are not very different in terms of average length of service. There is only a one year difference between the members in the two subgroups.

Members of the subgroups have some commonalities. In particular, members of subgroup A, compared to those of subgroup B, are generally older, more senior, have higher educational qualifications, and have been trainers longer. This pattern indicates that rank and other attributes such as age, tenure and education are important unifying features of the subgroups in the knowledge network of the GTC trainers.

The knowledge network discussed above is an amalgamation of four relations. The structure of each type of relation making up the knowledge network will be considered as a network in its own right, and examined separately. However, due to the sparseness of these separate networks, strong symmetrising criterion, that is, keeping reciprocated ties, cannot be applied.

As can be seen in Table 7.2, if only reciprocated ties are considered, the networks are excessively sparse, disintegrated, and have no core region. The largest cluster is found in the communication network, but it only contains 12 actors. For these single relational (uniplex) networks, therefore, a weak criterion is more informative. In this case, a tie from x to y exists if at least one nominates the other. Thus, cliques are detected from the underlying graphs emerging from the data symmetrised in this manner.

Table 7.2. GTC networks fragmentation (symmetrised with strong criterion)

Component	Communication	Collaboration	Advice-seeking	Advice-giving
12-cluster	1	0	0	0
9-cluster	1	0	0	0
8-cluster	0	1	0	0
4-cluster	0	0	0	1
Triad	0	3	1	0
Dyad	3	2	3	2
Singleton	17	23	35	36
Network density	0.028	0.018	0.005	0.006

Note: strong criterion means a tie connecting a pair of actors is considered symmetric if both of them actually nominated each other

The underlying graphs, however, are still expected to reflect the cohesiveness of subgroups, as the most stringent subgroup definition of *clique* is used. In addition, the criterion for building intersection graphs is made more stringent by considering only cliques at level 2-overlap or higher. Hence, here a pair of cliques are considered adjacent if they had at least 2 members in common. Furthermore, although the data incorporates asymmetric (only) nominations of relations, in reality, learning resources may flow in both directions. The subgroup analysis was performed on the weakly symmetrised main connected region of each network, leaving out isolates as well as isolated dyads and triads.

Communication Network

The main region of the communication network contains 34 actors which accounts for 77% of the 44 participating trainers in the GTC. The density of this main connected region is 17.65. Of the 34 actors in the main region, only 17 (50%) are part of cohesive subgroups, defined by overlapping cliques. As shown in the left panel of Figure 7.6, the main region contains 28 highly overlapping cliques. The maximum clique size is 6, and there are four cliques of this size. Seven other cliques are of size 5, three cliques of size 4 and the remaining 14 cliques are of size 3. The maximum number of cliques to which a pair of actors both belonged is 10. The pair of actors 17 and 28 are the only example of this high level of co-membership. These actors both belong to cliques 1 through to 10.

The degree of clique overlap can be seen in the right panel of Figure 7.6. The maximum number of actors shared by pairs of cliques is five, for instance the pairs of cliques 2 and 1, 3 and 1, as well as 4 and 2. Some actors have a high clique centrality by being members of many different cliques. For example, actors 28 and 17 are members of 12 and 11 different cliques respectively.

[redacted]

1:	6 11 16 17 25 28
2:	11 16 17 25 28 29
3:	6 16 17 19 25 28
4:	16 17 19 25 28 29
5:	10 17 19 25 28
6:	3 6 17 25 28
7:	3 17 25 28 29
8:	3 17 18 28 29
9:	16 17 18 28 29
10:	10 17 18 28
11:	11 12 16 25 28
12:	28 29 33
13:	2 3 8
14:	2 8 9
15:	1 2 8
16:	4 23 27 30 40
17:	4 10 27 30
18:	5 8 19
19:	7 31 41
20:	8 10 18
21:	8 10 19
22:	1 8 10
23:	3 8 18
24:	27 30 31 34
25:	10 17 27
26:	30 31 41
27:	31 32 34
28:	31 32 41

Clique-by-Clique Co-membership matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
1	6	5	5	4	3	4	3	2	3	2	4	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
2	5	6	4	5	3	3	4	3	4	2	4	2	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
3	5	4	6	5	4	4	3	2	3	2	3	1	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0
4	4	5	5	6	4	3	4	3	4	2	3	2	0	0	0	0	0	1	0	0	1	0	0	0	1	0	0	0
5	3	3	4	4	5	3	3	2	2	3	2	1	0	0	0	0	1	1	0	1	2	1	0	0	2	0	0	0
6	4	3	4	3	3	5	4	3	2	2	2	1	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
7	3	4	3	4	3	4	5	4	3	2	2	2	1	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
8	2	3	2	3	2	3	4	5	4	3	1	2	1	0	0	0	0	0	0	1	0	0	2	0	1	0	0	0
9	3	4	3	4	2	2	3	4	5	3	2	2	0	0	0	0	0	0	0	1	0	0	1	0	1	0	0	0
10	2	2	2	2	3	2	2	3	3	4	1	1	0	0	0	0	1	0	0	2	1	1	1	0	2	0	0	0
11	4	4	3	3	2	2	2	1	2	1	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	1	2	1	2	1	1	2	2	2	1	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	1	1	1	0	0	0	0	3	2	2	0	0	1	0	1	1	1	2	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	2	3	2	0	0	1	0	1	1	1	1	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	2	2	3	0	0	1	0	1	1	2	1	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	0	0	0	0	0	0	2	1	1	0	0
17	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	3	4	0	0	1	1	1	0	2	2	1	0	0
18	0	0	1	1	1	0	0	0	0	0	0	0	1	1	1	0	0	3	0	1	2	1	1	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	0	0	0	1	0	2	1	2
20	0	0	0	0	1	0	0	1	1	2	0	0	1	1	1	0	1	1	0	3	2	2	2	0	1	0	0	0
21	0	0	1	1	2	0	0	0	0	1	0	0	1	1	1	0	1	2	0	2	3	2	1	0	1	0	0	0
22	0	0	0	0	1	0	0	0	0	1	0	0	1	1	2	0	1	1	0	2	2	3	1	0	1	0	0	0
23	0	0	0	0	0	1	1	2	1	1	0	0	2	1	1	0	0	1	0	2	1	1	3	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	0	1	0	0	0	0	4	1	2	2	1
25	1	1	1	1	2	1	1	1	1	2	0	0	0	0	0	1	2	0	0	1	1	1	0	1	3	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	0	0	0	2	0	3	1	2
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	2	0	1	3	2
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	1	0	2	2	3

Figure 7.6. Clique overlap in the GTC trainers' communication network

The simplification of the overlapping cliques can be seen in the intersection graph in Figure 7.7. The graph shows the cliques interconnections based on at least 2-overlap level. As noted earlier, a level 1-overlap is not considered cohesive enough in order to compensate for the more relaxed symmetry criterion used to detect cliques from the underlying graph. The thinnest edges represent 2-overlaps, while the thickest ones indicate 5-overlaps.

It is evident in Figure 7.7 that a number of cliques, including cliques 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12, are more highly overlapping than the others. When considering a pair of cliques are adjacent if they share at least two members in common (2-overlap level), all 28 cliques are part of one group. If the number of overlap is increased to at least three before two cliques are considered adjacent, two groups of cliques emerge. The first group consists of cliques 16 and 17 and the second of cliques 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11. If the requirement for cliques to be considered adjacent is raised to at least 4-overlaps, cliques 16 and 17 become disconnected, leaving only one group consisting of cliques 1, 2, 3, 4, 5, 6, 7, 8, 9 and 11. At level 5-overlaps, the remaining group fragments even further, leaving only one subgroup which contains the more tightly connected cliques of 1, 2, 3 and 4.

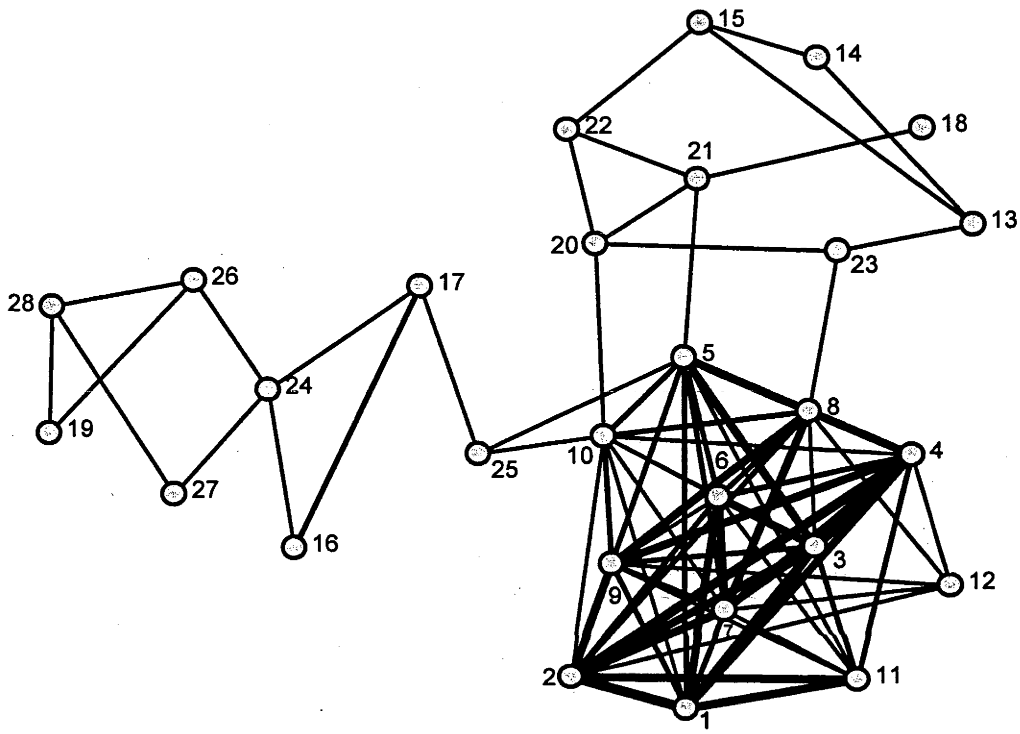


Figure 7.7. Intersection graph of the GTC trainers' communication network

The exact grouping of actors at different levels of clique overlap can be found in Figure 7.8. At level 3-overlaps, the actors are divided into two subgroups labelled A and B, indicated by the perforated boundaries. Subgroups at this level of overlap contain all actors who form the cohesive part of the communication network, accounting for half of the 34 trainers in the main connected region of the communication network. Subgroup A contains 6 actors {4, 10, 23, 27, 30, 40}, with a density of 0.87. Subgroup B contains 12 actors {3, 6, 10, 11, 12, 16, 17, 18, 19, 25, 28, 29}, with a density of 0.67.

It is important to note that the two subgroups are still overlapping, with actor 10 being the intersection of the two subgroups. At level 4-overlaps, there is only one group which is enclosed within the thin solid boundary line labelled C. Members of this more cohesive group are 3, 6, 10, 11, 12, 16, 17, 18, 19, 25, 28 and 29 (identical to those at level 3-overlaps). The fact that clique 10 drops out from level 4-overlaps does not reduce the size of subgroup C because it has no unique member. In other words, the members of clique 10 are fully enclosed in the other cliques that form a group at level 3-overlaps. Consequently, the density of ties also remains the same. At level 5-overlaps, a group of actors forming the core of the communication network can be identified, bounded by the thick solid line labelled D in Figure 7.8. The actors who belong to this most highly cohesive subset are 6, 11, 16, 17, 19, 25, 28 and 29. The density of interconnections among them is 0.93.

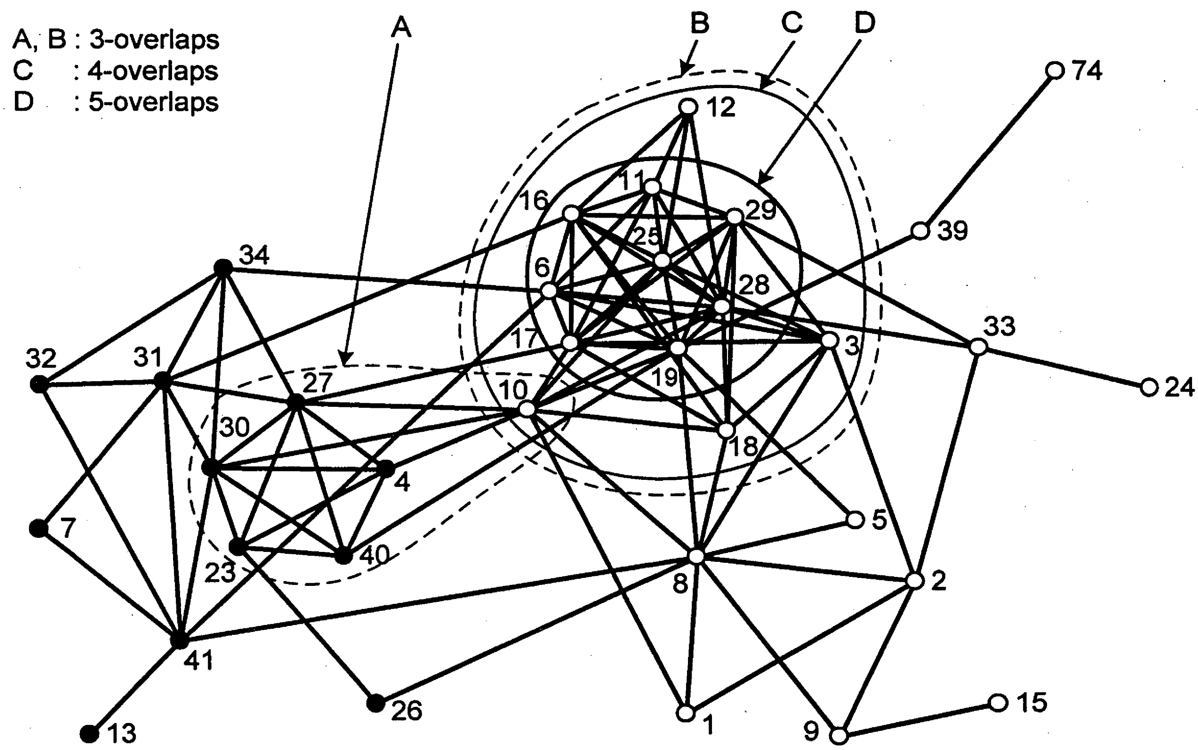


Figure 7.8. The cohesive subgroups in the GTC communication network

It is apparent that some peripheral actors are not accounted for, as can be seen in Figure 7.8. By observation, some of these peripheral actors can be assigned to one of the subgroups. However, for some others, it is not as straightforward. Therefore, the *Newman-Girvan* method was applied to divide the actors into mutually exclusive and exhaustive groups. This method preserves the original cohesive groupings and assigns the peripheral actors to one of them. Actor 10 still plays a bridging role by belonging to both subgroups. Although actors 6 and 17 are not part of both subgroups, they have direct connections to members of each.

It is important to note that the subgroups in the communication network are quite integrated. Subgroups A and B overlap by one member. Subgroups C and D are not disjointed; rather, they are enclosed within subgroup B. Nevertheless, the simplification of clique overlaps makes the cohesive subgroups much more evident. It also provides an indication of the solidity of the subgroup structure.

Indeed, the communication network appears to be quite solid in the sense that the removal of its cut points (actors 9, 19, 33 and 41) would not cause a major disruption to its main region. Actor 19 is the only cut point who is a member of the most cohesive part of the network. Moreover, only two other actors who are peripheral depended on actor 19. Each of the other three cut points bridge only one peripheral actor.

The groupings discussed above correspond to the results of multidimensional scaling based on geodesic distances between actors who belong to the main region of the communication network, as can be seen in Figure 7.9. The stress value is 0.223, slightly above the maximum desirable value of 0.2. Nevertheless, the cohesive subgroups that were identified earlier can still be located quite clearly.

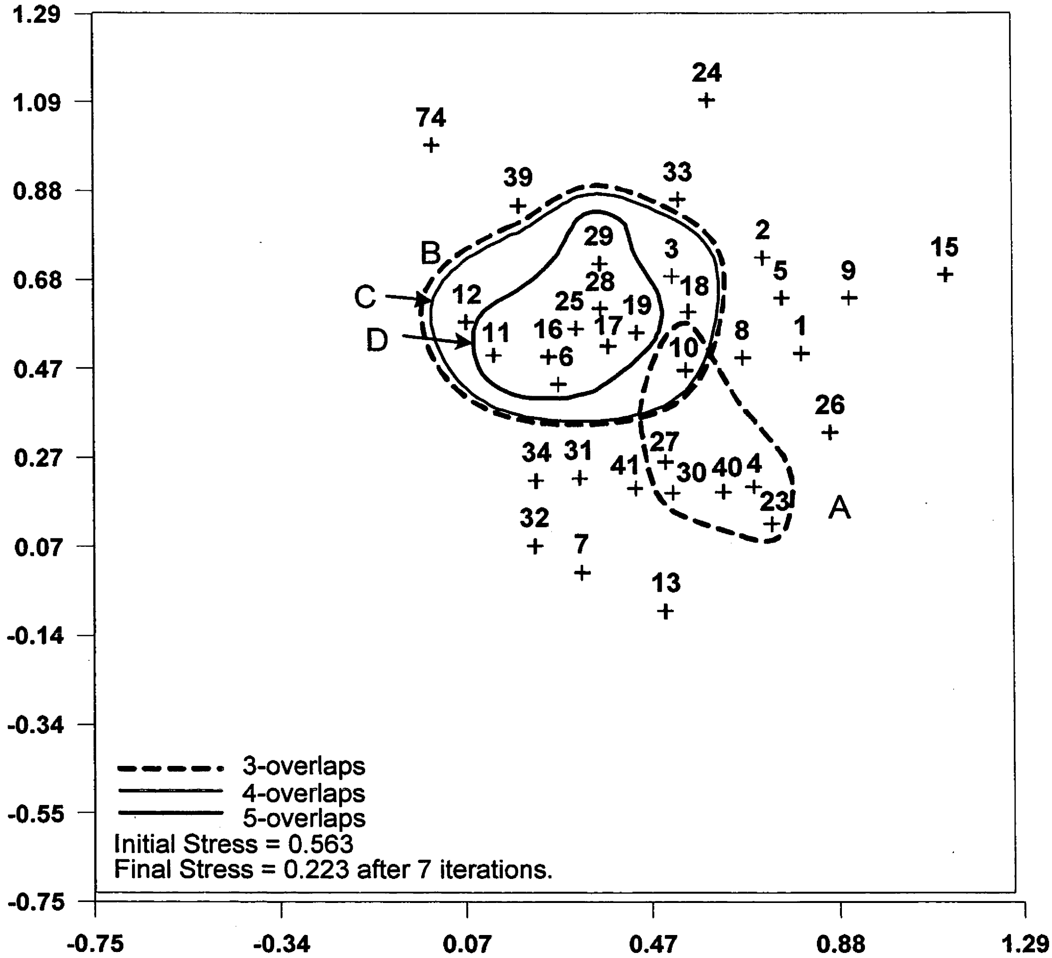


Figure 7.9. MDS of distance in the GTC communication network

The distribution of trainers by attributes into these subgroups can be seen in Table 7.3. For the communication network, level 3-overlaps are the most inclusive, and contain two subgroups, A and B.

It appears that both subgroups contain primarily middle rank trainers, accounting for 71 percent and 67 percent in subgroup A and subgroup B respectively. The remaining members are junior trainers. Thus, senior trainers are not part of the network in which communication exchanges take place more intensively.

In terms of educational levels, trainers with undergraduate and Masters degrees seem to be differentially represented in these two subgroups, where those with Masters degree make up the majority of subgroup A and those with undergraduate degree the majority of subgroup B. None of the trainers with a doctoral degree is engaged in either cohesive part of the communication network. Physical location seems to also play a role. Trainers from work units B and D are particularly dominant in the subgroups. The majority (86%) of the members of subgroup A are drawn from work unit D; while of those in subgroup B, 75 percent are from work unit B. Both subgroups are composed primarily of male trainers, accounting for 71 percent and 75 percent in subgroups A and subgroup B respectively. The average age and tenure of the members of each subgroup does not differ greatly. In fact, the average tenure in both subgroups is identical. The relatively high standard deviation indicates that the age and tenure of the members in each subgroup vary considerably.

Table 7.3. Subgroups by actor attributes in the GTC communication network

	Subgroup A		Subgroup B	
Attribute	n	(%)	n	(%)
Rank				
Junior	2	(28.6)	3	(25.0)
Middle	5	(71.4)	8	(66.7)
Senior	0	(0.0)	1	(8.3)
Education				
Undergrad	2	(28.6)	9	(75.0)
Masters	5	(71.4)	3	(25.0)
Doctoral	0	(0.0)	0	(0.0)
Work Unit				
A	0	(0.0)	1	(8.3)
B	0	(0.0)	9	(75.0)
C	1	(14.3)	0	(0.0)
D	6	(85.7)	2	(16.7)
Gender				
Male	5	(71.4)	9	(75.0)
Female	2	(28.6)	3	(25.0)
Age*	54	(7.0)	52	(6.4)
Tenure*	5	(2.3)	5	(2.7)

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

Thus, in general, subgroup members are quite homogeneous in terms of rank, education, and work unit. More specifically, subgroups A and B are composed of middle rank, male trainers who have been trainers for about five years. However, members of subgroup A mostly come from unit D, while those in subgroup B from work unit B. In addition, members of subgroup A have relatively higher educational qualifications than those of subgroup B.

Collaboration Network

The main region of the collaboration network consists of 30 actors, which accounts for 68% of the total 44 actors in the GTC. The density of this main connected region is 13.79. As can be seen in Figure 7.10, the collaboration network has 18 cliques in its main connected region. The largest clique contains four members. There are four cliques of this size. The remaining 14 cliques are of size three, which is the minimum number of actors for a group to be considered a clique.

[redacted]

1:	27 30 31 32
2:	30 31 32 34
3:	16 31 32
4:	31 32 41
5:	7 31 41
6:	17 27 31
7:	6 16 25 31
8:	6 31 41
9:	2 3 8 9
10:	3 8 18
11:	3 6 16
12:	3 16 18
13:	5 8 10
14:	5 10 15
15:	8 10 18
16:	1 8 10
17:	10 18 28
18:	1 10 15

Clique-by-Clique Co-membership matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	4	3	2	2	1	2	1	1	0	0	0	0	0	0	0	0	0	0
2	3	4	2	2	1	1	1	1	0	0	0	0	0	0	0	0	0	0
3	2	2	3	2	1	1	2	1	0	0	1	1	0	0	0	0	0	0
4	2	2	2	3	2	1	1	2	0	0	0	0	0	0	0	0	0	0
5	1	1	1	2	3	1	1	2	0	0	0	0	0	0	0	0	0	0
6	2	1	1	1	1	3	1	1	0	0	0	0	0	0	0	0	0	0
7	1	1	2	1	1	1	4	2	0	0	2	1	0	0	0	0	0	0
8	1	1	1	2	2	1	2	3	0	0	1	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	4	2	1	1	1	0	1	1	0	0
10	0	0	0	0	0	0	0	0	2	3	1	2	1	0	2	1	1	0
11	0	0	1	0	0	0	2	1	1	1	3	2	0	0	0	0	0	0
12	0	0	1	0	0	0	1	0	1	2	2	3	0	0	1	0	1	0
13	0	0	0	0	0	0	0	0	1	1	0	0	3	2	2	2	1	1
14	0	0	0	0	0	0	0	0	0	0	0	0	2	3	1	1	1	2
15	0	0	0	0	0	0	0	0	1	2	0	1	2	1	3	2	2	1
16	0	0	0	0	0	0	0	0	1	1	0	0	2	1	2	3	1	2
17	0	0	0	0	0	0	0	0	0	1	0	1	1	1	2	1	3	1
18	0	0	0	0	0	0	0	0	0	0	0	0	1	2	1	2	1	3

Figure 7.10. Clique overlap in the GTC trainers' collaboration network

The maximum number of cliques to which a pair of actors belongs is four. For example, actors 31 and 32 both belong to cliques 1, 2, 3 and 4. The maximum number of actors that pairs of cliques have in common is three, such as cliques 1 and 2 sharing actors 30, 31 and 32. Actor 31 appears to have the greatest clique centrality, belonging to eight different cliques, followed by actor 10 who is a member of six different cliques.

The intersection graph in Figure 7.11 shows adjacent cliques based on the number of actors that each pair of cliques has in common. If the adjacency of cliques is defined at level 2-overlaps, all cliques are connected. This is problematic as it means that all actors belong to a single group. In other words, the whole main region is considered one cohesive group. However, the 3-overlap level is also problematic as there is only one pair of connected cliques. These are cliques 1 and 2, shown as connected by the thickest edge. All the other cliques are singletons. At this level of cohesiveness, too many actors are ignored. Hence, 2-overlap level is used. Although all cliques are connected at this level of overlap, it is evident from the intersection graph that there are two groups. However, rather than partitioning members of the cliques arbitrarily, a more systematic technique was used. In this case, the cliques were grouped into two using the concept of *Faction*, which was also used for dividing actors into mutually exclusive subgroups.

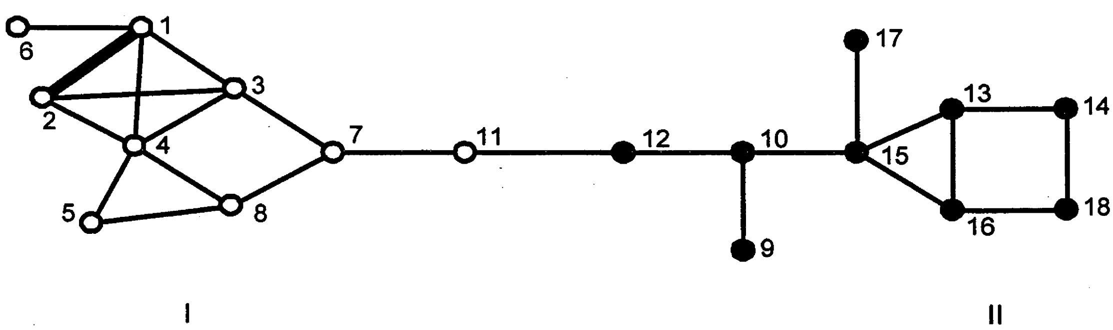


Figure 7.11. Intersection graph of the GTC trainers' collaboration network

The *Faction* algorithm separates the cliques into group I (white nodes), containing cliques 1, 2, 3, 4, 5, 6, 7, 8 and 11, and group II (dark nodes) contains cliques 9, 10, 12, 13, 14, 15, 16, 17 and 18.

Figure 7.12 shows the actors who belong to the subgroups based on the intersection graph in Figure 7.11. At 2-overlap level, and based on the division of cliques using *Faction*, the set of actors 3, 6, 16, 17, 25, 27, 30, 31, 32, 34 and 41 belong to subgroup A. The density of ties among these 11 actors is 0.38. The set of actors 1, 2, 3, 5, 8, 9, 10, 15, 16, 18 and 28 belong to subgroup B. This subgroup also has 11 members but with a slightly higher density of 0.42. The two subgroups contain 20 (67%) of the 30 actors in the main region of the collaboration network. The set of actors who belong to the most highly overlapping cliques (1 and 2) consists of 27, 30, 31, 32 and 34, with a density of 0.90. These actors are shown within the thick boundary line labelled C in Figure 7.12. In this network, none of the peripheral actors are bridges between the two cohesive subgroups. Thus, they are all 'hangers-on'.

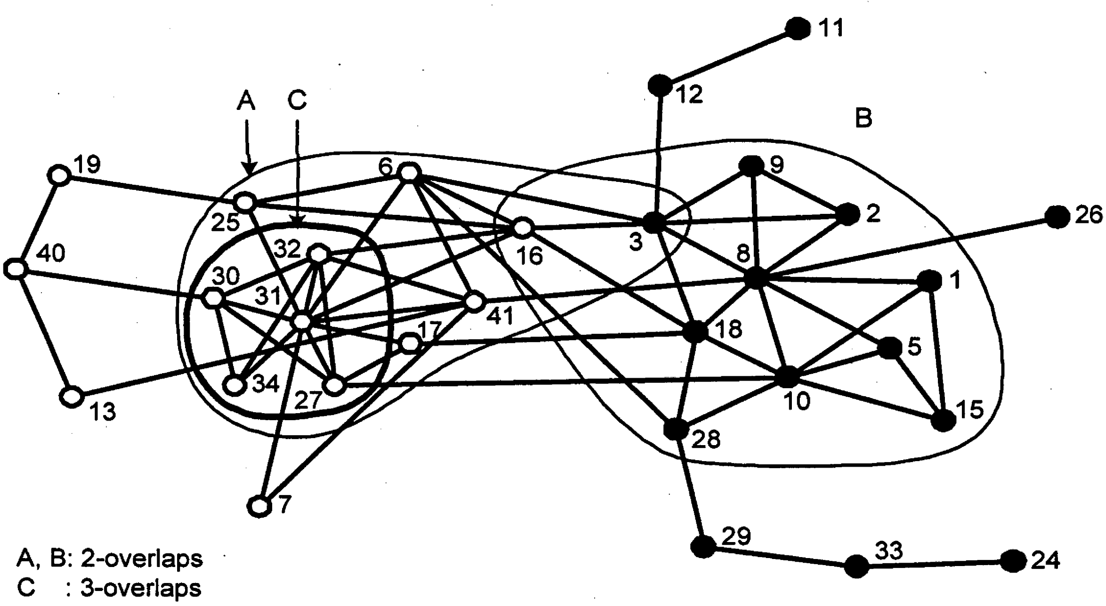


Figure 7.12. Cohesive subgroups in the GTC trainers' collaboration network

It can also be noted that the number of actors and the number of cliques containing them are almost identical, indicating that the cliques are highly overlapping; hence, actors in them form cohesive subgroups. The peripheral actors were assigned to the identified cohesive subgroups using the concept of

Faction. It is important to note that the *Newman-Girvan* and *Faction* methods produced identical results for this dataset.

The subgroup structure in the collaboration network is also quite solid. The subgroups themselves are not totally separated, but are still overlapping, where actors 3 and 16 are in the intersection of subgroup A and B; and subgroup C is completely enclosed within subgroup A. The strength of the subgroups may also be seen from the fact that despite having six cut points (actors 3, 8, 12, 29, 29 and 33), the connectivity of the subgroups would not be greatly affected if those cut points were removed. These cut points would potentially disconnect up to three peripheral actors if removed.

The representation of the cohesive subgroups in a two dimensional space can be seen in Figure 7.13.

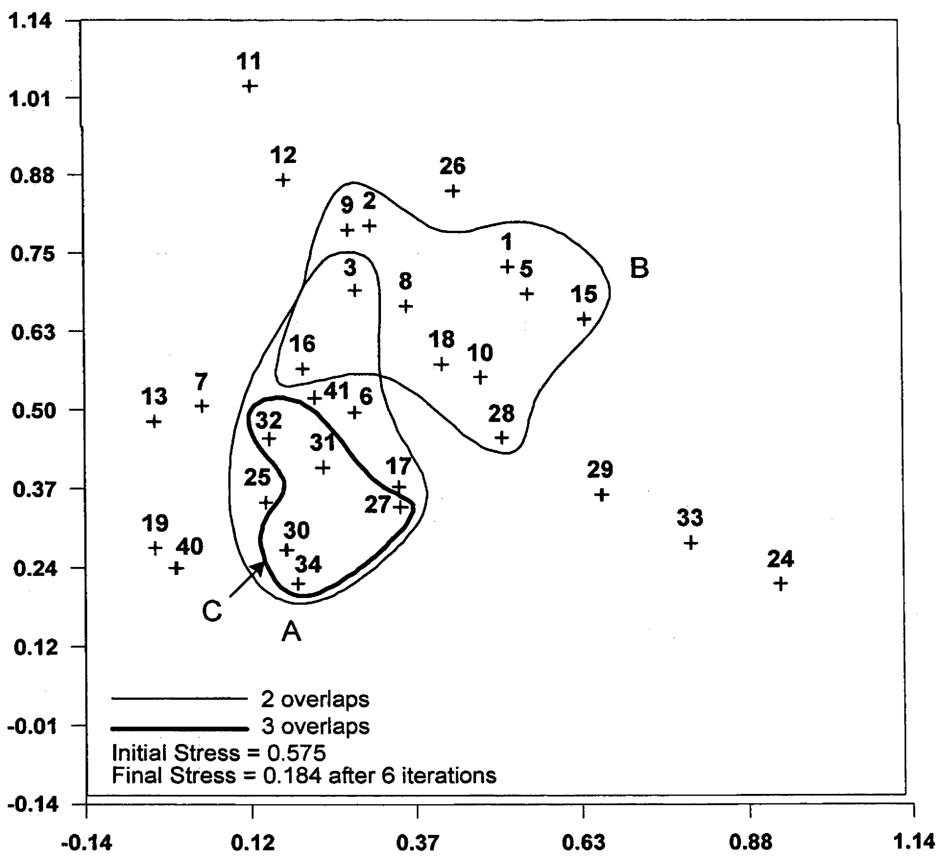


Figure 7.13. MDS of the distance in the GTC collaboration network

The cohesive subgroups at level 2-overlaps are indicated by the thin boundary lines, and at level 3-overlaps by the thick boundary line. All peripheral actors are scattered around these cohesive subgroups. The stress value of 0.184 is still below the maximum desirable value of 0.2, indicating that the position of each actor in the two dimensional space is not a highly distorted representation of the geodesic distance matrix.

Table 7.4 shows the subgroup memberships by actor attributes. These subgroups are identifiable at level 2-overlaps. For the subgroups in the collaboration network, rank, level of education, gender and, to some extent tenure, seem to be the important unifying features.

Table 7.4. Subgroups by actor attributes in the GTC collaboration network

	Subgroup A		Subgroup B	
Attribute	n	(%)	n	(%)
Rank				
Junior	1	(9.1)	3	(27.3)
Middle	7	(63.6)	8	(72.7)
Senior	3	(27.3)	0	(0.0)
Education				
Undergrad	4	(36.4)	7	(63.6)
Masters	6	(54.6)	4	(36.4)
Doctoral	1	(9.1)	0	(0.0)
Work Unit				
A	1	(9.1)	6	(54.6)
B	4	(36.4)	4	(36.4)
C	4	(36.4)	0	(0.0)
D	2	(18.2)	1	(9.1)
Gender				
Male	6	(54.6)	9	(81.8)
Female	5	(45.5)	2	(18.2)
Age*	55	(4.4)	49	(8.9)
Tenure*	4	(1.9)	4	(0.8)

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

The middle rank trainers appear to be the majority in both subgroups. However, subgroup A contains relatively higher ranking trainers than subgroup B. In subgroup A, the 64 percent middle rank trainers are complemented by 27 percent senior trainers. Thus, they represent the upper end of the rank scale. In contrast, in subgroup B the 73 percent middle rank trainers are joined by 27 percent junior trainers, so that subgroup contains trainers from the lower end of the ranks.

In terms of educational qualifications, subgroup A contains primarily trainers with Masters degrees together with some trainers with undergraduate qualifications. In comparison, subgroup B contains mainly trainers with undergraduate qualifications together with some trainers with Masters degrees. Thus, members of subgroup A have a relatively higher level of education than those of subgroup B.

Male trainers generally predominate in both subgroups. In subgroup A, however, although male trainers still form the majority, the number of female trainers is only one less.

The length of service in both subgroups is identical, 4 years. The relatively low standard deviations suggest that members of these subgroups are quite homogeneous. This is especially true for members of subgroup B where the standard deviation is below one, indicating that the length of service of the trainers in this subgroup is not dispersed too far away from the average of four years. Members of these subgroups are drawn from different work units. In subgroup A, none of the work units is represented in a majority. Subgroup B is composed of a greater proportion (55%) of trainers from unit A. However, the proportion of trainers from unit B is also substantial. Finally, the standard deviation of the age distribution of subgroup members indicates that they are not homogeneous in terms of age.

Overall, the GTC trainers are inclined to collaborate with others more or less similar in terms of rank, tenure, gender, and educational qualifications. In particular, members of the two subgroups are composed of male trainers who have been trainers for about four years. However, members of subgroup A have relatively higher ranks and education levels than their colleagues in subgroup B.

Advice-seeking Network

The advice-seeking network has a quite small and very sparse main region. It contains 27 actors, 61 percent of the total 44 actors in the GTC. The density of this main connected region is 13.11. As shown in Figure 7.14, there are 13 cliques in its main region. Three of the cliques are of size four and the remaining nine cliques of size three. Actors share a maximum of three cliques with other actors, such as actors 15 and 8 who both belong to cliques 1, 2 and 3; as well as actors 31 and 32 who belong to cliques 9, 10 and 13. The cliques also share a maximum of three actors. For example, cliques 1 and 2 share actors 1, 8 and 15. Actor 31 appears to have the highest clique centrality, belonging to five different cliques.

[redacted]

1:	1 2 8 15
2:	1 8 10 15
3:	5 8 15
4:	15 17 19
5:	3 12 16
6:	6 16 25
7:	7 31 41
8:	2 8 9
9:	16 31 32
10:	27 31 32 34
11:	27 30 31
12:	27 30 40
13:	31 32 41

Clique-by-Clique Co-membership matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13
1	4	3	2	1	0	0	0	2	0	0	0	0	0
2	3	4	2	1	0	0	0	1	0	0	0	0	0
3	2	2	3	1	0	0	0	1	0	0	0	0	0
4	1	1	1	3	0	0	0	0	0	0	0	0	0
5	0	0	0	0	3	1	0	0	1	0	0	0	0
6	0	0	0	0	1	3	0	0	1	0	0	0	0
7	0	0	0	0	0	0	3	0	1	1	1	0	2
8	2	1	1	0	0	0	0	3	0	0	0	0	0
9	0	0	0	0	1	1	1	0	3	2	1	0	2
10	0	0	0	0	0	0	1	0	2	4	2	1	2
11	0	0	0	0	0	0	1	0	1	2	3	2	1
12	0	0	0	0	0	0	0	0	0	1	2	3	0
13	0	0	0	0	0	0	2	0	2	2	1	0	3

Figure 7.14. Clique overlap in the GTC trainers' advice-seeking network

The intersection graph in Figure 7.15 shows cliques grouped based on their degree of overlap. Even at level 1-overlap as indicated by the thin edges, the cliques are already divided into two groups. However, in order to compensate for the use of the weak symmetric form of the advice-seeking network, only two or more overlaps should be considered in grouping the cliques. At level 2-overlaps, as indicated by thick edges, cliques 1, 2, 3 and 8 form group I, and cliques 7, 9, 10, 11, 12 and 13 form group II.

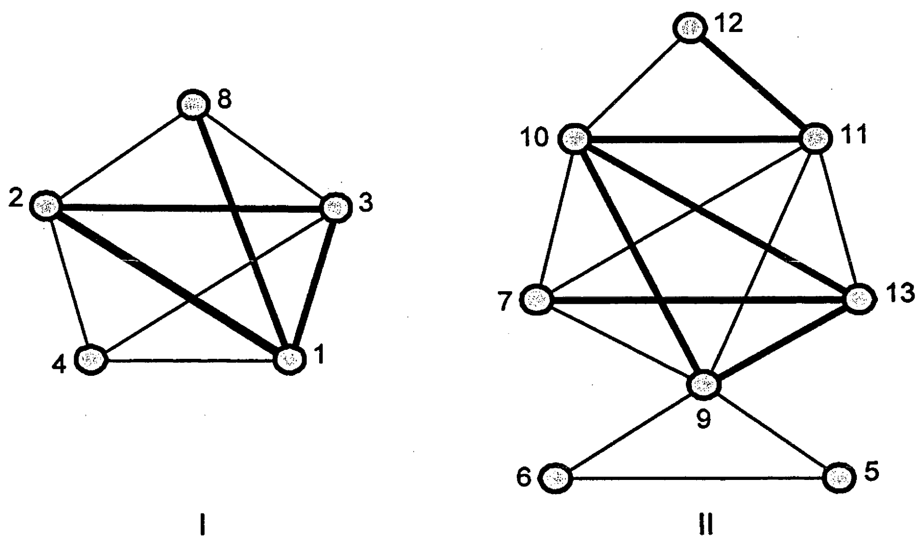


Figure 7.15. Intersection graph of the GTC trainers' advice-seeking network

The division of actors into cohesive subgroups based on the degree of clique overlaps can be seen in Figure 7.16. At level 2-overlaps, the actors are divided into two relatively small subgroups. Subgroup A consists of seven actors {1, 2, 5, 8, 9, 10, 15} in cliques 1, 2, 3 and 8. The density of interconnections within this subgroup is 0.57. Subgroup B consists of nine actors {7, 16, 27, 30, 31, 32, 34, 40, 41} corresponding to the overlapping cliques 7, 9, 10, 11, 12 and 13. The density of this subgroup is 0.44. The number of actors belonging to these cohesive subgroups is 16, about 59 percent of the 27 trainers in the main region of advice-seeking network in the GTC.

At level 3-overlaps, a more cohesive part of the network is identified, containing actors 1, 2, 8, 10 and 15, indicated by the thick boundary line labelled C. These actors form a subset of subgroup A. The density of this more cohesive subgroup is quite high, i.e., 0.90.

The peripheral actors were assigned to the existing subgroups using the *Newman-Girvan* method. Actors 17, 18, 19, 28 and 39 then become parts of subgroup A, while actors 3, 4, 6, 12, 23 and 25 parts of subgroup B.

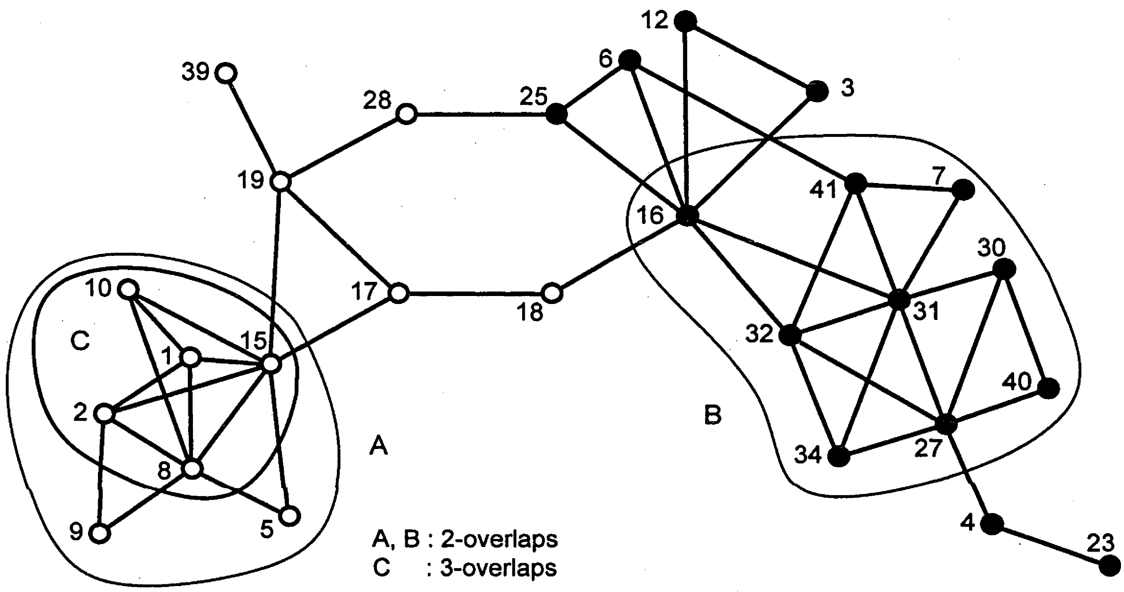


Figure 7.16. Cohesive subgroups in the GTC trainers' advice-seeking network

The two subgroups A and B do not overlap; rather, the connection between them relies entirely on peripheral actors. Overall, the structure seems to be vulnerable. There are five actors who constitute cut points, including 4, 15, 16, 19 and 27. The position of actor 15 is especially critical. All members of subgroup A, hence subgroup C, are dependent on actor 15 for connection to subgroup B as well as to the rest of the main region of the advice-seeking network. Actor 16 also constitutes a critical point in the network. Although the removal of this actor would only cause peripheral actors 3 and 12 to be disconnected from the rest of the main region or subgroup B, it would increase the path length connecting subgroup B and A from three to five steps. The other cut points would not cause disruption of this magnitude. In this structure, peripheral actors also play important roles in providing alternative pathways through which actors between the opposing subgroups can access advice from each other.

As can be seen in Figure 7.17, plotting the actors' positions in a two dimensional space based on the geodesic distances between them indicates the same division of actors into subgroups. The stress value of 0.095 is quite low, indicating that this MDS provides a good representation of the distances among actors.

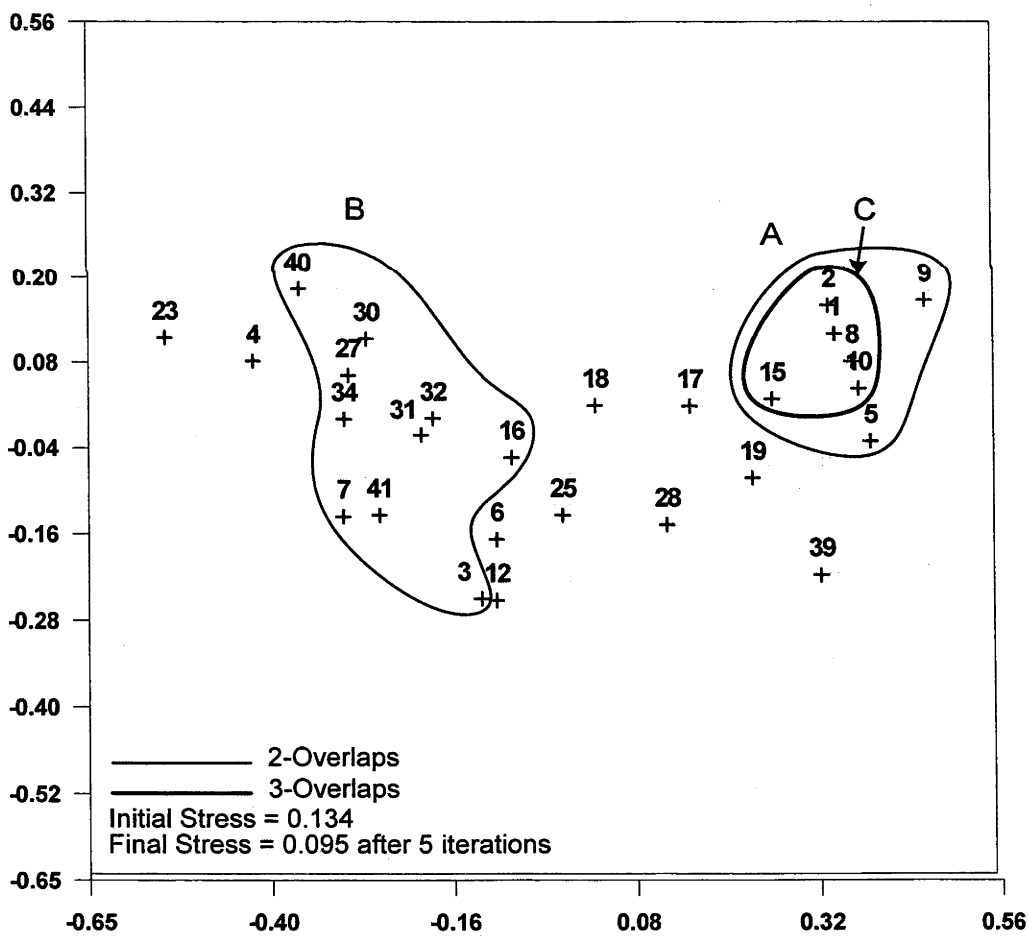


Figure 7.17. MDS of the distance in the GTC advice-seeking network

The attributes of the trainers who make up each of the cohesive subgroups can be seen in Table 7.5. Subgroup A and B are defined at level 2-overlaps. For the subgroups in the advice-seeking network, rank and level of education appear to be quite important unifying features.

Subgroup B contains trainers with relatively higher ranks, including 56 percent middle rank trainers and 44 percent senior trainers. None of the junior trainers is involved in this subgroup. On the other hand, subgroup A consists of relatively lower rank trainers, of whom 43 percent are junior trainers and 57 percent are middle rank trainers. None of the senior trainers is part of this subgroup.

Table 7.5. Subgroups by actor attributes in the GTC advice-seeking network

	Subgroup A		Subgroup B	
Attribute	n	(%)	n	(%)
Rank				
Junior	3	(42.9)	0	(0.0)
Middle	4	(57.1)	5	(55.6)
Senior	0	(0.0)	4	(44.4)
Education				
Undergrad	5	(71.4)	0	(0.0)
Masters	2	(28.6)	8	(88.9)
Doctoral	0	(0.0)	1	(11.1)
Work Unit				
A	5	(71.4)	1	(11.1)
B	1	(14.3)	1	(11.1)
C	0	(0.0)	4	(44.4)
D	1	(14.3)	3	(33.3)
Gender				
Male	6	(85.7)	7	(77.8)
Female	1	(14.3)	2	(22.2)
Age*	48	(11.2)	58	(2.8)
Tenure*	4	(0.9)	6	(2.89

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

The subgroups also tend to be homogeneous in terms of their members' educational level, where subgroup B is composed of trainers with relatively higher levels of education than those in subgroup A. In subgroup B, there is no trainer with an undergraduate degree, but 89 and 11 percent have Masters and doctoral degrees respectively. In contrast, the members of subgroup A are mostly trainers with undergraduate and Masters degrees, accounting for 71 percent and 29 percent respectively, and no member has a doctoral degree.

There is a fairly large difference in average age between members of subgroups A and B. Members of subgroup B are older, with an average age of 58 years old, compared with 48 years old for members of subgroup A. However, the homogeneity in age is much higher in subgroup A, as indicated by the low standard deviation of 2.76, compared to 11.18 in subgroup A. In terms of length of service, members of subgroup A are more homogeneous with a standard deviation of tenure as low as 0.90. Male trainers are consistently dominant in both subgroups, accounting for 78 percent of members of subgroup B and 86 percent of members of subgroup A.

Members of subgroup B are drawn from all of the four work units, none of which really dominates. The majority of members of subgroup A, however, come from unit A. Smaller proportions also come from units B and D.

The way the trainers are distributed into subgroups suggests that GTC trainers seek advice mostly from their colleagues who have about the same rank, educational level, age and tenure as themselves. More specifically, subgroup B contains male trainers who are relatively older and higher in both rank and educational qualifications than those in subgroup A.

Advice-giving Network

The advice-giving network has the smallest and sparsest main region. It contains 26 actors, constituting 59% of the total number of actors (44) in the GTC. The density of this main connected region is 12.62. As can be seen in

Figure 7.18, the advice-giving network has only 10 cliques, the fewest compared to the three networks discussed previously in this chapter. One clique has five members and the rest only three each. At maximum, a pair of actors share common members in three different cliques. For instance, actors 31 and 32 belong to cliques 1, 2 and 3. Also, a pair of cliques share at most two actors. For example, cliques 1 and 2 share actors 31 and 32. Actor 31 appears to have the highest clique centrality, belonging to 6 different cliques.

[redacted]

1:	27 30 31 32 34
2:	16 31 32
3:	31 32 41
4:	7 31 41
5:	16 25 31
6:	6 25 31
7:	2 8 9
8:	3 6 25
9:	8 10 18
10:	27 30 40

Clique-by-Clique Co-membership matrix

	1	2	3	4	5	6	7	8	9	10
1	10	2	2	1	1	1	0	0	0	2
2	2	6	2	1	2	1	0	0	0	0
3	2	2	6	2	1	1	0	0	0	0
4	1	1	2	6	1	1	0	0	0	0
5	1	2	1	1	6	2	0	1	0	0
6	1	1	1	1	2	6	0	2	0	0
7	0	0	0	0	0	0	6	0	1	0
8	0	0	0	0	1	2	0	6	0	0
9	0	0	0	0	0	0	1	0	6	0
10	2	0	0	0	0	0	0	0	0	6

Figure 7.18. Clique overlap in the GTC trainers' advice-giving network

Figure 7.19 shows the intersection graph of the advice-giving network. At level 1-overlap, these trainers are split into two groups. Cliques 7 and 9 form group I; and the other cliques (1, 2, 3, 4, 5, 6, 8, and 10) form another group, II. However, 1-overlap level may not be sufficiently informative as the cliques are identified from the underlying graph of advice-giving network. Therefore, a criterion level of at least 2-overlaps is also considered. At this 2-overlap level, cliques 7 and 9 become disconnected but the cliques in group II remain connected.

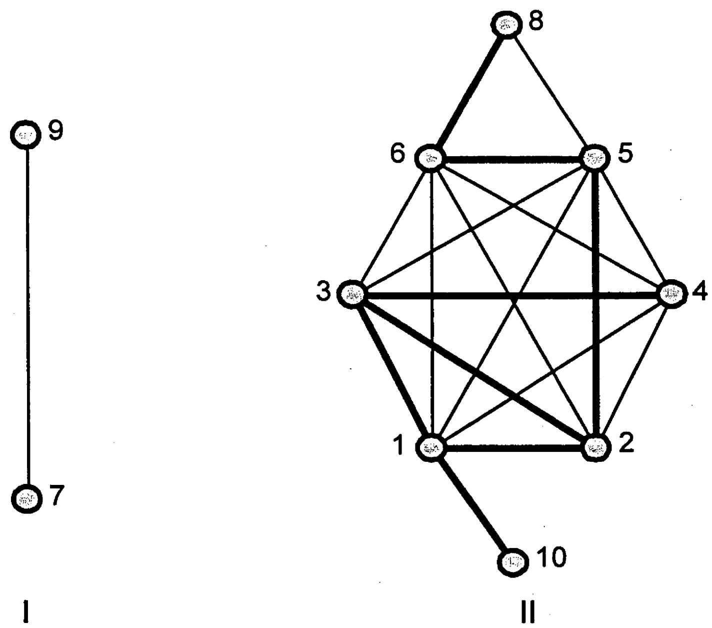


Figure 7.19. Intersection graph for the GTC trainers' advice-giving network

The actual grouping of actors into cohesive subgroups based on the degree of overlap of the cliques to which they belonged can be seen in Figure 7.20. Although the focus is mainly on level 2-overlaps, subgroups at level 1-overlap are shown in the diagram, labelled A and B. The actors in subgroup A are 2, 8, 9, 10 and 18; in B, they are 3, 6, 7, 16, 25, 27, 30, 31, 32, 34, 40 and 41. At level 2-overlaps, only one subgroup exists. It is identical with subgroup B at level 1-overlap, but at level 2-overlaps it is labelled C. The density of this subgroup is 0.36, which is rather low. Nevertheless, it is much higher than the density of interconnections to actors outside this subgroup, which is obvious from visual inspection (Figure 7.20).

The peripheral actors were assigned to one of the cohesive parts of the advice-giving network using the *Newman-Girvan* method. As can be seen in Figure 7.20, actors 11, 13, 17, 24, 29 and 33 were assigned to subgroups B and actors 1, 15, and 26 to subgroup A. Actors 11 and 17 are peripheral actors yet play an important bridging role, connecting subgroup B or C to the rest of the main region of the advice-giving network.

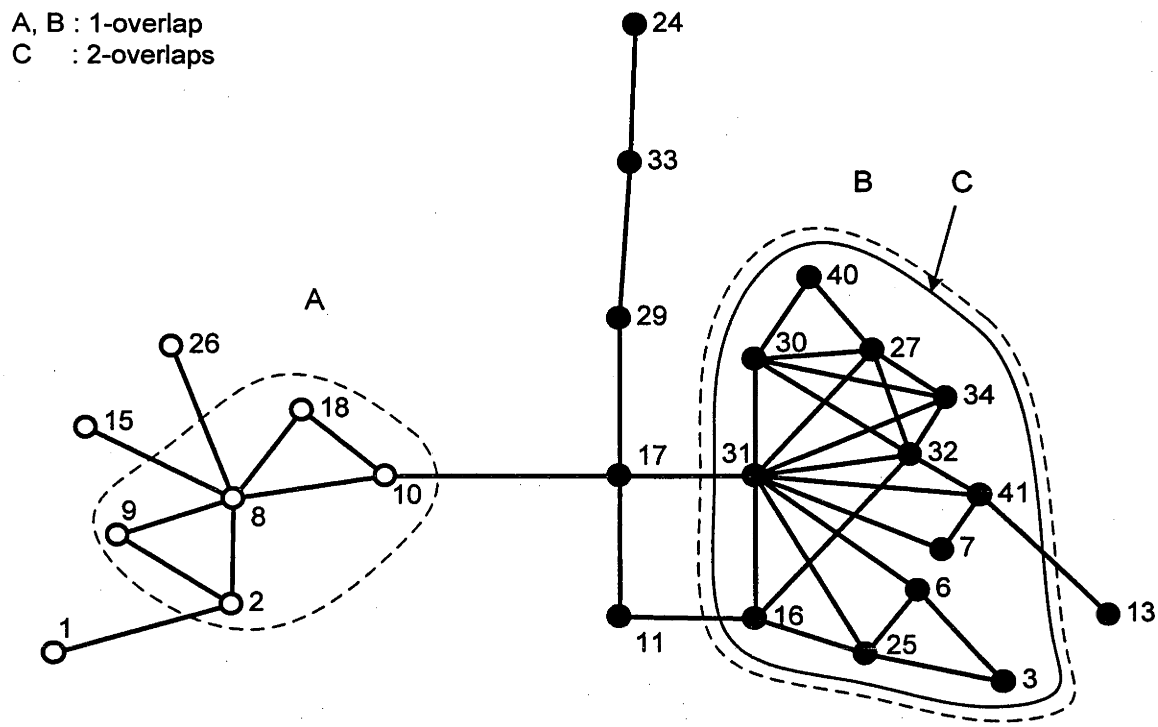


Figure 7.20. Cohesive subgroups in the GTC trainers' advice-giving network

There are seven critical points in the main region of the advice-giving network, including actors 2, 8, 10, 17, 29, 33 and 41. Actors 10 and 17 are particularly critical as removing one, or both, would disconnect subgroup B or C from almost all the other actors outside these subgroups. Actor 8 also plays an important role in connecting actors 1, 2, 9, 15 and 26 to the main region of the advice-giving network.

The multidimensional scaling of geodesic distances in Figure 7.21 provides additional support for the subgroupings. The relatively low stress value of 0.14 indicates that the positions of actors in the two dimensional space are not highly distorted.

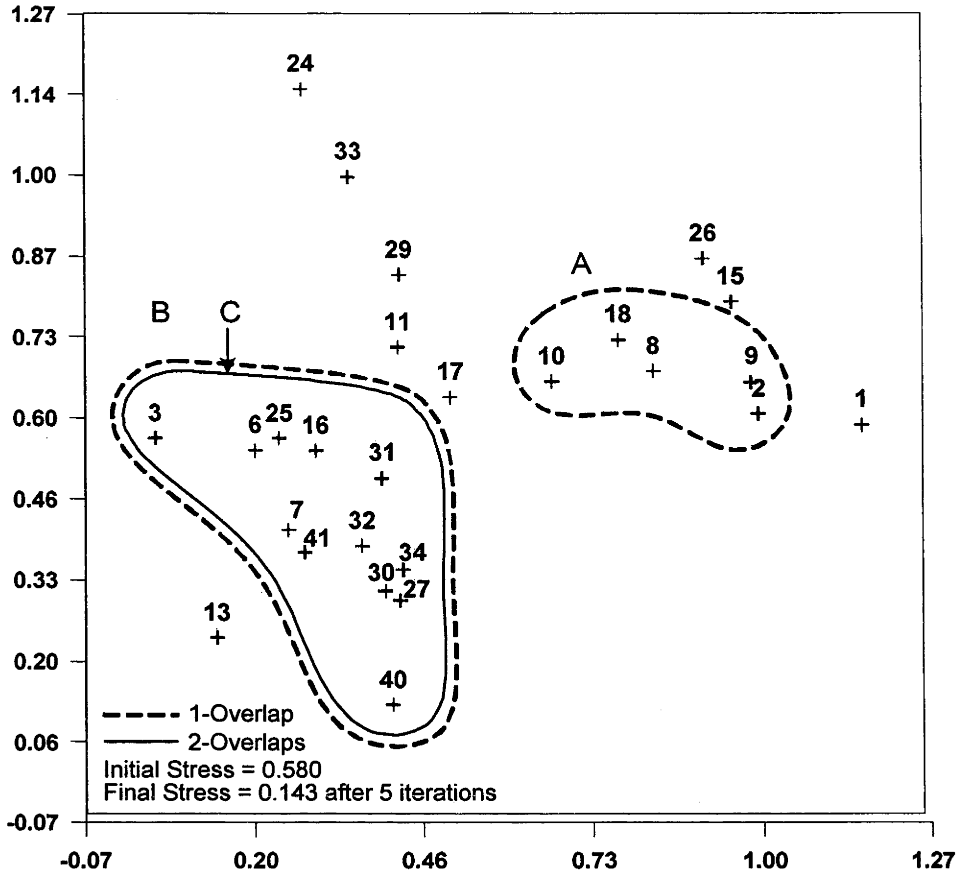


Figure 7.21. MDS of the distance in the GTC advice-giving network

The distribution of actors by attributes can be seen in Table 7.6. For the advice-giving network, only subgroup C, which is based on 2-overlaps, is regarded as cohesive. The members of this subgroup are relatively high rank trainers, of whom 58 percent are middle rank and 33 percent are senior trainers. Junior trainers only account for 8 percent. This is quite reasonable, as it reflects an inclination of junior trainers to position themselves as advise-seekers, rather than advice-givers.

The educational level leans towards the lower end, where the majority have Masters degrees (67%), and 25 percent have undergraduate degrees. Only one trainer has a doctoral degree in this subgroup. The members of subgroup C are drawn from all of the four work units. Except for those who are from unit A, of whom there are fewer, all the other units have about equal representation in this subgroup. As was the case in the cohesive subgroups observed in the other networks, male trainers are the dominant players. Finally, subgroup C contains trainers who are 56 years old on average but who have worked as trainers for only about 5 years.

Table 7.6. Subgroups by actor attributes in the GTC advice-giving network

Attribute	Subgroup C n	(%)
Rank		
Junior	1	(8.3)
Middle	7	(58.3)
Senior	4	(33.3)
Education		
Undergrad	3	(25.0)
Masters	8	(66.7)
Doctoral	1	(8.3)
Work Unit		
A	1	(8.3)
B	4	(33.3)
C	4	(33.3)
D	3	(25.0)
Gender		
Male	8	(66.7)
Female	4	(33.3)
Age*	56	(4.7)
Tenure*	5	(2.6)

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

Overall Characteristics of the Subgroups in GTC Trainers' Networks

The subgroup structure in each of the five networks involving GTC trainers has been identified and examined. As can be seen in Table 7.7, the main region of each network generally contains numerous, highly overlapping cliques. The cliques are generally small, as indicated by the fact that the vast majority of the cliques in all of the networks contain the minimal number of three members. The cliques of six members found in the communication network are the largest. The communication network appears to be quite distinct from the other networks in several key respects. It has the highest number of cliques, contains the largest clique, has the highest level of clique co-membership and clique overlap. This trend is followed next by the collaboration network. The advice-seeking and the advice-giving networks, on the other hand, have the fewest number of cliques, the smallest clique size, and the least clique overlap.

Table 7.7. Cliques and their degree of overlap in the GTC trainers' networks

	Number of cliques	Max clique size	Dominant clique size	Max Co-membership	Max clique overlap
Knowledge	14	5	3	3	2
Communication	28	6	3	10	5
Collaboration	18	4	3	4	3
Advice-seeking	13	4	3	3	3
Advice-giving	10	5	3	3	2

The data observed at the clique level is rather complicated. That is, numerous, but small and overlapping cliques do not provide much information as to how the cohesive subgroups are structured. In general, these data seem to suggest that the GTC trainers' networks are highly fragmented. This is, of course, due to the strict criterion underlying the clique definition (which is used here for the reasons indicated earlier).

In this study, the composition of the cliques themselves is not the end result of the analysis. Rather, the amount of overlap is considered. Through a process of simplification by systematically merging highly overlapping cliques, a more discernible structure of subgroups emerges. The subgroups at this aggregated level contain both direct and indirect ties, and show more integrated networks. The inclusion of indirect ties is relevant to the cohesion required for exchanging learning resources. Thus, the cohesive subgroups that form the central part of the networks are the regions where learning resources are expected to flow more freely and more intensively.

In general, these subgroups are quite inclusive, integrating a large proportion of the actors in the main region of each network. As can be seen in Table 7.8, except for the advice-giving network, at least half of the actors in the main regions belong to cohesive subgroups, forming the cohesive parts as well as the cores of the networks. More specifically, the subgroups in the knowledge network are the most inclusive. Despite it being sparse, 22 of the 31 actors (71%) in its main region are part of its cohesive subgroups. By way of comparison, the communication network, which has the largest main region, includes only half of the actors in its main region in its cohesive subgroups. The subgroups in the advice-seeking network are surprisingly more inclusive than those in the communication network. The subgroup in the advice-giving network, however, remains the least inclusive.

Table 7.8. Size and density of the main region of the GTC trainers' networks

Network	Size of main region n (%)[1]	Main region Density	Cumulative subgroups size n (%)[2]	Number of subgroups and level of cohesiveness				
				1-ovr	2-ovrs	3-ovrs	4-ovrs	5-ovrs
Knowledge	31 (70.45)	0.12	22 (70.97)	2	3	-	-	-
Communication	34 (77.27)	17.65	17 (50.00)	-	-	2	1	1
Collaboration	30 (68.18)	13.79	20 (66.67)	-	2	1	-	-
Advice-seeking	27 (61.36)	13.11	16 (59.26)	-	2	1	-	-
Advice-giving	26 (59.09)	12.62	12 (46.15)	-	1	-	-	-

[1]The percentage values indicate the proportion of actors in the main region of each network to the total 44 actors in the GTC

[2]The percentage values indicate the proportion of actors in the subgroups relative to the number of actors in the main region of each network

It can also be seen in Table 7.8 that the subgroups in all of the networks can be defined at level 2-overlaps (2-ovrs) or higher, indicating that these subgroups are indeed cohesive. In fact, in the communication network, subgroups can be defined up to level 5-overlaps (5-ovrs). Except for the subgroup in the advice-giving network, at least two subgroups can be identified at cohesion level of 2-overlaps.

Subgroup structures in some of the networks are robust, whilst in some others they are rather vulnerable to disruption. The subgroup structures in the communication and collaboration networks are examples of strong structures. In both networks, subgroups overlap to some extent, reflecting the fact that these networks contain integrated and robust internal structures. However, the real reason for the robustness of these networks is that the cut points they contain tend only to integrate small numbers of peripheral actors into the main structure. These peripheral actors themselves do not play bridging roles. Thus, the cut points did not present a threat to the connectivity within and between the subgroups.

The knowledge, advice-seeking and advice-giving networks, in contrast, are rather vulnerable to being disintegrated if some actors leave the networks. The subgroups in these networks are all separated and partly dependent on peripheral actors to connect them. In addition, they also contain cut points which play bridging roles.

The importance of peripheral actors should be underscored. Many of them play crucial bridging roles, connecting otherwise unconnected subgroups, or provide alternative paths through which inter-subgroups interactions can take place. This is especially true for peripheral actors in the networks with non-overlapping subgroups, such as those in the knowledge, advice-seeking and advice-giving networks. However, in the networks where subgroups are overlapping, such as in the communication and collaboration networks, many peripheral actors are merely hangers-on, so to speak, being connected directly to a limited number of subgroup members, or connected to the subgroups through other peripheral actors.

Subgroup members are drawn from the GTC trainers with varying attributes. Some actor attributes represent important unifying features of the subgroups. As can be seen in Table 7.9, educational level, gender and rank appear to be the most common unifying features as these are homogeneous within subgroups in most or all of the networks. It is important to note, however, that the homogeneity of gender is partly affected by the dominant number of male trainers in the whole network. In the GTC, there are 34 male trainers, compared to only 10 female trainers. Nevertheless, in some cases the female trainers are more highly represented on a proportional basis. For example, in the collaboration network, half of the female trainers in the GTC are part of one subgroup, while male trainers' representation in the same subgroup is only 18 percent. Other attributes are only homogeneous in one or two networks.

Table 7.9. Unifying features of the subgroups in the GTC networks

	Dominant unifying features					
Network	Age	Rank	Tenure	Education	Work unit	Gender
Knowledge	-	✓	-	✓	-	✓
Communication	-	-	-	✓	✓	✓
Collaboration	-	✓	✓	✓	-	✓
Advice-seeking	✓	✓	✓	✓	-	✓
Advice-seeking	-	✓	-	✓	-	✓

The analyses reveal cohesive subgroups of each of the networks. Members of the identified subgroups were closer and more densely tied to one another than to non-members. Therefore, it is plausible to expect that learning resources such as general information, expert advice, tacit knowledge and a combination of these should be able to flow more freely and more intensively among members of these subgroups.

Cohesive Subgroups in the CTU Trainers' Networks

As an aim of this study was to compare informal learning among trainers in both public and private organisations, it is important to look at subgroups within the Company Training Unit (CTU). The number and the type of networks in the CTU are the same as those in the Government Training Centre (GTC). Therefore, the subgroups in the CTU trainers' networks are examined along the same lines as those in the GTC.

Knowledge Network

The reciprocal-symmetrised main connected region in the CTU trainers' knowledge network contains 27 actors. This is quite inclusive, accounting for 87% of the 31 trainers in the CTU. These actors are connected by 62 mutual ties, with a density of 0.18. As can be seen in the left panel of Figure 7.22, 16 overlapping cliques can be identified in this main region. The largest clique has five members, and there is only one clique of this size. Seven other cliques have four members, and the remaining cliques are of size three. At maximum, a pair of actors belong to the same cliques three times. For example, actors 22 and 24 are co-members of cliques 1, 2 and 6. The right panel of Figure 7.22 shows the degree of overlap among the cliques. It can be seen that a pair of cliques have a maximum of three members in common. For example, cliques 1 and 2 share actors 2, 3 and 26. Some actors have particularly high clique centrality. For example, actors 22 and 30 each belong to seven different cliques.

[redacted]

1:	15 16 22 24
2:	16 22 24 30
3:	16 19 22
4:	14 19 21 22
5:	14 15 22
6:	21 22 24 30
7:	22 27 30
8:	11 27 28
9:	13 16 24 30
10:	2 26 3 4 5
11:	1 2 26 3
12:	16 23 30
13:	21 23 30
14:	26 27 28 30
15:	26 28 29
16:	26 28 3

Clique-by-Clique Co-membership matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	4	3	2	1	2	2	1	0	2	0	0	1	0	0	0	0
2	3	4	2	1	1	3	2	0	3	0	0	2	1	1	0	0
3	2	2	3	2	1	1	1	0	1	0	0	1	0	0	0	0
4	1	1	2	4	2	2	1	0	0	0	0	0	1	0	0	0
5	2	1	1	2	3	1	1	0	0	0	0	0	0	0	0	0
6	2	3	1	2	1	4	2	0	2	0	0	1	2	1	0	0
7	1	2	1	1	1	2	3	1	1	0	0	1	1	2	0	0
8	0	0	0	0	0	0	1	3	0	0	0	0	0	2	1	1
9	2	3	1	0	0	2	1	0	4	0	0	2	1	1	0	0
10	0	0	0	0	0	0	0	0	0	5	3	0	0	1	1	2
11	0	0	0	0	0	0	0	0	0	3	4	0	0	1	1	2
12	1	2	1	0	0	1	1	0	2	0	0	3	2	1	0	0
13	0	1	0	1	0	2	1	0	1	0	0	2	3	1	0	0
14	0	1	0	0	0	1	2	2	1	1	1	1	1	4	2	2
15	0	0	0	0	0	0	0	1	0	1	1	0	0	2	3	2
16	0	0	0	0	0	0	0	1	0	2	2	0	0	2	2	3

Figure 7.22. Clique overlap in the CTU trainers' knowledge network

The intersection graph in Figure 7.23 shows the grouping of cliques based on the degree of overlap among them. The pairs of cliques are connected by thin edges if they overlap by one actor, medium weight edges if they overlap by two actors, and thick edges if they overlap by three actors. At level 1-overlap and level 2-overlap, the cliques remain connected. Only at level 3-overlap are the cliques split into two groups. The first group contains cliques 1, 2, 6 and 9; the second group contains cliques 10 and 11. All the other cliques are singletons. For present purposes, cohesive subgroups for the knowledge network will be defined based on level 3-overlaps.

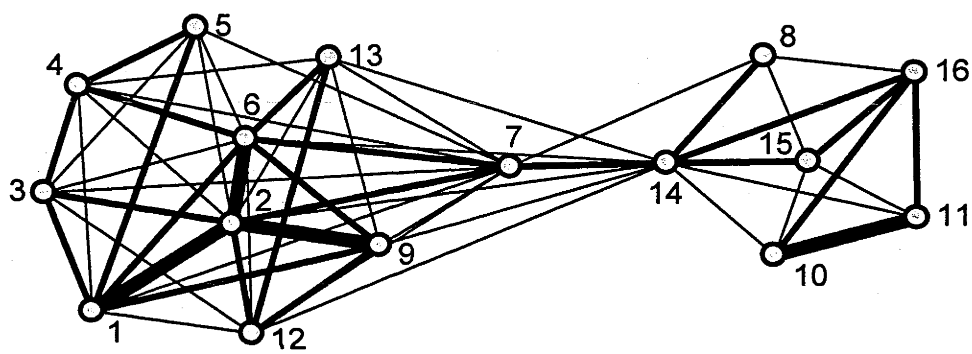


Figure 7.23. Intersection graph of the CTU trainers' knowledge network

Figure 7.24 shows the groups of actors who belong to the two groups identified at the 3-overlap level. Clearly, the two highly overlapping cliques contain actors who form cohesive subgroups A and B. Subgroup A contains seven actors, 13, 15, 16, 21, 22, 24 and 30. The density of interconnections among these actors is 0.71, which is quite high. The cohesive subgroup B contains only six actors, 1, 2, 3, 4, 5 and 26. The density of ties in the subgroup is even higher, 0.87. These two subgroups constitute the cohesive part of the knowledge network, and enclose only 13 (48%) of the 27 actors in its main region.

Although the two subgroups are separated, there are also some pathways through which members of the different subgroups can interact. The links between the two subgroups partly pass through group members, for example the tie between actor 30 in subgroup A and actor 26 in subgroup B. However, some pass through non-members (for example, actors 27, 28 and 29) and provide alternative paths through which members in the two subgroups can reach each other.

Peripheral actors were assigned to the two subgroups using *Newman-Girvan*'s social group detector, a division indicated by dark and white nodes in Figure 7.24. The *Newman-Girvan* method recognised A and B as two separate subgroups and assigned peripheral actors 14, 18, 19, 23, 25 and 31 to subgroup A, and actors 6, 7, 8, 11, 12, 27, 28 and 29 to subgroup B.

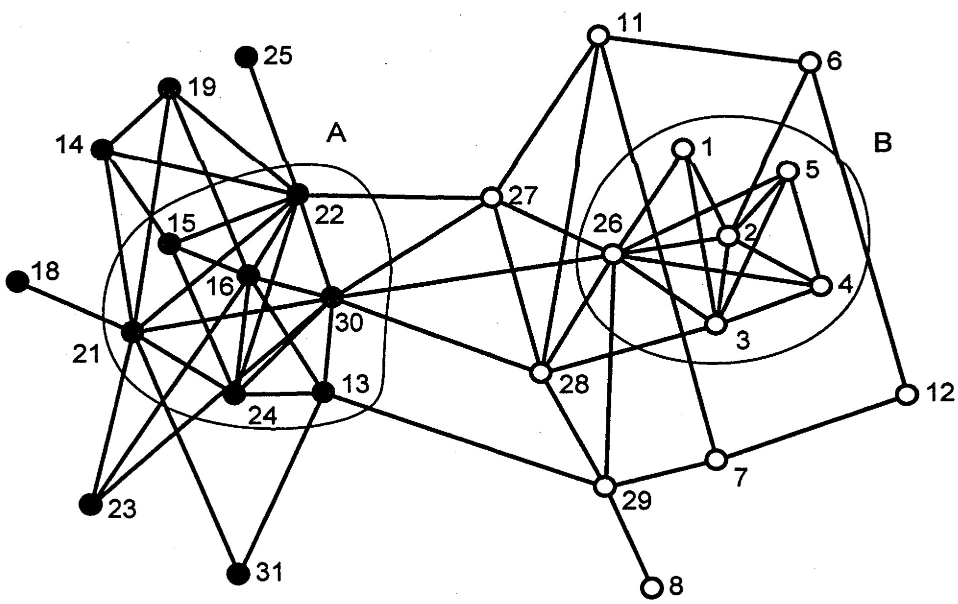


Figure 7.24. The cohesive subgroups in the CTU trainers' knowledge network

The knowledge network in the CTU appears to be quite robust. There are only three cut points in it, actors 21, 22 and 29. Each of them connects only one peripheral actor to the main region. The connectivity between subgroups in the main region, and between actors within the subgroups, would be relatively unaffected if these actors dropped out of the network.

Figure 7.25 shows the multidimensional scaling (MDS) of the distances among actors in terms of knowledge exchange relations. This MDS analysis demonstrates a result consistent with the subgroups identified above. Subgroups A and B are indicated by borderlines. The stress level of 0.159 is quite high but still within an acceptable range (to ensure that the positions of nodes on the two dimensional space are not distorted).

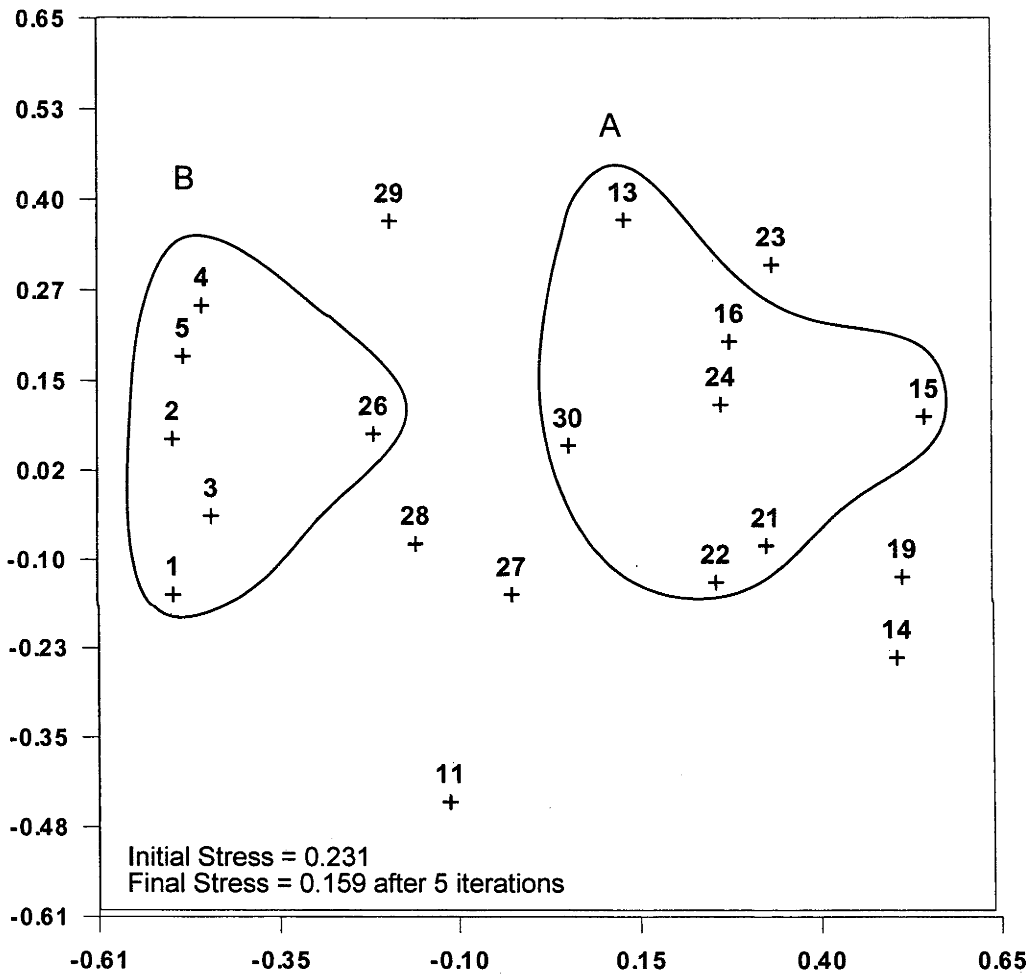


Figure 7.25. MDS of the distance in the CTU knowledge network

The cohesive subgroups are identified purely based on the ties among the trainers. It is useful to see if they constitute meaningful social groups by looking at the characteristics of their members. More specifically, it is useful to see if actors within each subgroup are homogeneous in terms of sociologically meaningful attributes such as age, rank, tenure, education and work unit.

Subgroup memberships by actor attributes can be seen in Table 7.10. The subgroups are defined at level 3-overlap. Among the attributes, work unit appears to be the most important unifying feature. A large proportion (86%) of the members of subgroup A are from unit C. In subgroup B, all of the members are from work unit A. The cohesive part of the knowledge network in the CTU, then, is formed primarily by trainers from these two units.

Table 7.10. Subgroups by actor attributes in the CTU knowledge network

Attribute	Subgroup A n	(%)	Subgroup B n	(%)
Rank				
Junior	0	(0.0)	1	(16.7)
Senior	6	(85.7)	4	(66.7)
TE	1	(14.3)	1	(16.7)
Education				
Undergrad	4	(57.1)	5	(83.3)
Masters	3	(42.9)	1	(16.7)
Doctoral	0	(0.0)	0	(0.0)
Work Unit				
A	0	(0.0)	6	(100.0)
B	0	(0.0)	0	(0.0)
C	6	(85.7)	0	(0.0)
D	1	(14.3)	0	(0.0)
E	0	(0.0)	0	(0.0)
Gender				
Male	7	(100.0)	5	(83.3)
Female	0	(0.0)	1	(16.7)
Age*	41	(2.1)	40	(6.4)
Tenure*	18	(6.4)	10	(4.9)

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

Other attributes that appear to be homogeneous within each subgroup include rank, education, and gender. In both subgroups A and B, the majority of their members are senior trainers, accounting for 86 percent in subgroup A and 67 percent in subgroup B. In terms of educational level, trainers with undergraduate degrees are dominant in both subgroups. In terms of gender, male trainers predominate in both subgroups. Specifically, all members of subgroup A are male trainers; and, 83 percent of members of subgroup B are male, compared to only 17 percent female. However, it is important to note that, overall, senior trainers, trainers with undergraduate degrees, and male trainers outnumber all the other categories within each attribute.

In general, these data suggest that CTU trainers exchange knowledge with colleagues who are in the same work unit as they are. Since the work unit in which CTU trainers are assigned reflects their area of specialisation, this also suggests that CTU trainers who are teaching in the same area of specialisation exchange knowledge more intensively with each other than with those specialising in different areas. In particular, both subgroups which form the cohesive part of the knowledge network are composed of trainers who are male, senior and have undergraduate degrees. Also, those in subgroup A are slightly older than their colleagues in subgroup B.

Ideally, cohesive subgroups should be identified on the basis of reciprocated relations. However, mutuality that actually exists may not always be reported. The communication, collaboration, advice-seeking and advice-giving networks in the CTU are generally sparse and fragmented into small components if symmetrised on the basis of reported reciprocated ties only. As can be seen in Table 7.11, by this criterion, only the communication and collaboration networks have main connected regions, containing 20 and 16 actors respectively, large enough for cohesive subgroups to be meaningfully examined. Therefore, the main regions of these two networks are symmetrised using the strong criterion, that is, by keeping reciprocated ties only. For these two networks, therefore, clique intersections as the basis for defining cohesive subgroups may be based on the 1-overlap level or higher.

Table 7.11. CTU networks fragmentation (symmetrised with strong criterion)

Component	Communication	Collaboration	Advice-seeking	Advice-giving
20-cluster	1	0	0	0
16-cluster	0	1	0	0
8-cluster	0	0	1	0
6-cluster	0	0	0	1
4-cluster	0	0	0	1
Triad	0	0	1	1
Dyad	1	3	3	2
Singleton	9	9	14	14
Density	0.054	0.067	0.039	0.032

Note: strong criterion means a tie connecting a pair of actors is considered symmetric if both of them actually nominated each other

The same criterion, however, could not be applied to the advice-seeking and advice-giving networks because the largest clusters in these two networks contain only 8 and 6 actors respectively. These clusters are too small, and therefore analyses of them would not be meaningful. Therefore, they were symmetrised using the underlying graphs. That is, a symmetric tie was established between a pair of actors if at least one of them nominated the other. In order to compensate for the use of the underlying graph, however, it is necessary to restrict the simplification of clique structure by using the strongest possible criterion in building their intersection graphs. In this case, cliques are considered adjacent only if they have at least two actors in common (level 2-overlap or higher).

Communication Network

The main region of the communication network to be searched for cohesive subgroups contains 20 actors, accounting for 65 percent of the total 31 actors in the CTU. The density of this main connected region is 0.15. As can be seen in Figure 7.26, the communication network contains only seven cliques in its main region. The cliques are generally small. Only one of them contains four members and the rest contain three members. At most, a pair of actors belongs to two cliques together. For example actors 2 and 3 are both members of cliques 1 and 2; actors 14 and 22 both appear in cliques 4 and 5. The cliques themselves have a maximum of two members in common, again referred to as 2-overlaps (or the 2-overlap level). For instance, cliques 1 and 2 both contain actors 2 and 3; cliques 4 and 5 share actors 14 and 22. Two actors (actors 3 and 22) have the highest clique centrality, each belonging to three different cliques.

[redacted]

1:	2 3 4 26
2:	2 3 5
3:	1 3 26
4:	14 21 22
5:	14 15 22
6:	16 24 30
7:	19 21 22

Clique-by-Clique
Co-membership matrix

	1	2	3	4	5	6	7
1	4	2	2	0	0	0	0
2	2	3	1	0	0	0	0
3	2	1	3	0	0	0	0
4	0	0	0	3	2	0	2
5	0	0	0	2	3	0	1
6	0	0	0	0	0	3	0
7	0	0	0	2	1	0	3

Figure 7.26. Clique overlap in the CTU trainers' communication network

The groupings of cliques based on their degree of overlap can be seen in Figure 7.27. The thickness of the edges is proportional to the number of actors the pairs of cliques have in common, where thick edges indicate that the adjacent cliques have up to two members in common. Clique 6 is the only one that has completely unique members; hence, it is disconnected from the others.

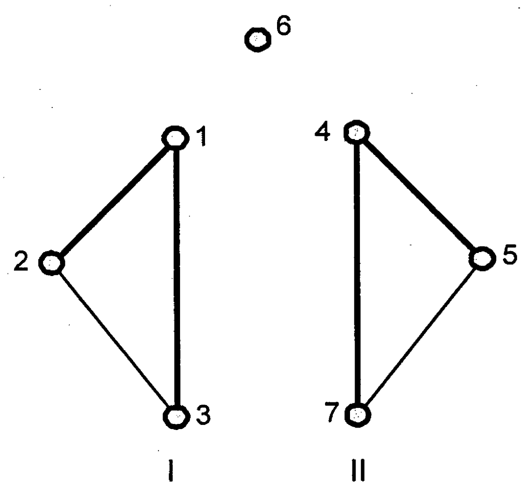


Figure 7.27. Intersection graph of the CTU trainers' communication network

At 1-overlap, two groups emerge. Group I contains cliques 1, 2, and 3, while group II consists of cliques 4, 5 and 7. At the 2-overlap level, the direct connections between cliques 2 and 3 in group I and between cliques 5 and 7 in group II disappear. Nevertheless, the cliques in each group remain connected. Thus, the sets of actors who belong to each subgroup at level 1-overlap and 2-overlaps are identical.

Figure 7.28 shows the actors who belong to each of the highly overlapping cliques. The subgroups resulting from the intersection graph are indicated by boundary lines and are labelled A and B. These subgroups are quite small, where subgroups A and B contain only six and five actors respectively. The set of actors 1, 2, 3, 4, 5 and 26 correspond to the group of cliques I, and is labelled A. The density among these actors is 0.67. Subgroup B, which corresponds to group of cliques II in the intersection graph, contains the set of actors 14, 15, 19, 21 and 22 with a density of 0.70. Thus, only 11 (55%) of the 20 actors in the main region are in the cohesive parts of the communication network.

Peripheral actors (27, 28, 11, 6, 12, 24, 30 and 23) were assigned to these two subgroups using a subgroup detection which divides actors into mutually exclusive subgroups, as indicated by the contrasting dark and white nodes in Figure 7.28. For the communication network, both *Factions* and *Newman-Girvan* produced identical groupings. Actors 6, 11, 12, 27 and 28 were assigned to subgroups A, and actors 16, 23, 24 and 30 to subgroup B.

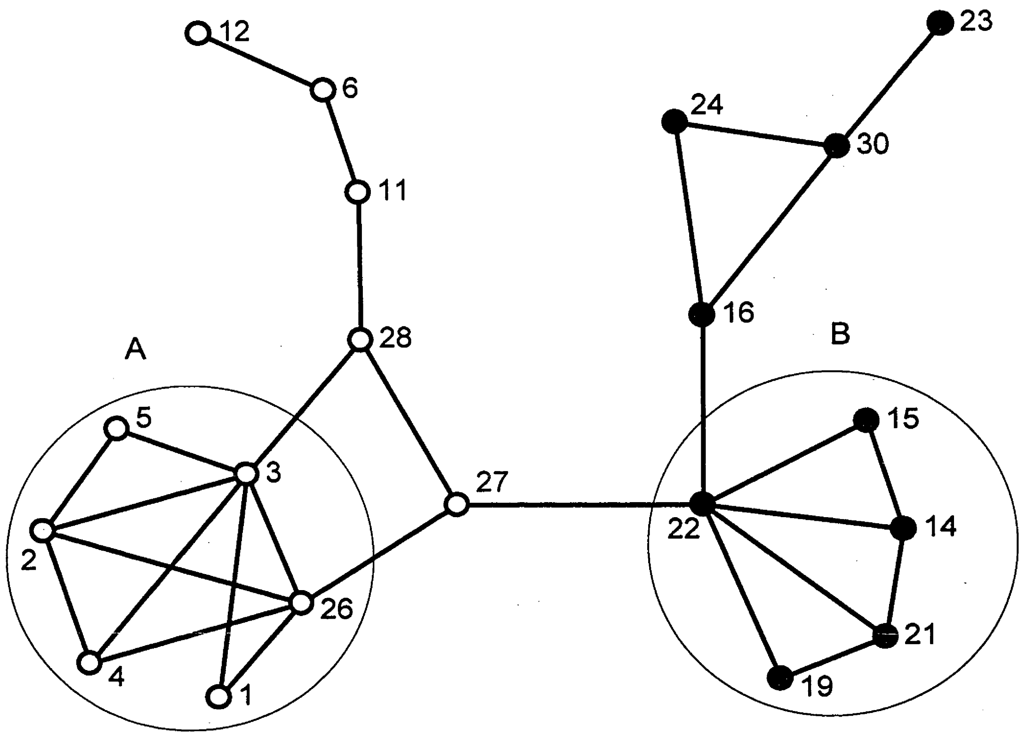


Figure 7.28. Cohesive subgroups in the CTU trainers' communication network

The two groups are separated, and are rather vulnerable to disconnection if some actors leave the network. There are seven cut points (6, 11, 16, 22, 27, 28, and 30) which – if removed – could potentially cause the structure to disintegrate. Actors 22 and 27 are particularly critical because removing either or both of them would disconnect the two subgroups. Actors 16 and 28 were also critical as each has three actors whose connections to the structure depends of them.

These observations can also be examined using multidimensional scaling of the geodesic distances among actors, as shown in Figure 7.29. The two groups identified above appear closer together in two dimensional space and are clearly shown by the boundary lines. The stress value of 0.1 falls within the acceptable range.

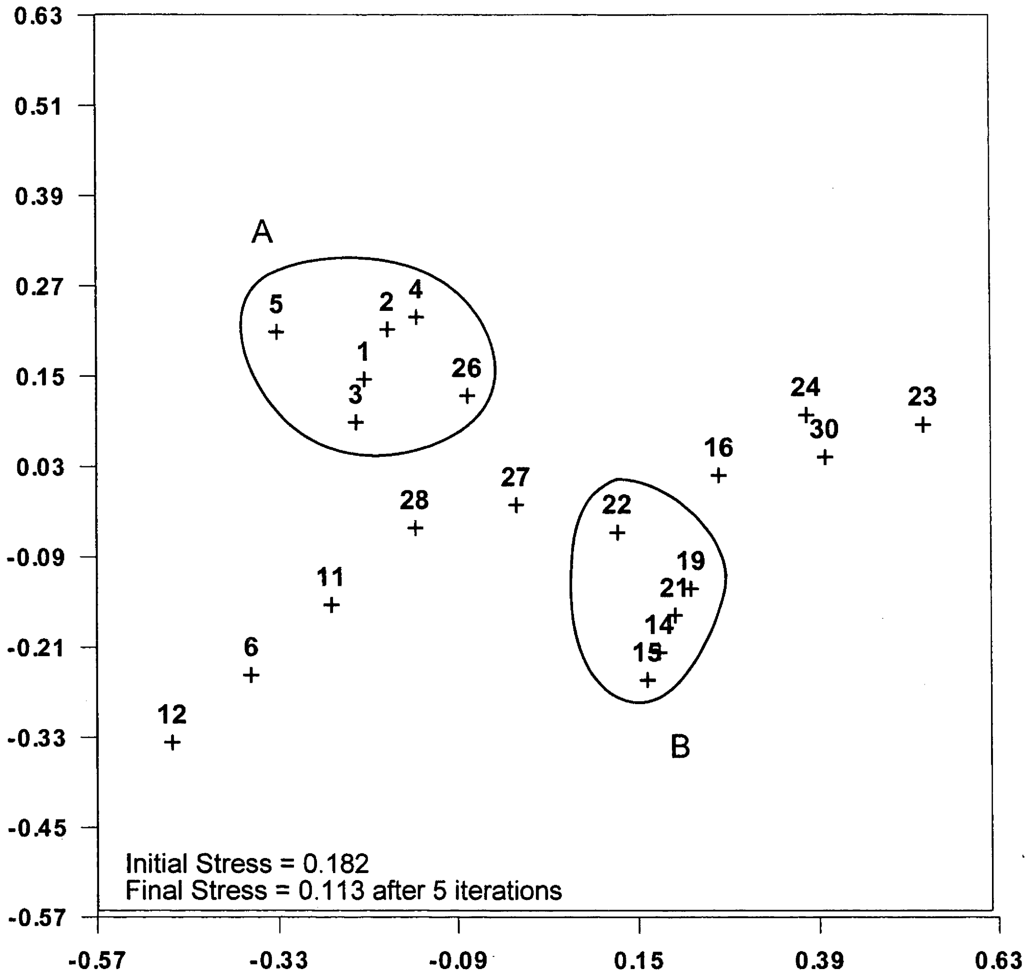


Figure 7.29. MDS of the distance in the CTU communication network

The association between various actor attributes and subgroup memberships can be seen in Table 7.12. As becomes evident, work unit constitutes the strongest unifying feature of the subgroups in the communication network. That is, trainers within each subgroup are perfectly homogeneous in terms of work units. Subgroup A is made up entirely of trainers from unit A, while trainers in subgroup B are from unit C.

Other attributes, which are more homogeneous within each subgroup, include rank, education and gender. However, they are less differentiating than work unit. As indicated earlier the values of these attributes across categories are not well balanced. Nevertheless, it can be seen that male, senior trainers with undergraduate qualifications predominate in all of the subgroups.

Table 7.12. Subgroups by actor attributes in the CTU communication network

Attribute	Subgroup A n	(%)	Subgroup B n	(%)
Rank				
Junior	1	(16.7)	0	(0.0)
Senior	4	(66.7)	5	(100.0)
TE	1	(16.7)	0	(0.0)
Education				
Undergrad	5	(83.3)	3	(60.0)
Masters	1	(16.7)	2	(40.0)
Doctoral	0	(0.0)	0	(0.0)
Work Unit				
A	6	(100.0)	0	(0.0)
B	0	(0.0)	0	(0.0)
C	0	(0.0)	5	(100.0)
D	0	(0.0)	0	(0.0)
E	0	(0.0)	0	(0.0)
Gender				
Male	5	(83.3)	5	(100.0)
Female	1	(16.7)	0	(0.0)
Age*	40	(5.2)	41	(1.7)
Tenure*	10	(4.8)	18	(6.2)

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

In terms of tenure, there is a marked difference in the average length of service between the two subgroups. Members of subgroup A have an average tenure of 10 years, while those in subgroup B have been working as trainers for 18 years on average.

Collaboration Network

There are 16 actors in the main region of the collaboration network, accounting for 52 percent of the 31 trainers in the CTU. The density of ties within this main region is 0.23. The main region contains 10 cliques, as can be seen in Figure 7.30. The cliques are generally small. The maximum size is four, and there are only two cliques of this size. The remainder have only three members. The maximum number of cliques to which a pair of actors both belong is two. For example, actors 2 and 3 are both in cliques 1 and 5; actors

26 and 27 belong to cliques 3 and 4. On the right panel of Figure 7.30 it can be seen that the cliques have a maximum of three members in common. Cliques 1 and 5 share three actors, 2, 3, and 4. Actor 26 has the highest clique centrality, belonging to four different cliques.

[redacted]

1:	2 3 4 26
2:	1 3 26
3:	26 27 28
4:	26 27 30
5:	2 3 4 5
6:	16 22 24
7:	16 24 30
8:	16 23 30
9:	19 21 22
10:	21 22 24

Clique-by-Clique
Co-membership matrix

	1	2	3	4	5	6	7	8	9	10
1	4	2	1	1	3	0	0	0	0	0
2	2	3	1	1	1	0	0	0	0	0
3	1	1	3	2	0	0	0	0	0	0
4	1	1	2	3	0	0	1	1	0	0
5	3	1	0	0	4	0	0	0	0	0
6	0	0	0	0	0	3	2	1	1	2
7	0	0	0	1	0	2	3	2	0	1
8	0	0	0	1	0	1	2	3	0	0
9	0	0	0	0	0	1	0	0	3	2
10	0	0	0	0	0	2	1	0	2	3

Figure 7.30. Clique overlap in the CTU trainers' collaboration network

At 2-overlap level, three groups emerge. The first group consists of cliques 1, 2 and 5; the second contains cliques 3 and 4; and, the third group contains cliques 6, 7, 8, 9 and 10. At 3-overlap level, only cliques 1 and 5 are connected, as indicated by the thickest edge connecting the two cliques in Figure 7.31.

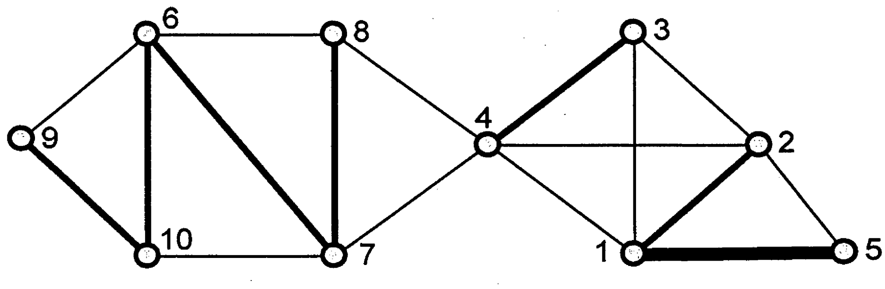


Figure 7.31. Intersection graph of the CTU trainers' collaboration network

Based on the intersection graph, actors who belong to the cohesive part of the network can be identified. At level 2-overlaps, three groups emerge, labelled A, B and C in Figure 7.32. Subgroup A contains the set of actors 16, 19, 21, 22, 23, 24 and 30, corresponding to cliques 6, 7, 8, 9, and 10. The density of subgroup A is 0.52. Subgroup B is composed of cliques 3 and 4, and contains the set of actors 26, 27, 28 and 30. Its density is 0.83.

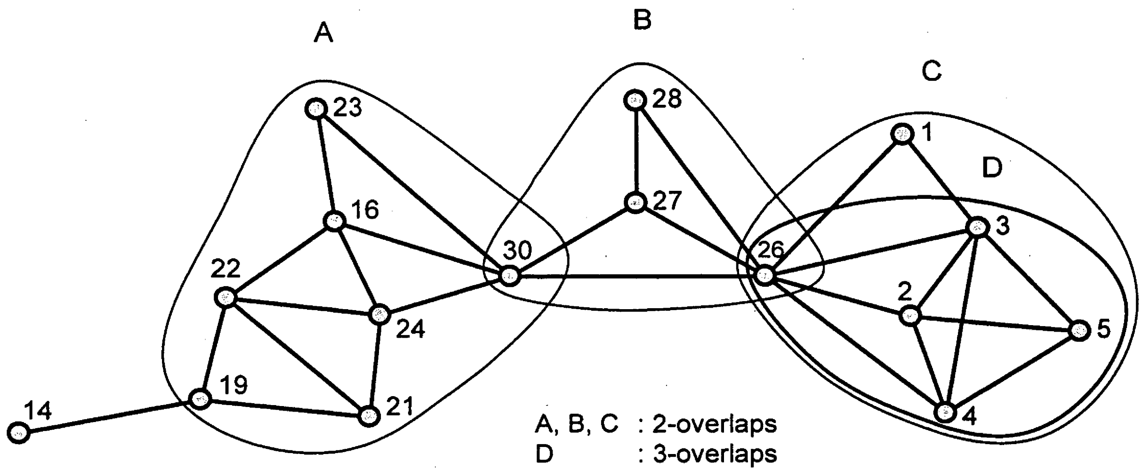


Figure 7.32. The cohesive subgroups in the CTU collaboration network

Subgroup C is the amalgamation of cliques 1, 2 and 5, and contains the set of actors 1, 2, 3, 4, 5 and 26, with a density of 0.73. The cliques that are adjacent at level 3-overlaps define the set of actors {2, 3, 4, 5, 26}, labelled D in Figure 7.32 and are enclosed within the thick boundary line. The density of ties in subgroup D is 0.90. It appears that the subgroups in the collaboration network are highly inclusive, accommodating 15 (94%) of all the 16 actors in the main region. Actor 14, who is the only one excluded from the cohesive subgroups, clearly belongs to subgroup A.

As can be seen, all subgroups are connected, where subgroup B is an intermediary. Despite the fact that they are overlapping, the subgroup structure is quite prone to disintegration. Although there are only three cut points (actors 19, 29 and 30), two of them (actors 26 and 30) particularly play critical roles in ensuring the connectivity of the cohesive subgroups; and hence that of the main region of the collaboration network. If for some reason, either or both of these actors leaves the network, the three subgroups could break apart.

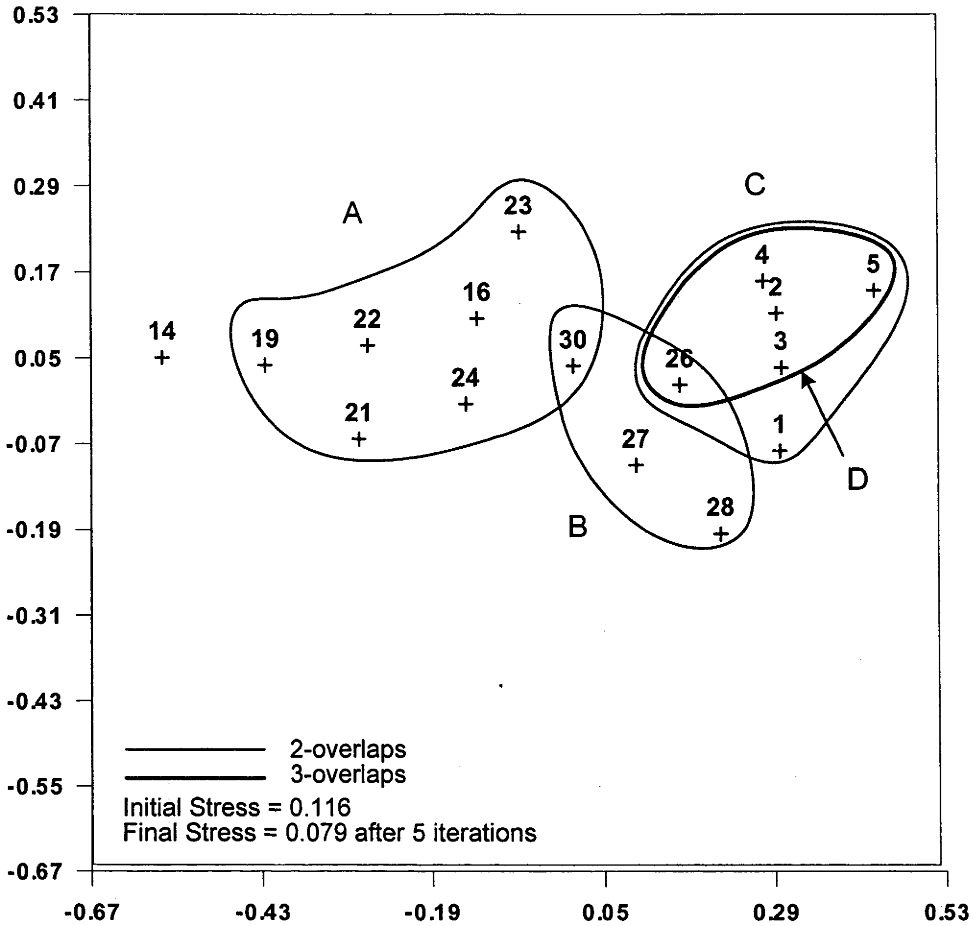


Figure 7.33. MDS of the distance in the CTU collaboration network

Multidimensional scaling of the geodesic distances between pairs of actors, represented in Figure 7.33, clearly reveals the same grouping. The stress value is quite low, 0.079, indicating that the positions of nodes in the two dimensional space is quite accurate.

The distribution of actors by attributes into these subgroups can be seen in Table 7.13. The subgroup structure of the collaboration network shows a markedly different configuration from the knowledge and communication networks discussed earlier. It contains three subgroups at the same level of cohesiveness (2-overlap level).

Table 7.13. Subgroups by actor attributes in the CTU collaboration network

Attribute	Subgroup A n	(%)	Subgroup B n	(%)	Subgroup C n	(%)
Rank						
Junior	0	(0.0)	0	(0.0)	1	(16. 7)
Senior	6	(85.7)	0	(0.0)	4	(66.7)
TE	1	(14.3)	4	(100.0)	1	(16.7)
Education						
Undergrad	4	(57.1)	4	(100.0)	5	(83.3)
Masters	3	(42.9)	0	(0.0)	1	(16.7)
Doctoral	0	(0.0)	0	(0.0)	0	(0.0)
Work Unit						
A	0	(0.0)	1	(25.0)	6	(100.0)
B	0	(0.0)	0	(0.0)	0	(0.0)
C	7	(100.0)	1	(25.0)	0	(0.0)
D	0	(0.0)	1	(25.0)	0	(0.0)
E	0	(0.0)	1	(25.0)	0	(0.0)
Gender						
Male	7	(100.0)	4	(100.0)	5	(83.3)
Female	0	(0.0)	0	(0.0)	1	(16.7)
Age*	40	(1.8)	40	(1.5)	40	(5.2)
Tenure*	17	(7.3)	9	(10.9)	10	(4.8)

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

Subgroups A and C seems to reflect the subgroup configurations encountered previously in the knowledge and communication networks, in which the members are mainly male, senior trainers, with undergraduate qualifications. In addition, all of the trainers in subgroup A are from unit C, while those in subgroup C are all from work unit A. In terms of length of service, members of subgroup A have an average tenure of 17 years, compared to only 10 years for those in subgroup C.

Subgroup B, however, is a new group and it displays different characteristics. It is composed entirely of training experts, the highest rank in the training career in the CTU. Four of the five training experts in the CTU form this subgroup. The grouping of the training experts in the collaboration network is supported by qualitative evidence. That is, in the interviews with the trainers, the training experts indicate that although each of them is assigned to a different unit, many of their actual activities are collaborative, involving all training experts from different units.

Advice-seeking Network

The main region of the advice-seeking network contains 21 (68%) of the 31 trainers in the CTU, with a density of 0.17. As Figure 7.34 shows, the main region has 14 overlapping cliques. The largest cliques contain up to five members. Only two of the cliques, however, are this large. Five other cliques have four members and seven have three members. There is a maximum of four cliques in which a pair of actors are co-members. Actors 4 and 26 are the only pair to reach this maximum co-membership, belonging to cliques 1, 2, 3, and 4. Pairs of cliques have up to four members in common, such as cliques 1 and 2 sharing actors 2, 3, 4, and 26. Actor 26 has the highest clique centrality, belonging to 6 different cliques. The other prominent actors in terms of clique centrality are 4, 27, 28 and 30, each of whom belong to four different cliques.

[redacted]

1:	2 3 4 5 26
2:	1 2 3 4 26
3:	3 4 26 28
4:	4 26 27 28
5:	7 8 10 29
6:	11 27 28
7:	13 16 24 30
8:	13 30 31
9:	14 19 21
10:	15 19 21 22
11:	21 22 24
12:	26 28 29
13:	26 27 30
14:	27 30 31

Clique-by-Clique
Co-membership matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	5	4	3	2	0	0	0	0	0	0	0	1	1	0
2	4	5	3	2	0	0	0	0	0	0	0	1	1	0
3	3	3	4	3	0	1	0	0	0	0	0	2	1	0
4	2	2	3	4	0	2	0	0	0	0	0	2	2	1
5	0	0	0	0	4	0	0	0	0	0	0	1	0	0
6	0	0	1	2	0	3	0	0	0	0	0	1	1	1
7	0	0	0	0	0	0	4	2	0	0	1	0	1	1
8	0	0	0	0	0	0	2	3	0	0	0	0	1	2
9	0	0	0	0	0	0	0	0	3	2	1	0	0	0
10	0	0	0	0	0	0	0	0	2	4	2	0	0	0
11	0	0	0	0	0	0	1	0	1	2	3	0	0	0
12	1	1	2	2	1	1	0	0	0	0	0	3	1	0
13	1	1	1	2	0	1	1	1	0	0	0	1	3	2
14	0	0	0	1	0	1	1	2	0	0	0	0	2	3

Figure 7.34. Clique of overlap in the CTU trainers' advice-seeking network

The intersection graph in Figure 7.35 shows the cliques that are adjacent based on the number of actors they have in common. If the condition for adjacency is 2-overlaps, two groups of cliques can be identified. Cliques 1, 2, 3, 4, 6, 7, 8, 12, 13, and 14 become one group, and cliques 9, 10 and 11 form the other group.

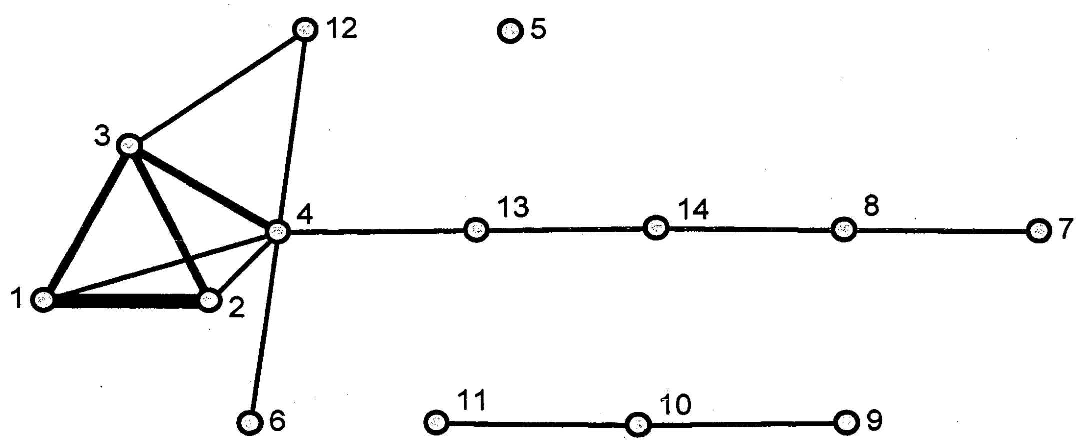


Figure 7.35. Intersection graph of the CTU trainers' advice-seeking network

If the criterion level is raised to 3-overlaps, many cliques become disconnected, leaving only cliques 1, 2, 3 and 4 connected. If the criterion level is further increased to 4-overlaps, only cliques 1 and 2 are connected, as indicated by the thickest edge connecting the two cliques. Clique 5 is not connected to any group at any level of overlap because it has an exclusive set of members.

Based on the intersection graph, actors can be grouped into cohesive subgroups as shown in Figure 7.36. The least cohesive subgroups are A and B which are based on level 2-overlaps. Subgroup A contains only six actors {14, 15, 19, 21, 22, 24},and has a density of 0.67. Subgroup B contains 15 actors {1, 2, 3, 4, 5, 11, 13, 16, 24, 26, 27, 28, 29, 30, 31}, with a density of 0.31. Subgroups A and B enclose all actors who belong to the cohesive parts of the advice-seeking network. This accounts for 75 percent of the 28 actors in the main region of this network.

Subgroup C is based on level 3-overlaps and contains eight actors {1, 2, 3, 4, 5, 26, 27, 28} with a density of 0.71. Subgroup D is the most cohesive one (based on level 4-overlaps), consisting of actors 1, 2, 3, 4, 5 and 26, as indicated by the thick boundary line. Its density is 0.93. Both the *Faction* and the *Newman-Girvan* method produce the same exhaustive subgroups and assign peripheral actors to these subgroups as indicated by white and dark nodes in Figure 7.36. It is important to note that this is the only network in which the identified agglomerative-based subgroups do not fit perfectly with the divisive-based subgroups. This could be affected by the fact that the subgroup structure in this network is more complex and more highly overlapping at level 2-overlaps compared to that of the other networks examined in this study. At a higher level of overlap, however, the results of the two approaches remain consistent.

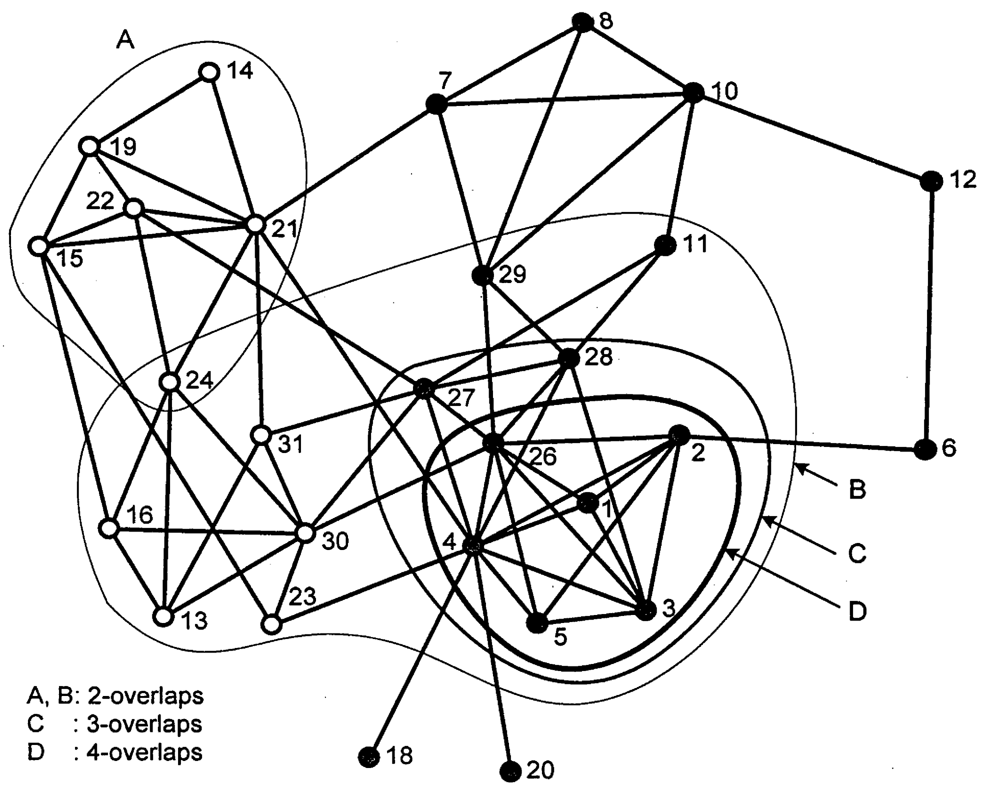


Figure 7.36. Cohesive subgroups in the CTU trainers' advice-seeking network

The structure of the subgroups in the main region of the advice-seeking network appears to be very robust and is not easy to fragment. Actor 4 is the only cut point and the removal of this actor would cause only peripheral actors 18 and 20 to be disconnected.

Figure 7.37 shows the multidimensional scaling on the geodesic distances between actors in the advice-seeking network. The multidimensional scaling is consistent with the subgroups identified above. However, the stress level is 0.2, indicating that the positions of the nodes might not be highly accurate. Nevertheless, the subgroups can still be located quite easily.

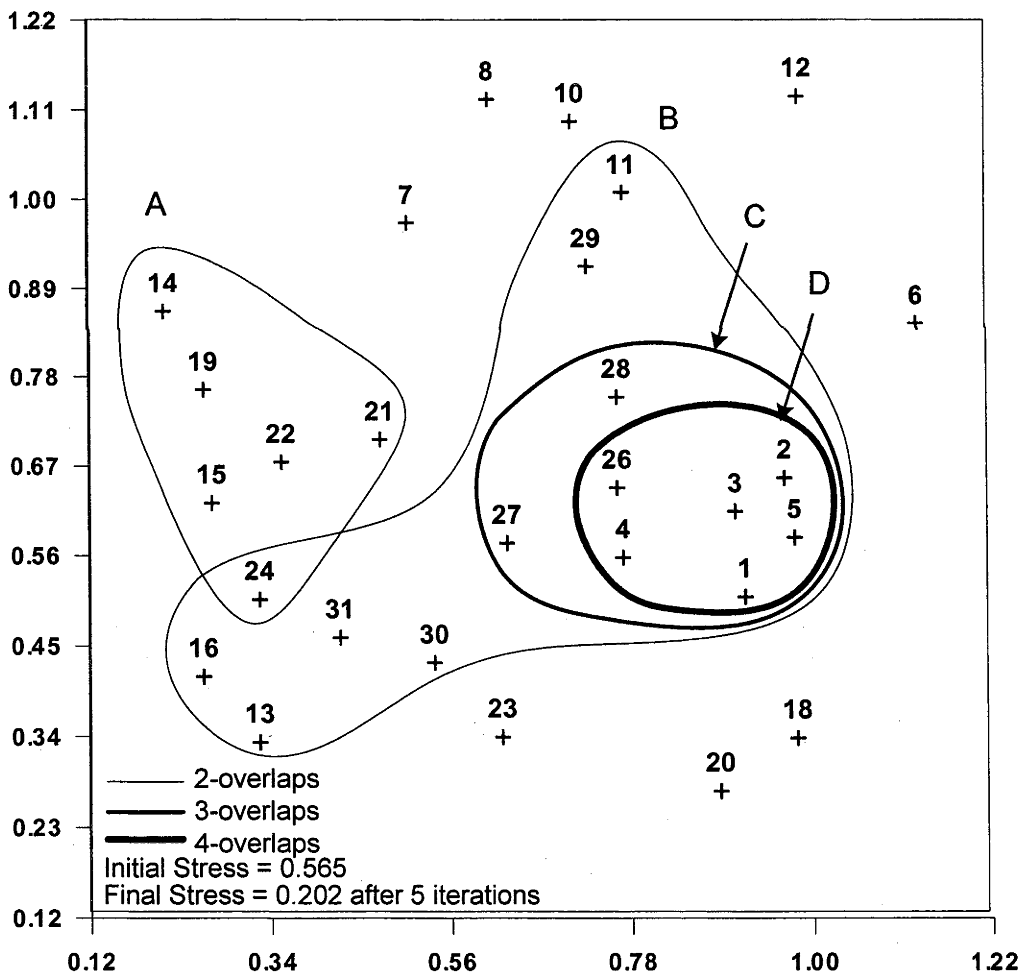


Figure 7.37. MDS of the distance in the CTU advice-seeking network

The distribution of trainers by attributes in these cohesive subgroups can be seen in Table 7.14. The subgroups to be considered are A and B, which are defined at level 2-overlap. These two subgroups are inclusive enough and the level of cohesiveness at which they are defined is quite high.

Table 7.14. Subgroups by actor attributes in the CTU advice-seeking network

	Subgroup A		Subgroup B	
Attribute	n	(%)	n	(%)
Rank				
Junior	0	(0.0)	1	(6.7)
Senior	6	(100.0)	9	(60.0)
TE	0	(0.0)	5	(33.3)
Education				
Undergrad	4	(66.7)	12	(80.0)
Masters	2	(33.3)	3	(20.0)
Doctoral	0	(0.0)	0	(0.0)
Work Unit				
A	0	(0.0)	6	(40.0)
B	0	(0.0)	2	(13.3)
C	6	(100.0)	3	(20.0)
D	0	(0.0)	3	(20.0)
E	0	(0.0)	1	(6.7)
Gender				
Male	6	(100.0)	13	(86.7)
Female	0	(0.0)	2	(13.3)
Age*	41	(1.5)	40	(3.5)
Tenure*	18	(5.7)	12	(7.9)

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

Members of both subgroups are about equal in terms of rank, educational level and gender. They are generally male trainers at senior rank levels, with undergraduate qualifications. However, their members differ in terms of work unit and tenure. Members of subgroup A come from unit C, and are relatively older than those of subgroup B. Members of subgroup B are relatively younger, and come from all units within the CTU.

Advice-giving Network

Of the 31 trainers in the CTU, 29 (94%) form the main region of the advice-giving network, with a density of 0.14. As can be seen in Figure 7.38, this main region has 22 cliques, of which six consist of four members and 16 of three members. At most, a pair of actors both belong to four different cliques. Actors 2, 3 and 26 are jointly members of three different cliques. The maximum number of members that a pair of cliques have in common is three. For example, cliques 1 and 2 share actors 2, 3 and 26. Three actors have exceptionally high cliques centrality. That is, actor 26 belongs to seven different cliques; and, actors 22 and 30 belong to six different cliques.

[redacted]

1:	2 3 4 26
2:	2 3 5 26
3:	1 2 3 26
4:	2 6 26
5:	26 27 28 30
6:	26 28 29
7:	3 26 28
8:	7 11 29
9:	11 27 28
10:	11 28 29
11:	13 16 24 30
12:	13 15 24
13:	14 21 22
14:	15 19 22
15:	15 22 24
16:	16 19 23
17:	16 23 30
18:	19 21 22
19:	19 21 23
20:	21 22 24 30
21:	21 23 30
22:	22 27 30

Clique-by-Clique Co-membership matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	4	3	3	2	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	3	4	3	2	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	3	3	4	2	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	2	2	2	3	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	1	1	1	1	4	2	2	0	2	1	1	0	0	0	0	0	1	0	0	1	1	2
6	1	1	1	1	2	3	2	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0
7	2	2	2	1	2	2	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	1	0	3	1	2	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	2	1	1	1	3	2	0	0	0	0	0	0	0	0	0	0	0	1
10	0	0	0	0	1	2	1	2	2	3	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	1	0	0	0	0	0	4	2	0	0	1	1	2	0	0	2	1	1
12	0	0	0	0	0	0	0	0	0	0	2	3	0	1	2	0	0	0	0	1	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	3	1	1	0	0	2	1	2	1	1
14	0	0	0	0	0	0	0	0	0	0	0	1	1	3	2	1	0	2	1	1	0	1
15	0	0	0	0	0	0	0	0	0	0	1	2	1	2	3	0	0	1	0	2	0	1
16	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	2	1	2	0	1	0
17	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	2	3	0	1	1	2	1
18	0	0	0	0	0	0	0	0	0	0	0	0	2	2	1	1	0	3	2	2	1	1
19	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	1	2	3	1	2	0
20	0	0	0	0	1	0	0	0	0	0	2	1	2	1	2	0	1	2	1	4	2	2
21	0	0	0	0	1	0	0	0	0	0	1	0	1	0	0	1	2	1	2	2	3	1
22	0	0	0	0	2	0	0	0	1	0	1	0	1	1	1	0	1	1	0	2	1	3

Figure 7.38. Clique overlap in the CTU trainers' advice-giving network

Figure 7.39 shows how the cliques are grouped together based on the number of actors they have in common. When cliques are considered adjacent if they shared at least 2 actors, all of the cliques are adjacent. Clearly, there is not much that can be said as far as detecting subgroups is concerned.

Nevertheless, it was clearly evident, even from a visual inspection of the intersection graph, that there could be two groups of cliques. The difficult part is, however, in deciding where to draw the boundary between the two groups. Rather than using an *ad hoc* approach, the two groups were identified using the concept of *Faction* in UCINET 6 (Borgatti *et al.*, 2002) and NetDraw (Borgatti, 2002). Group I contains cliques 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10, and is indicated by white nodes in Figure 7.39. Group II (indicated by dark nodes) consists of cliques 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21 and 22. At level 3-overlaps, cliques 1, 2 and 3 form a group. Actors in these cliques are members of the most cohesive part of the advice-giving network.

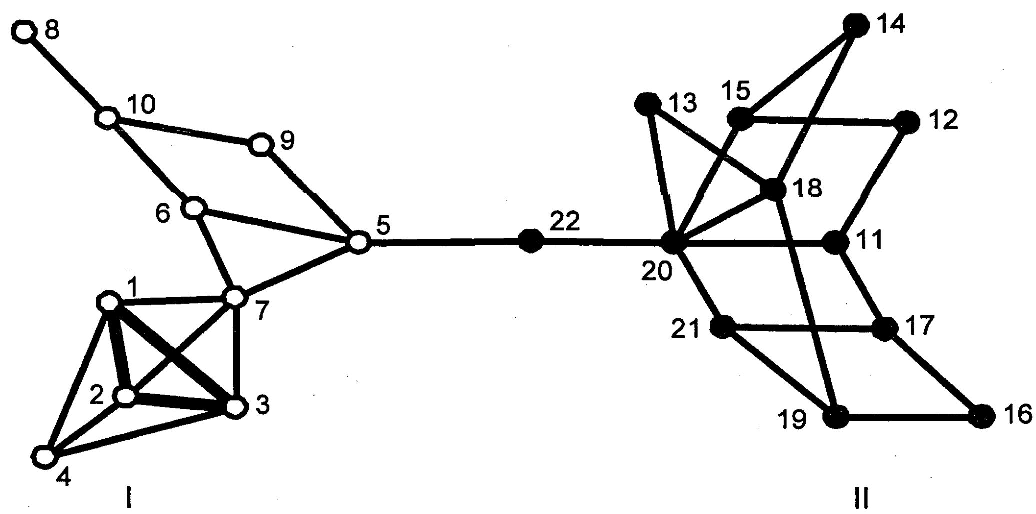


Figure 7.39. Intersection graph of the CTU trainers' advice-giving network

These sets contain actors who clearly form cohesive subgroups as shown in Figure 7.40. One of the subgroups is labelled A and contains 13 actors {1, 2, 3, 4, 5, 6, 7, 11, 26, 27, 28, 29, 30}, with a density index of 0.37. The other subgroup, B, contains 11 actors {13, 14, 15, 16, 19, 21, 22, 23, 24, 27, 30}, with a density of 0.47. Level 3-overlaps define the most cohesive subgroup within subgroup A, containing actor set {1, 2, 3, 4, 5, 26}, and labelled C as indicated by the thick borderline. The density of this subgroup is 0.80. In total, 22 (76%) of the 29 actors in the main region are included in these cohesive subgroups. Using *Faction*, peripheral actors 8 and 12 are assigned to subgroup A, and actors 17, 18, 20, 25 and 31 to subgroup B.

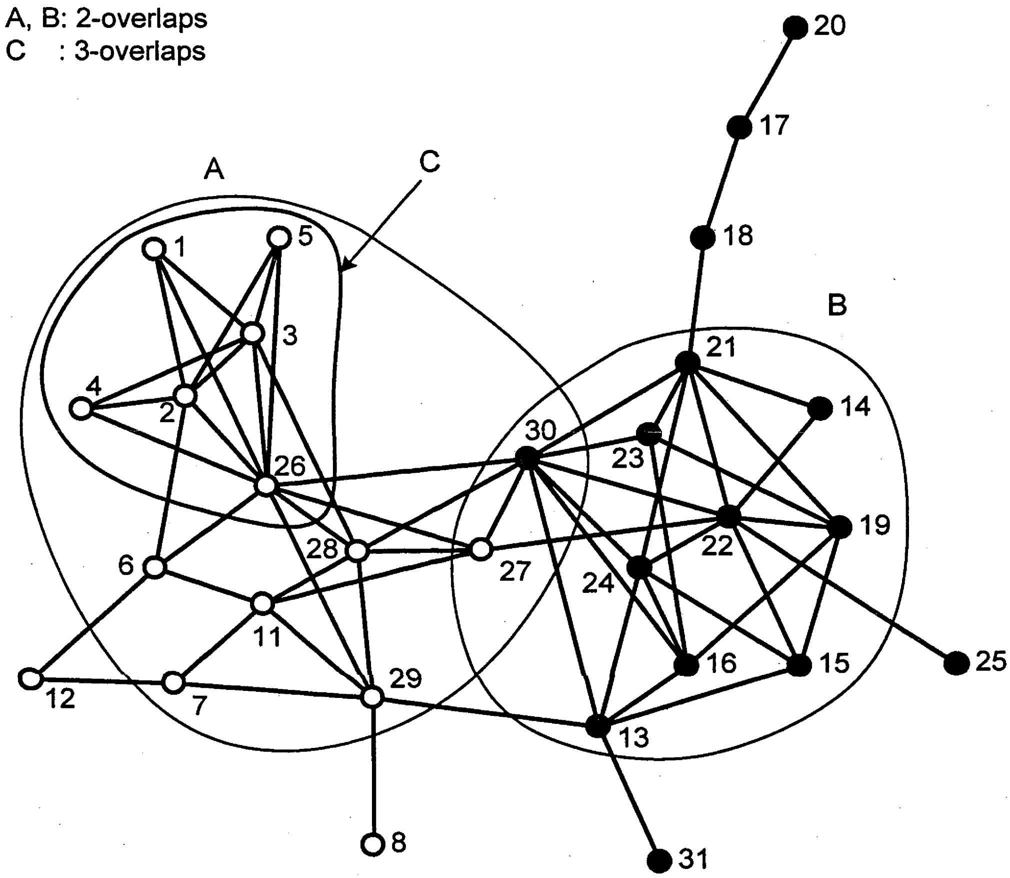


Figure 7.40. Cohesive subgroups in the CTU trainers' advice-giving network

The main region of the advice-giving network appears to have strong interconnections despite its six cut points (actors 13, 17, 18, 21, 22 and 29). The departure of actor 21 would cause three other actors to be disconnected, but this does not affect the interconnection of the two subgroups because the three actors who depend on actor 21 for their link to subgroup B are all peripheral to the cohesive subgroups.

The cohesive subgroups above are also identified within multidimensional scaling of geodesic distances between actors, as shown in Figure 7.41. The actors who belong to the same cohesive subgroups appear closer to one another. Actors 27 and 30 belong to two different subgroups. The stress value of 0.1 is within the acceptable range, indicating that the positions of nodes representing actors in the two dimensional space are not highly distorted.

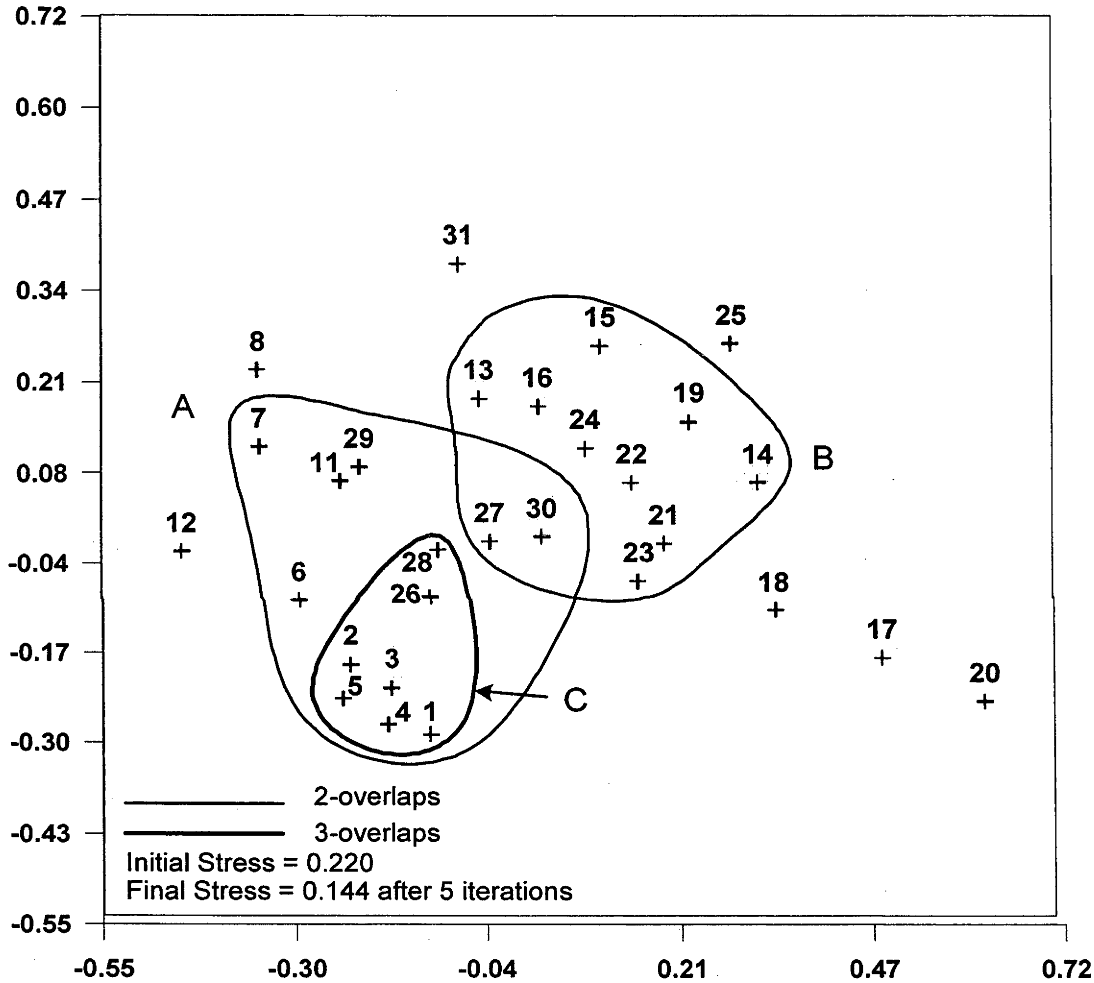


Figure 7.41. MDS of the distance in the CTU advice-giving network

The distribution of trainers by attributes in these cohesive subgroups can be seen in Table 7.15. Subgroup A and B are both considered at level 2-overlaps. Although to some extent the subgroup memberships in terms of work units are mixed, the majority (54%) of subgroup A members are from unit A, while those in subgroup B are from unit C (82%).

Senior trainers constitute the majority in all subgroups, accounting for 54 percent and 82 percent in subgroups A and B respectively. Nevertheless, it is interesting to note that all training experts in the CTU are linked to the senior trainers in subgroup A. The junior trainers are not well represented here. This appears quite reasonable as – in terms of giving advice – higher rather than lower rank trainers might be more confident or are in a better position to provide advice. Consequently, the senior trainers and the training experts are in the majority in the cohesive parts of the advice-giving network.

Table 7.15. Subgroups by actor attributes in the CTU advice-giving network

	Subgroup A		Subgroup B	
Attribute	n	(%)	n	(%)
Rank				
Junior	1	(7.7)	0	(0.0)
Senior	7	(53.9)	9	(81.8)
TE	5	(38.5)	2	(18.2)
Education				
Undergrad	9	(69.2)	7	(63.6)
Masters	3	(23.1)	4	(36.4)
Doctoral	1	(7.7)	0	(0.0)
Work Unit				
A	7	(53.9)	0	(0.0)
B	3	(23.1)	0	(0.0)
C	1	(7.7)	9	(81.8)
D	1	(7.7)	2	(18.2)
E	1	(7.7)	0	(0.0)
Gender				
Male	10	(76.9)	11	(100.0)
Female	3	(23.1)	0	(00.0)
Age*	40	(3.6)	41	(2.1)
Tenure*	12	(7.5)	15	(7.4)

*For age and tenure, the values in the *n* columns indicate average (year) and those in the (%) columns are standard deviations

Trainers with undergraduate qualifications still predominate in the subgroups. However, it is interesting to note that this is the only network subgroup (A) where the trainer with a doctoral degree participated. This could be related to the nature of advice-giving, which requires a certain level of intellectual capacity. In addition, higher educational qualifications may increase trainers' confidence in their ability to provide useful advice.

Male trainers are consistently more numerous, especially in subgroup B where all members were male. Average age differences are small here too. The difference in tenure, which is high in the other networks, is quite small in the advice-giving network. The average tenure of the trainers in subgroups A and B differs only by 3 years.

Overall Characteristics of the subgroups in CTU Trainers' Networks

Overall, the main region of the CTU trainers' networks contains small and overlapping cliques. As can be seen in Table 7.16, the largest cliques have only five members, and these are found in the advice-seeking network. The dominant clique size in all networks is three, which is the minimum size for a group to qualify as a clique. The degree of overlap among these cliques is quite high as indicated by the maximum co-membership and the maximum clique overlaps. These clique structures, however, only provided a rather vague picture of the internal structures of the networks in the CTU.

Table 7.16. Cliques and their degree of overlap in the CTU trainers' networks

	Number of cliques	Max clique size	Dominant clique size	Max Co-membership	Max clique overlap
Knowledge	16	5	3	3	3
Communication	7	4	3	2	2
Collaboration	10	4	3	2	3
Advice-seeking[1]	14	5	3	4	4
Advice-giving[1]	22	4	3	4	3

[1]Cliques are identified from the underlying graphs, that is, ties in the networks are symmetrised using a weak criterion (a tie between a pair of actors is considered existing if at least one of them nominates the other)

To gain a better understanding of the subgroups, the clique structures were simplified by merging highly overlapping cliques. The characteristics of the networks and the subgroups they contain are summarised in Table 7.17. The table shows, for each network, the size and the density of its main region from which subgroups are identified, as well as the number, the inclusiveness, and the level of cohesiveness of the identified subgroups.

It becomes apparent that the main region of each network from which subgroups are detected contains quite high proportions of all of the actors in the CTU networks. The lowest proportion is the main region of the collaboration network, although even this represents more than half of the whole trainers in the CTU.

It can also be seen that the main regions from which subgroups are identified are generally sparse. The most dense is the main region of the collaboration network with a density of 0.23, indicating that only about 23 percent of all possible ties in the main region are actually present. The density of the main region of all the other networks is less than 20 percent.

Table 7.17. Size and density of the main region of the CTU trainers' networks

Network	Size of Main region n (%)[1]	Main region Density	Cumulative Size of subgroups n (%)[2]	Number of subgroups and level of cohesiveness			
				1-ovr	2-ovrs	3-ovrs	4-ovrs
Knowledge	27 (87.10)	0.18	13 (48.15)	-	-	2	-
Communication	20 (64.52)	0.15	11 (55.00)	-	2	-	-
Collaboration	16 (51.61)	0.23	15 (93.75)	-	3	1	-
Advice-seeking[3]	28 (90.32)	0.17	21 (75.00)	-	2	1	1
Advice-giving[3]	29 (93.55)	0.14	22 (75.86)	-	2	1	-

[1]The percentage values indicate the proportion of actors in the main region of each network to the total 31 actors in the CTU

[2]The percentage values indicate the proportion of actors in the subgroups relative to the number of actors in the main region of each network

[3] Subgroups are identified from the underlying graphs

The subgroups themselves are generally quite inclusive. Apart from the subgroups in the knowledge network, the remaining networks contain more than 50 percent of the actors in their main regions. The subgroups in the collaboration network are particularly inclusive, integrating almost 95 percent of actors in the main region of this network.

The level of overlap at which the subgroups are defined indicates the degree of cohesiveness of the subgroups. The higher the amount of clique overlap is, the more cohesive are the resulting subgroups, It is important to note that for the knowledge, communication and collaboration networks, level 1-overlap is sufficient to ensure that the subgroups identified are cohesive. However, due to the use of the underlying graphs for the advice-seeking and advice-giving networks, the criterion for identifying cohesive subgroups is raised to level 2-overlaps or higher. Indeed, subgroups can be identified in these networks at these (higher) levels of overlap.

It can also be seen in Table 7.17 that some networks contain multilevel subgroups, while others have only one level. For instance, the two subgroups in the knowledge network are defined at level 2-overlaps. In contrast, the advice-seeking network has four subgroups at multiple levels of cohesiveness. There are three subgroups at level 2-overlaps, and one subgroup at levels 3-overlaps and 4-overlaps. At higher levels of overlap, there is a tendency for a subgroup to be contained within a subgroup defined at lower level of overlap, thus forming multilayered subgroups. For example, in the advice-seeking network, only at level 2-overlaps can more than two subgroups be identified. At level 3-overlaps, only one subgroup is identified, which is contained within one of the subgroups of level 2-overlaps. At level 4-overlaps, the identified subgroup is also completely contained within the level 3-overlaps subgroup.

In general, the subgroups revealed by the simplification of the clique structure still overlap slightly, such as those in the collaboration, advice-seeking and advice-giving networks. However, the overlapping subgroups beyond the clique structures are much easier to interpret. In fact, the overlapping subgroups, to some extent, underscore the cohesiveness of the network. In addition, certain degrees of overlap reflect the nature of real social groups. However, subgroups in the other networks are disjointed. Nonetheless, either separated or overlapping, the members of each subgroup are able to reach members of the other subgroups. Such connections are established through subgroups' members, non-members or both.

In some networks, subgroup structures are robust, but in others are somewhat weak and susceptible to potential fragmentation. In particular, the subgroup structures in the knowledge, advice-seeking and advice-giving networks are quite strong. Although there are some cut points in these, they do not affect the connectivity within and between subgroups. Their removal would only cause some peripheral actors to be disconnected from a subgroup. However, the communication and collaboration networks seem to be at greater risk of fragmentation. In both networks, removal of a single (critical) actor could cause the subgroups to be disconnected from each other.

Some peripheral actors play important bridging roles, especially in the networks where subgroups are not overlapping, such as those in the knowledge and communication networks. In these networks, peripheral actors provide the only pathway or serve as alternative routes by which the members of the different subgroups can interact with each other.

As can be seen in Table 7.18, for the CTU trainers, work unit appears to be the most important unifying feature of the subgroups in all networks. The trainers who work in the same unit have a strong tendency to be in the same subgroups. This applies to all of the networks. Apart from age, all the other attributes tend to be homogeneous within each subgroup. However, it is important to note that these other attributes are not as strongly unifying as work unit. To some extent, these other attributes are homogeneous within subgroups because of population proportions. For example, if there are nine males and one female in a subgroup, it is not possible to have a 50:50 distribution on gender. The male trainers in the GTC outnumber the female trainers. The same is true for senior trainers in terms of rank and for trainers with undergraduate qualifications in terms of education.

Table 7.18. Unifying features of the subgroups in the CTU networks

	Dominant unifying features					
Network	Age	Rank	Tenure	Education	Work unit	Gender
Knowledge	-	✓	✓	✓	✓	✓
Communication	-	✓	✓	✓	✓	✓
Collaboration	-	✓	✓	✓	✓	✓
Advice-seeking	-	✓	✓	✓	✓	✓
Advice-seeking	-	✓	-	✓	✓	✓

Overall Features of the Subgroups in the GTC and the CTU

The features and the structures of subgroups in the two organisations share some similarities, but also have some differences.

In general, cliques found in the networks in both organisations are small and highly overlapping. The vast majority of them are of size three, the minimum size for a clique. Although the cliques are equally small and overlapping in the networks in both organisations, the actual characteristics of the cliques in each of the two organisations are different. In terms of number, the networks in the Government Training Centre (GTC) generally contain more cliques, ranging from 10 to 28; compared to only 7 to 22 in the networks in the Company Training Unit (CTU). The clique size in the GTC is also larger, ranging from 4 to 6; while that in the CTU ranges from 4 to 5. In the GTC, a pair of actors belongs to a maximum of 10 different cliques, while in the CTU the maximum clique co-membership is four. Finally, the cliques in the GTC have up to five actors in common, while those in the CTU have a maximum of four. Thus, in general, the GTC has more cliques, of larger size, with a greater degree of overlap.

For the networks in both GTC and CTU, the simplification of the overlapping clique structures is useful for locating cohesive subgroups, which form the cores of the networks. Some of the identified cohesive subgroups still overlap to a lesser degree in some of the networks, but are totally separated from each other in some of the other networks. Nevertheless, the subgroups based on the simplification of overlapping cliques become more comprehensible than original clique structures.

The cohesive subgroups detected as a result of the amalgamation of highly overlapping cliques are also different in the two organisations. The subgroups in the CTU are generally more inclusive than those in the GTC. In the CTU, the percentage of actors in the main region of each network who are part of the cohesive subgroups ranges from 48 to 94 percent, while in the GTC it ranges from only 45 to 71 percent. This suggests that learning resources in various forms are more likely to flow more freely and quickly to reach a higher proportion of trainers in the CTU than in the GTC.

The dominant unifying features of the subgroups in the GTC and in the CTU are also different. In the GTC, level of formal education and rank are two of the most homogeneous attributes within the subgroups across the different networks. In contrast, in the CTU the most homogeneous attributes are work unit and tenure. This difference obviously has something to do with the relative importance attached to these attributes by the trainers in each of the organisations.

For the GTC trainers, both education and rank are important factors in their work and career. These two attributes affect the trainers' entitlements, as well as rights and obligations. More importantly, they affect the trainers' opportunities to interact with one another. For example, rank and level of education determine the level and the type of training programs in which the trainers are entitled to teach. Consequently, the trainers have more opportunity to interact with others who are about equal in rank and educational level.

In the CTU, the trainers are highly specialised in disciplines relevant to their units' areas of service delivery. Therefore, trainers from similar units, hence the same areas of expertise, are more likely to interact and work together.

These subgroups configurations can become structural impediments to the flow of knowledge among the trainers in each of the two organisations. In the CTU, the more junior trainers who have relatively lower educational qualifications do not have much opportunity to learn from and tap the experience of their more senior and more highly educated colleagues. In the CTU, the trainers did not have much opportunity to share ideas and techniques that might be useful irrespective of their work units or their areas of specialisation.

In both organisations, some networks have robust subgroup structures and others have weaker ones. This is indicated by the presence of cut points, which could fragment subgroup structures if removed from a network. In the GTC, the communication and the collaboration networks are both robust; and the removal of some cut points – e.g. the departure of key trainers – from these networks would have little or no effect on the connectivity within and between the relevant subgroups. However, the knowledge, advice-seeking and advice-giving networks contain some actors whose withdrawal from the structure could cause subgroups to become disconnected from each other. In the CTU, the opposite is true. The subgroup structures in the communication and collaboration networks are vulnerable to being disconnected, although the subgroup structures in the other three networks are robust.

In both organisations, peripheral actors play important roles in keeping different subgroups connected. In the GTC, this is especially true for the peripheral actors in the knowledge, communication, advice-seeking and advice-giving networks. In the CTU, this applies to the peripheral actors in the knowledge, communication and advice-seeking networks. In some of the networks where subgroups are disjointed, peripheral actors provide the only path(s) through which resources can flow between different subgroups. In cases where cohesive subgroups are themselves overlapping, the peripheral actors provide alternative pathways. Thus, despite being peripheral to the cohesive subgroups, they serve as a glue that helps maintain the cohesion of the social groups.

In conclusion, the analysis of the trainers' informal networks provides evidence of the existence of cohesive subgroups, which form the cores of the networks. The important unifying features of the subgroups are unique to each organisation even though they are engaged in essentially the same kinds of activities. Actors in the subgroups within the networks in the GTC are unified primarily by their rank and educational qualification. These two attributes happen to be some of the most important factors in the training career in the GTC as they determine the trainers' entitlement and involvement in their professional activities. For the trainers in the CTU, their divisions into cohesive subgroups is associated with their area of teaching specialisation, which is a very important organising principle of the trainers in the CTU. As the interconnections within these subgroups are more intense than in the other parts of the networks, it is expected that the results have revealed the locations where learning resources can disseminate more freely and more intensively.

The approach used here, which combines agglomerative and divisive perspectives, has some advantages. First, it demonstrates that the competing divisive and agglomerative perspectives can be reconciled. Second, the identified subgroups are consistent with both the density and the closeness based subgroup concepts. The sets of actors who are found to have dense interconnections are also shown to be closer to one another in the multidimensional scaling analyses. The opportunity to support the cohesive subgroup identification with density and closeness measures makes the results more convincing. Third, apart from identifying cohesive subgroups within a network, the technique used also shows the core of the network, consisting of one or more cohesive subgroups. Finally, unlike pure agglomerative approaches, the approach used does not ignore peripheral actors. In fact, the results suggest that some peripheral actors play a vital role in integrating the subgroups or the cores of the networks.

CHAPTER EIGHT. THE TRAINERS' INFORMAL ORGANISATIONS: DETECTING PATTERNS IN LOOSELY BOUNDED STRUCTURES

The examination of the internal structure of the trainers' informal social networks in the previous chapter revealed that despite being sparse, all of the networks contain cohesive parts which may be regarded as the cores of the networks, and in which the learning resources are expected to flow more intensively. The assignment of the trainers into subgroups was based on their cohesiveness or proximity to one another. Although a cohesive-based approach is basic and relatively old, its use in this study has provided a better understanding of the trainers' learning and knowledge exchange relations.

This chapter extends the substructure analysis of the previous chapter by using the relatively recent social network concept of positional analysis. In this chapter, the trainers are assigned to positions based on similarities in the way they engage in the structural interactions (how they are connected), rather than on their proximity to one another (with whom they are connected).

The chapter is organised into two main sections. The first section discusses the conceptual backgrounds of the positional analysis, concentrating on structural equivalence and regular equivalence notions of position. The second section presents positional analyses of the trainers in the Government Training Centre (GTC) and the Company Training Unit (CTU). This includes assessment of actors' relational similarity to identify subsets of actors who are structurally or regularly equivalent across multiple relations, aggregation of actors into equivalent classes, and description of the system of relations within and between the identified positions.

Positional Analysis

Culturally or formally ascribed social positions are generally based on exogenously defined attributes. The abstract classification or stratification of members of society into capitalist and working class is a case in point. Although such a classification is in fact inherently relational, for example, viewed by some as a relation of exploitation between the members of the two class positions, even here it is commonly thought of as being based on class members' attributes, such as their economic status.

Although individual attributes may indeed reflect the way members of a population are organised, their use can only capture explicit social positions. In some cases, however, the way individuals are organised is emergent and may not be culturally or formally recognised by those involved or by external observers at an early stage. As Scott (1991b, p. 127) notes, "relations between more or less clearly defined categories of agents may begin to crystallise long before people come to perceive what is going on and to give a name to it". By conceiving of social positions as inherently relational, the social network approach is able to delineate the already existing positions as well as unveil emerging ones based on the analysis of patterns of relationships.

Social network analysis offers an alternative conceptualisation of social positions based on the way actors are embedded in networks of social relations. It provides powerful tools for formally studying complex systems of interaction (Smith and White, 1992). According to Blau (1982), looking at the patterns of relations is one way of examining relations and positions. As Faust (1988, p. 337) notes, "social positions are evidenced in the interactions among individuals as occupants of positions and performance of roles". Arabie (1984) notes that Nadel (1957) was one of the earliest sociologists to propose the intuitive idea of homogeneous groups performing consistent behaviour towards others, which was later formalised and operationalised by Lorrain and White (1971) as a blockmodeling technique.

In principle, "the objective of positional analysis is to partition actors into mutually exclusive classes of equivalent actors who have similar relational patterns" (Borgatti and Everett, 1992, p. 3). This is commonly accomplished using a blockmodel technique. The usefulness of blockmodels in positional analysis lies in their capacity to simplify the structure of a complex multirelational network so that the inherent regularity in the way people act and relate to one another in it can be revealed and examined. A blockmodel is essentially a hypothesis about the structure of a network (White, Boorman *et al.*, 1976). It consists of aggregating actors who are relationally similar into positions and modelling the system of relations that link these identified positions (Faust, 1988; Smith and White, 1992; Wasserman and Faust, 1994). More specifically, blockmodeling contains two main steps: blocking actors based on the similarity in their patterns of relations, defined by one of the relevant equivalence concepts, and then developing accounts of the aggregate relations between the identified blocks.

Defining equivalence is a critical step in blockmodel analysis, as it serves as a foundation for the interpretation of the adopted position model in later stages of analysis. It is also an important basis on which the validity of the whole position analysis is judged. According to Doreian (1988), the issue is not deciding which is the best equivalence. Rather, the important decision to make is choosing the best definition of equivalence in light of the substantive issue at hand, and the appropriate algorithm that can reliably operationalise the adopted equivalence definition.

Two popular notions of positions, structural equivalence (Lorrain and White, 1971) and regular equivalence (White and Reitz, 1983), are used to elucidate the underlying groupings of the trainers in these networks of informal social relations. The two concepts represent different underlying definitions of equivalence; hence, models of positions resulting from each of these concepts yield different substantive meanings.

Structural Equivalence

Structural equivalence is one of the most restrictive equivalence definitions. It requires that actors have identical patterns of relations, to and from identical others in a network, to be regarded as structurally equivalent, hence to occupy the same position. The concept of structural equivalence has been fruitful in the study of various empirical social phenomena, for instance, innovation (Burt, 1980), the structure of positions among authors (Mullins, Hargens *et al.*, 1977), positions among members of a rural community (Schweizer, 1988), positions among biomedical scientists (Brieger, 1976), positions among economic development organisations (Hagen, Killinger *et al.*, 1997), structural positions in the world system (Snyder and Kick, 1979), and competition and technology adoption (Bothner, 2003), to mention but a few.

In general terms, two actors are structurally equivalent if they have identical ties to and from other actors in the network (Wasserman and Faust, 1994). If self ties are defined, the presence or absence of these also must be congruent (de Nooy, Mrvar *et al.*, 2005). Lorraine and White (1971) provide the following more formal definition of structural equivalence.

"Objects a, b of a category C are structurally equivalent if, for any morphism M and any object x of C, aMx if and only if bMx, and xMa if and only if xMb. In other words, a is structurally equivalent to b if a relates to every object x of C in exactly the same ways b does" (p. 63).

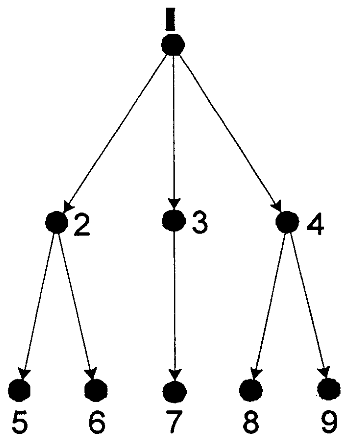
White and Reitz (1983, p. 200) provide an even more precise definition of structural equivalence as follows:

If $G = \langle P,R \rangle$ and $\equiv$ is an equivalent relation on P then $\equiv$ is a *structural equivalence* if and only if for all a, b, $c \in P$ such that $a \neq c \neq b$, $a \equiv b$ implies

(i) aRb if and only if bRa;
(ii) aRc if and only if bRc;
(iii) cRa if and only if cRb; and
(iv) aRa implies aRb.

Thus, by the principle of structural equivalence, people who occupy the same position are substitutable one for another (Sailer, 1978; Scott, 1991b; Wasserman and Galaskiewicz, 1994).

As an illustration, consider the stylised graph in Figure 8.1. Subsets of structurally equivalent actors in the graph include {1}, {2}, {3}, {4}, {5, 6}, {7} and {8, 9}. Assuming the graph represents a network of advice-giving relations among nine employees in a particular unit of an organisation, actors 5 and 6 are structurally equivalent because they both receive advice from the same person (actor 2), and both of them do not provide advice to anyone else in the network. Actor 2 and 4 are not structurally equivalent, despite getting advice from the same person (actor 1), because they provide advice to different persons. In this case, actor 2 gives advice to actors 5 and 6, whereas actor 4 advises actors 8 and 9.



Source: Wasserman and Faust (1994, p. 468)

Figure 8.1. Stylised equivalences

Borgatti and Everett (1992) provide a comprehensive discussion of the underlying principles and implications of structural equivalence. Briefly, they point out that structurally equivalent actors are connected in the same way to the same others. Thus, cohesion and proximity are an integral part of this equivalence definition. In fact, they indicate that structurally equivalent actors have overlapping neighbourhoods or identical ego networks. Therefore, structural equivalence is a local concept. Actors who are two links apart or more cannot be structurally equivalent. Consequently, they argue, an actor's position is completely unaffected by the changes in the system that occur more than one link away.

The implication of these underlying principles is that actors within each subset have equal exposure to resources that circulate the networks. Supposing the substance of a relation is the flow of specific information, a new idea or a communicable disease, it is likely that these structurally equivalent actors, for instance {5, 6} or {8, 9} in Figure 8.1 would hear the information, adopt the new innovation or get the disease at about the same time.

It is important to note that although the notion of structural equivalence has a close connection with the relational or cohesive approach as described above, they differ in their underlying principles. In a cohesive approach actors are grouped purely based on how closely they are connected to each other. In a structural equivalence analysis, actors are grouped together on the basis of the similarity of their tie profiles, irrespective of whether the actors are connected to each other (Schweizer, 1988; Borgatti and Everett, 1992). In addition, cohesive based approaches examine one relation at a time, whereas structural equivalence analyses take into account multiple relations as well as both ties given and received simultaneously.

Regular Equivalence

Due to the strict definition of structural equivalence, however, some social network analysts propose less stringent alternative definitions, such as isomorphic equivalence, regular equivalence, local role equivalence and ego algebras (see Wasserman and Faust, 1994). Sailer's (1978) attempt to relax the concept of structural equivalence involves not requiring two actors to have identical connections to identical other actors. Rather, it is sufficient here if they are connected to structurally related actors, and this has evolved into what White and Reitz (1983) referred to as regular equivalence (Doreian, 1988).

Regular equivalence, thus, is a more relaxed equivalence definition. Unlike structural equivalence, regular equivalence does not require actors to be connected to the same others to be regarded occupying the same position. This equivalence definition is even more flexible than the automorphic or isomorphic equivalence which requires that actors must have the same *in-degree* and *out-degree* to be automorphically or isomorphically equivalent.

For two doctors to be regularly equivalent, for instance, they do not have to work with the same nurses or treat the same patients as structural equivalence requires. Nor are they required to work with an equal number of nurses or treat an equal number of patients as would be required to satisfy the automorphic or isomorphic equivalence. It suffices that they work with a member or members of another equivalent class called nurses and treat members of another equivalent class called patients. Thus, the power of the regular equivalence lies in its close correspondence to the sociological concept of role.

In general, two actors are regularly equivalent if they are equally related to equivalent others (Borgatti and Everett, 1989). More precisely, White and Reitz (1983, p. 200) define regular equivalence as follows:

> If $G = \langle P,R \rangle$ and $\equiv$ is an equivalent relation on P then $\equiv$ is a *regular equivalence* if and only if for all $a, b, c \in P$, $a \equiv b$ implies
> (i) aRc implies there exist d $\in P$ such that bRd and $d \equiv c$; and
> (ii) cRa implies there exist d $\in P$ such that dRb and $d \equiv c$.

As an illustration, consider again the graph representing a network of advice-giving relations in Figure 8.1 earlier. Examples of regularly equivalent actors in the graph include {1}, {2, 3, 4} and {5, 6, 7, 8, 9}. Thus, although actors 2, 3 and 4 are not connected, they are regularly equivalent because each of them relates to at least one member of other regularly equivalent subsets such as {1} or {5, 6, 7, 8, 9}. Since regular equivalence is a weakened definition of structural equivalence, structurally equivalent actors are also regularly equivalent. The opposite, however, does not hold (Doreian, 1988; Borgatti and Everett, 1992).

Ultimately, however, the concern is not which concept of equivalence is better, but which concept is more appropriate for the substantive issue under investigation (Faust, 1988), and which algorithm(s) most reliably operationalise the underlying principle of relevant equivalence (Doreian, 1988).

Due to the importance of proximity in learning and knowledge exchange, structural equivalence is considered an appropriate notion of position in this study. Despite the relevance of structural equivalence to the substantive issue under investigation, it is important to also consider the regular equivalence.

Modelling the Structure of Positions for the GTC Trainers

The inherent structure in the Government Training Centre (GTC) networks will be analysed using both structural equivalence and regular equivalence, and the results of both sets of analyses are compared in order to determine which approach provides more meaningful and interpretable results for the organisations studied.

Structural Equivalence Based Positions in the GTC Networks

Based on structural equivalence, the similarity in the trainers' pattern of interconnections was measured using pairwise comparisons of their tie profiles. As the networks under investigation are multirelational (communication, collaboration, advice-seeking and advice-giving) and directed, all relations were analysed at once, and the transpose of each relation was considered so that both ties given and received were compared simultaneously.

Structural equivalence is a mathematical property, and it is seldom realised in real-world social network data (Wasserman and Faust, 1994). That is, "[e]mpirical data are seldom perfect" (de Nooy *et al.*, 2005, p. 259), and "irregularities in real social structures of any size will allow few instances of strict conformity" (Arabie, 1984, p. 379). Therefore, nearly equivalent actors are also considered. In this study, the extent to which actors across the four relations approach exact structural equivalence is measured using the Pearson product moment correlation coefficients. Basically, this procedure compares the profile of each pair of actors by considering how similar the entries in their rows or *out-degrees* (ties given) and column or *in-degrees* (ties received) simultaneously across the four relations. The more similar their profiles are the higher are their correlation scores.

The tie profile comparison was done using UCINET 6 (Borgatti *et al.*, 2002). The similarity matrix based on correlation can be found in Appendix 6. The correlation measure of structural equivalence was clustered using a single link hierarchical clustering procedure, also available in UCINET 6, so that mutually exclusive and exhaustive equivalence classes or positions could be identified. The results can be seen in Figure 8.2.

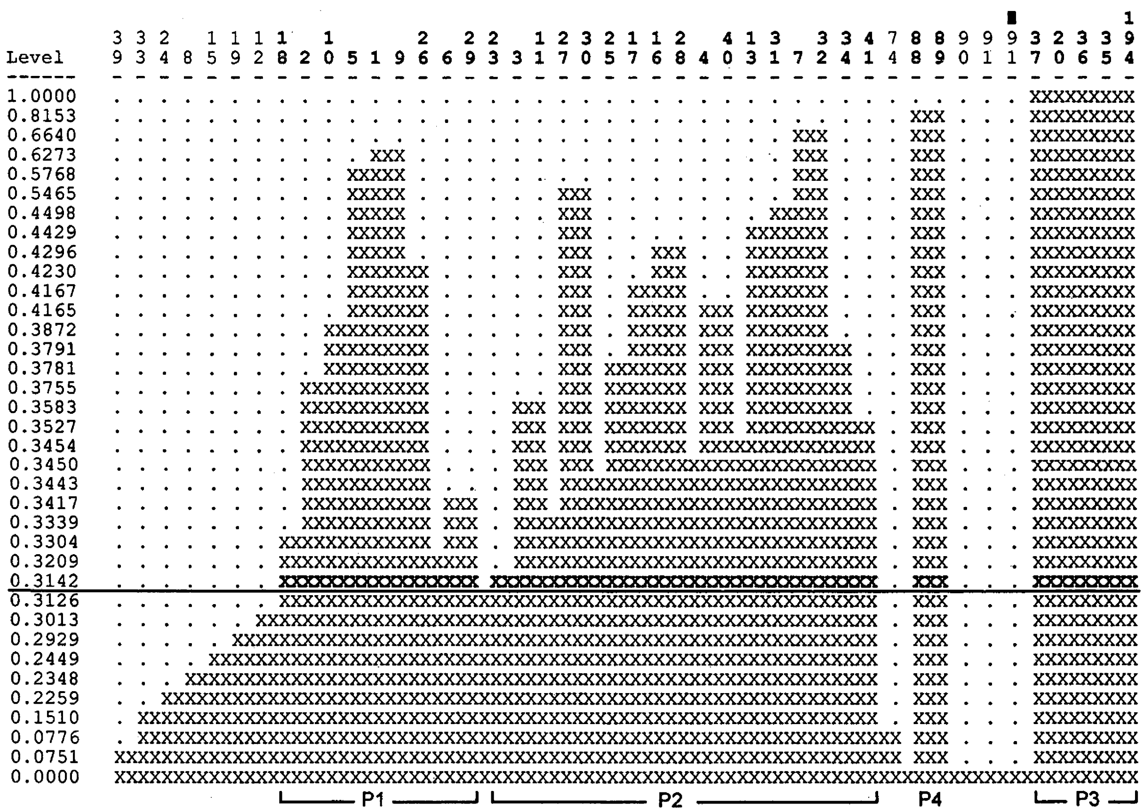


Figure 8.2. Single link hierarchical clustering of correlation for the GTC

The hierarchical clustering in Figure 8.2 shows the sets of actors who are structurally equivalent at different levels of refinement. Actors who belong to the same subset at a higher level are more similar in their pattern of ties than those at a lower level. Thus, subsets defined at a level lower than 1.0000 contain actors who are approximately, rather than exactly structurally equivalent. From the clustering it can be seen that some of the actors who belong to the same subsets have a high level of similarity and remained separate from the others until quite late in the aggregation process. Two subsets, {20, 35, 36, 37, 194} and {88, 89}, contain actors with exceptionally high levels of structural equivalence. They remain in distinct clusters until the lowest level of similarity (0.0). Some other actors display lesser degrees of similarity and join the existing subsets at a lower level of aggregation.

As indicated earlier, rarely does the strict equivalent definition apply perfectly to real-world social network data. Therefore, the criterion level has to be weakened to consider not just actors who are exactly equivalent (level 1.0000) but also those who are approximately equivalent. The criterion level of 0.3142, indicated by a horizontal line in Figure 8.2, seems to be the most inclusive, while at the same time separating the trainers into socially relevant groups at a reasonable level of similarity. This criterion indicates that every actor within a subset has at least a 0.3142 level of correlation with at least one other actor in the subset. At this level of refinement, the actors are divided into four non-overlapping (hierarchical) clusters, representing positions.

Some actors, including 8, 12, 15, 19, 24, 33, 39, 74, 90, 91 and 191, cannot be assigned to any of the positions identified because they join the other clusters below the chosen criterion level of 0.3142. Following Burt's (1976) approach, these conglomerations of various patterns of relations are referred to as "residual category". Although, these actors cannot be included in any of the position as they demonstrate weak structural equivalence with all the other actors, their connections with the members of the identified positions have important implications. Therefore, in some parts of the analysis, ties to and from them are considered.

Thus, a 4-position model is used to study the positions in detail. There are nine actors in position P1 {1, 2, 5, 6, 9, 10, 18, 26, 29}, 17 actors in position P2 {3, 4, 7, 11, 13, 16, 17, 23, 25, 27, 28, 30, 31, 32, 34, 40, 41}, five actors in position P3 {20, 35, 36, 37, 194} and two actors in position P4 {88, 89}.

As indicated by White, Boorman and Breiger (1976), a position model is a hypothesis. It is, therefore, useful to explore further whether or not these hypothetical positions, which are based solely on the similarity in the way the trainers are embedded in their networks, capture substantive aspects of the trainers' inherent social structure.

A hypothesised position model is commonly reflected in some already known positional structures identified by means of different approaches or through previous social network approaches. For example, studies of structural positions in the world system, by Snyder and Kick (1979) and by Smith and White (1992), try to provide an explanation of Wallerstein's world-system/dependency theories that recognise "core-semiperiphery-periphery" positions in the modern world system from a social network perspective. Similarly, Mullins *et al.* (1977) provide evidence, using a network-based positional analysis, for the existence of a "centre-periphery" structure of scientific specialties. Some researchers also associate their identified position models with specific and explicitly identifiable outcomes. For example, using Sampson's detailed account of social relations in a monastery in crisis White *et al.* (1976) show that monks left their monastery in groups (blocks) identified using blockmodel analysis. More recently, Krackhardt and Porter (1986) demonstrate that turnover in three fast food restaurants occurs in clusters of employees who occupy similar informal roles in their communication networks.

This study is necessarily exploratory because as far as is known there has not been an attempt to partition a learning or knowledge exchange system into positions against which the results of this study could be compared. Outcomes of informal learning, a phenomenon under investigation, are also difficult to measure explicitly. The study participants themselves are unaware of undertaking it and of the outcomes that they obtain from such learning. An approximation to the current research is the identification of a center-periphery structure among scientific specialties by Mullins *et al.* (1977). However, the trainers studied here are not necessarily similar to members of scientific communities, such as researchers, in the way in which they interact. The only available data on which the hypothesised position model may be compared are the trainers' attributes.

Actor attributes have been used by some researchers to interpret position models. For example, Arabie (1984) used actors' attributes in describing the structure linking prison inmates, Brieger (1976) used these in studying the network structure of a biomedical research specialty, and Mullins, Hargens, Hecht and Kick (1977) in studying the structure of co-citation networks. Some actor attributes relevant for the present research are provided in Table 8.1, Table 8.2 and Table 8.3.

In general, each position in the GTC networks demonstrates quite distinct characteristics in terms of actor attributes. More specifically, there seems to be a strong indication of partitioning along rank lines for the position memberships. As can be seen in Table 8.1, position P1 is generally occupied by relatively junior trainers. It contains three junior trainers (27 percent of all junior trainers) and six middle rank trainers (27 percent of all middle rank trainers) and no senior trainer. Among the six middle rank trainers, only one of them is at the highest grade of the middle rank. All the others are still in the middle or bottom grades of the middle rank.

Table 8.1. Classes of structurally equivalent actors by rank in the GTC

	Rank			
	Junior	Middle	Senior	Total
Position	n (%)	n (%)	n (%)	n (%)
P1	3 (27.27)	6 (27.27)	0 (0.00)	9 (20.45)
P2	1 (9.09)	11 (50.00)	5 (45.45)	17 (38.64)
P3	0 (0.00)	1 (4.55)	4 (36.36)	5 (11.36)
P4	0 (0.00)	2 (9.09)	0 (0.00)	2 (4.55)
Residual	7 (63.64)	2 (9.09)	2 18.18)	11 (25.00)
Total	11 (100.00)	22 (100.00)	11 (100.00)	44 (100.00)

Table 8.2. Classes of structurally equivalent actors by education in the GTC

	Educational Qualification			
	Undergraduate	Masters	PhD	Total
Position	n (%)	n (%)	n (%)	n (%)
P1	8 (40.00)	1 (4.55)	0 (0.00)	9 (20.45)
P2	4 (20.00)	12 (54.55)	1 (50.00)	17 (38.64)
P3	1 (5.00)	3 (13.64)	1 (50.00)	5 (11.36)
P4	1 (5.00)	1 (4.55)	0 (0.00)	2 (4.55)
Residual	6 (30.00)	5 (22.73)	0 (0.00)	11 (25.00)
Total	20 (100.00)	22 (100.00)	2 (100.00)	44 (100.00)

Table 8.3. Mean attributes of structurally equivalent actors in the GTC

Personal Attributes	P1	P2	P3	P4
Age	50.44 (8.40)	55.24 (4.79)	59.80 (3.35)	55.00 (0.00)
Tenure	3.89 (0.78)	4.88 (2.23)	6.00 (4.18)	4.00 (1.41)
N. of organisations joined	2.56 (2.07)	3.29 (2.08)	4.80 (5.26)	1.00 (0.00)
N. of subjects taught	4.56 (1.51)	5.88 (2.64)	3.00 (1.22)	4.00 (1.41)
N. of training attended	6.00 (1.87)	6.12 (3.26)	5.40 (1.14)	3.00 (1.41)
N. of seminars attended	5.11 (4.51)	6.06 (3.25)	4.20 (1.30)	4.00 (0.00)
External assignments (%)	73.89 (16.54)	52.65 (19.93)	57.00 (36.50)	42.50 (3.54)

Note: values in parentheses are standard deviations

Position P1, therefore, seems to represent relatively lower rank trainers. This is consistent with the other actor attributes, which all reflect the characteristics of trainers in the early stages of their careers. For example, as can be seen in Table 8.2, eight out of nine trainers in this position have only undergraduate qualifications, which is generally the entry level for public servants in Indonesia. These eight actors represent 40 percent of all trainers who have undergraduate qualifications. Only one has a Masters degree and none has a PhD degree. In addition, it can be seen in Table 8.3 that position P1 contains the youngest trainers (50 years of age on average). Trainers in position P1 also have the shortest average tenure (3.89 years) in the training profession.

Furthermore, the P1 members attend the highest average number of training programs (about six) and are the second highest in terms of seminar attendance. This reflects a need for new trainers in the GTC to prepare themselves for the complex and demanding tasks of their profession by attending as many training programs as possible. This is quite understandable as the recruitment system for the trainers in the GTC does not require a formal qualification in training or education. The management systems governing the public service trainers assume that trainers should be able to develop the relevant skills and knowledge through formal training programs and through experience after entering the profession. The relatively higher level of training and seminar attendance is also driven by the need to gain legitimacy and "licence" to teach training subjects. This is true because the eligibility to teach certain subjects is generally based on the training programs a trainer has attended. For the relatively more junior trainers there is a tendency to teach many subjects so that they can gain professional recognition. This is reflected in the relatively higher average number of subjects that they teach (4.56), compared to only three and four for those in positions P3 and P4 respectively. Actors in position P1 also have the second lowest organisational memberships (about 3 organisations). In addition, actors in this position spend most of their time (74 percent) teaching outside GTC.

Position P2 seems to reflect the middle rank level in the public service training system. As can be seen in Table 8.1, 11 out of 17 trainers in position P2 are middle rank trainers. These 11 middle rank trainers account for half of all middle rank trainers in the GTC. Although there are five senior trainers in this position, four of them are still in the lowest grade of the senior rank.

In terms of formal education (see Table 8.2), 12 out of 17 trainers have Masters degrees, which is a higher proportion than that in position P1 (mostly undergraduate degrees). The 12 actors represent 55 percent of all trainers with Masters degrees. As shown in Table 8.3, trainers in this position are 55 years old on average. They are the second oldest after those in position P3. Consistent with this, they also rank second in terms of length of service. On average, trainers in position P2 have been in the public service career for about 5 years. Trainers in this position have quite high levels of informal organisational affiliations, joining about three organisations on average. In terms of subjects taught these trainers come in second after the more junior trainers in position P1. However, they do not seem to be the ones who have the highest number of external teaching assignments. In addition, actors in this position have higher educational qualifications, are more experienced in the training profession and are older than their colleagues in position P1.

Position P3 is occupied mostly by senior trainers. Four out of five trainers in position P3 are senior trainers; and all of them are in the top grade of the senior rank. As indicated in Table 8.2, one of the trainers in this position has a PhD degree, three have Masters degree and one has an undergraduate degree. The seniority of actors in position P3 in terms of formal rank is also consistent with their average age and length of service in the training career. They are oldest, on average (59.80 years of age), and have the longest tenure in the training profession (6 years). They also have the most memberships in informal organisations. In terms of involvement in external teaching activities, they rank second after the members of position P1. However, in terms of the number of subjects taught, they are the lowest. As the trainers become more senior they tend to concentrate on a few specialised subjects. In contrast, junior trainers tend to keep their area of interest open and therefore are inclined to accept teaching assignments in a greater variety of subjects. Actors in position P3 also attend training and seminars less. This may reflect their sense of self-sufficiency in their areas of expertise. In fact, they are the ones who teach in many training programs designed for the more junior trainers.

Position P4 contains only two actors. In many ways they resemble their colleagues in position P2. The two members of position P4 are middle rank trainers, one of whom has a Masters degree and the other has an undergraduate qualification. They are both 55 years old and have served as trainers for four years. Although there are only two of them, they are regarded a separate position as they demonstrate high structural equivalence. It is important to note, moreover, that actors in position P4 are located in a different component of the disconnected GTC networks. The underlying principle of structural equivalence, which is based on direct ties, means that actors in different components of a disconnected graph (except isolates) can never be structurally equivalent (Borgatti and Everett, 1992). The fact that they have the fewest organisational memberships, the largest training and seminar attendance, as well as the fewest external teaching activities could reflect the limited opportunities available to them by virtue of their geographically separate location relative to those in positions P1, P2 and P3.

The 4-position model identified based on the structural equivalence will be used in the next stage of the blockmodeling, that is, modelling the structure of relations within and between these positions. The patterns of interactions within and between positions can be observed using image matrices found in Figure 8.3.

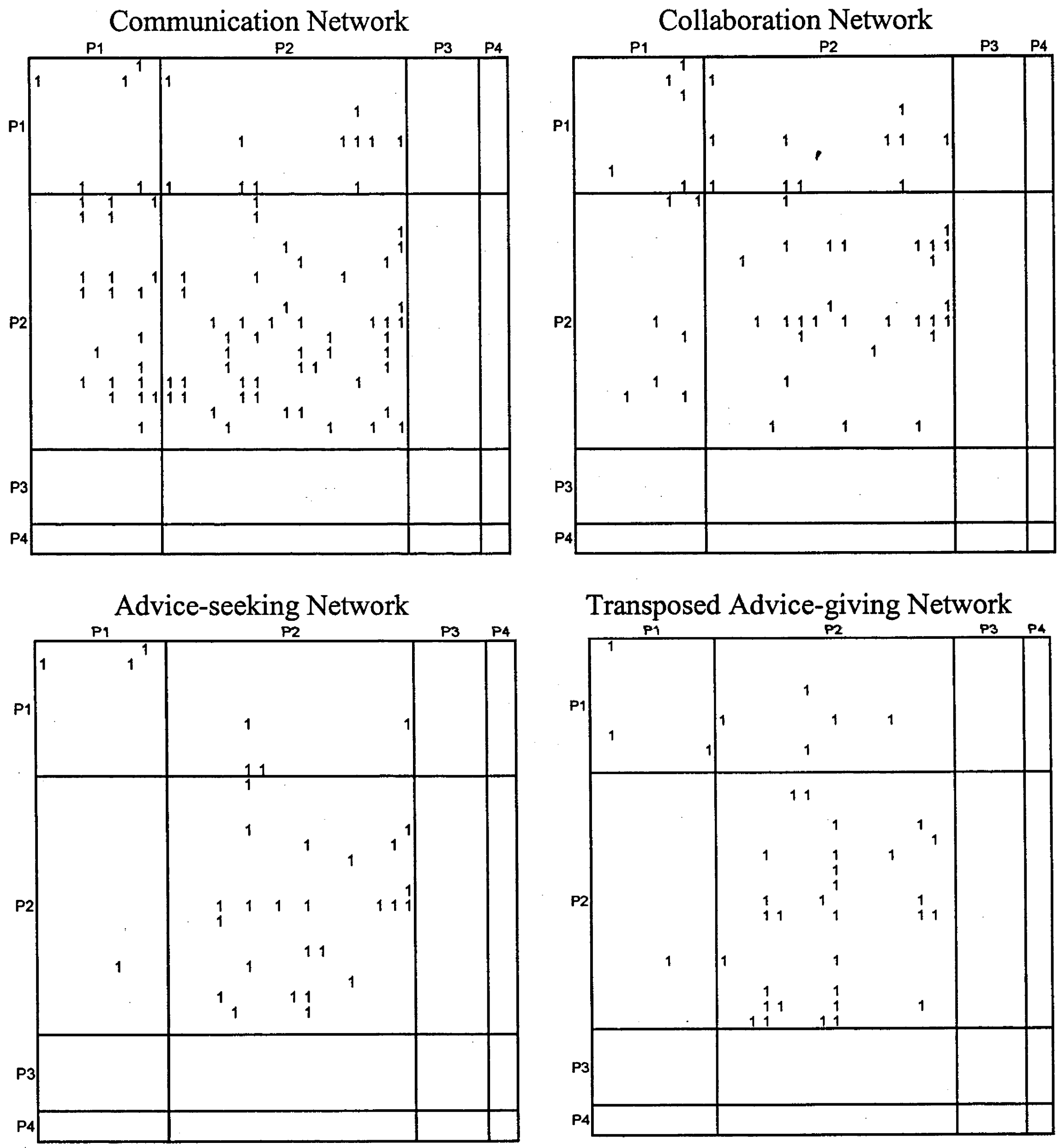


Figure 8.3. Blocked adjacency matrices for GTC (structural equivalence)

The process of building these image matrices involves permuting the adjacency matrices to form blocked adjacency matrices for all of the networks, calculating density for the blocks in each network, then determining if a block was a *oneblock* or a *zeroblock.* Actors who are assigned to the same position occupy adjacent rows and columns. The "0" entries in the matrices are suppressed to highlight the density of the blocks. A quick visual observation of the blocked adjacency matrices reveals that the blocks are quite sparse, indicating that the interaction among those blocks is quite low. This is especially true of the advice-seeking and the advice-giving networks.

There are a number of criteria that can be used for determining whether a block is a oneblock or a zeroblock, such as perfect fit (oneblock if the block is filled with all one and zeroblock if it is filled with all zeros), lean fit (oneblock if there is at least a 1 in the block, zeroblock otherwise), oneblock (oneblock if the block is filled completely with 1's, otherwise, it is a zeroblock), and α density criterion (oneblock and zeroblock are defined based on a predefined threshold) (see Wasserman and Faust, 1994, pp. 397-400).

Because some blocks contain a mixture of 1s and 0s, the α density criterion is used in this study. The value of α is the overall density of each adjacency matrix which corresponds to each relation. Such criterion have been used by researchers such as Snyder and Kick (1979). Thus, a block is a oneblock if its density is equal or greater than the criterion value, and zeroblock otherwise. A oneblock is then represented as a "1" in the corresponding cell entry in the image matrix, and zeroblock as a "0". In the reduced graphs, a oneblock or a bond is represented by a line, and a zeroblock by an absence of a line. The density of each submatrix (block) for each relation was computed using the UCINET 6 for Windows (Borgatti *et al.*, 2002) "block transformation" procedure. The overall density and the density of each block for each matrix are presented in Figure 8.4.

Communication Relation
Overall density: 0.067

	P1	P2	P3	P4
P1	0.069	0.072	0.000	0.000
P2	0.137	0.180	0.000	0.000
P3	0.000	0.000	0.000	0.000
P4	0.000	0.000	0.000	0.000

Collaboration Relation
Overall density: 0.043

	P1	P2	P3	P4
P1	0.069	0.072	0.000	0.000
P2	0.046	0.103	0.000	0.000
P3	0.000	0.000	0.000	0.000
P4	0.000	0.000	0.000	0.000

Advice-seeking Relation
Overall density: 0.029

	P1	P2	P3	P4
P1	0.042	0.026	0.000	0.000
P2	0.007	0.088	0.000	0.000
P3	0.000	0.000	0.000	0.000
P4	0.000	0.000	0.000	0.000

Transposed Advice-giving Relation
Overall density: 0.025

	P1	P2	P3	P4
P1	0.042	0.033	0.000	0.000
P2	0.007	0.110	0.000	0.000
P3	0.000	0.000	0.000	0.000
P4	0.000	0.000	0.000	0.000

Figure 8.4. The density tables for the four relations involving GTC trainers

It is important to note that inter-position density values in the density tables indicate the proportion of ties that are present from the actors in the row positions to the actors in the column positions. In calculating intra-position densities (the diagonal entries in the density tables in Figure 8.4), self ties at individual level (the diagonal entries in the corresponding blocked adjacency matrices in Figure 8.3) are excluded. However, in examining relations involving classes of actors, such as positions, they are considered because they carry important information, that is, ties within positions. Thus, the diagonal values in the density tables are meaningful.

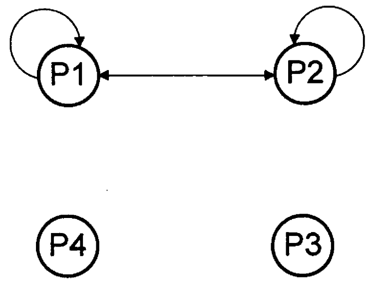
Consistent with the blocked adjacency matrices shown earlier in Figure 8.3, Figure 8.4 shows that the ties within and between positions are quite sparse for all relations. The rows and columns corresponding to positions P3 and P4 are all filled with zeros, indicating that the members of these positions do not give or receive nominations from the members of the other positions, nor do they exchange nominations among themselves within the same position. However, despite being unrelated, actors within these positions are equivalent so far as the structural equivalence definition is concerned.

The information in the density tables is sufficient to construct image matrices. Cell entries which are equal or greater than the overall density of the corresponding networks are coded "1" in the image matrices cells, and "0" otherwise.

The image matrices and corresponding reduced graphs can be seen in Figure 8.5. As indicated by the image matrices, positions P1 and P2 have reflexive ties in all relations, suggesting that the occupants of these positions have interactions with others who are structurally equivalent to them. Positions P1 and P2 also form mutual and multiplex ties in the communication and collaboration relation networks. In the transposed advice-giving relation, position P2 gives advice to position P1, but position P1 does not reciprocate. Although there is no tie between these two positions in the advice-seeking relation, a closer look at the density table reveals that the density of ties from position P1 to position P2 almost reaches the threshold for position P1 to be considered as seeking advice from position P2. However, for consistency in applying the criteria for building the image matrices and reduced graphs, it is assumed that there is no interaction between position P1 and P2 in the advice-seeking relation. Nevertheless, this demonstrates that positions P1 and P2 have quite intensive interactions.

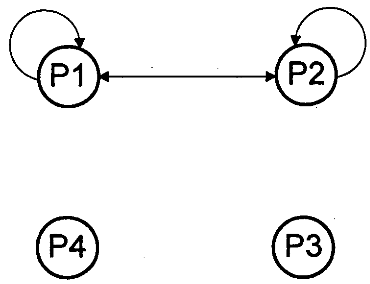
Communication Relation

	P1	P2	P3	P4
P1	1	1	0	0
P2	1	1	0	0
P3	0	0	0	0
P4	0	0	0	0



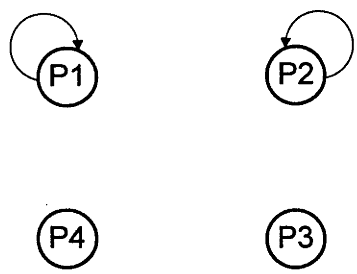
Collaboration Relation

	P1	P2	P3	P4
P1	1	1	0	0
P2	1	1	0	0
P3	0	0	0	0
P4	0	0	0	0



Advice-seeking Relation

	P1	P2	P3	P4
P1	1	0	0	0
P2	0	1	0	0
P3	0	0	0	0
P4	0	0	0	0



Transposed Advice-giving Relation

	P1	P2	P3	P4
P1	1	1	0	0
P2	0	1	0	0
P3	0	0	0	0
P4	0	0	0	0

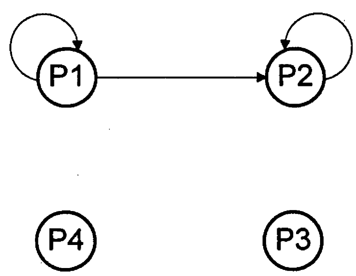


Figure 8.5. Image matrices and reduced graphs for the GTC networks

In contrast, position P3 and position P4 have neither reflexive ties nor ties to the other positions, indicating that actors in these equivalent positions do not interact with one another or with members of the other positions. In fact, the image "0"s representing the absence of ties within position P3 and P4, and between each of these positions and the other positions are reflections of true "0"s of the density table in Figure 8.4.

Substantively, the reduced graph for the communication relation suggests that apart from obtaining general knowledge from among themselves, members of position P1 also obtain such learning resource from members of position P2. Actors in position P2 also do exactly the same thing in relation to members of position P1. Collaboration relations allow collaborating partners to learn from each other directly through working together on particular activities. In such activities, not only do they exchange general explicit knowledge but they also exchange tacit knowledge. Thus, "collaborating with" implies having opportunities to obtain tacit knowledge of others. The image matrix of the collaboration relation, then, suggests that members of positions P1 and P2 are able to learn from each other at a more personal and deeper level through accessing each other's tacit knowledge.

The advice-seeking network implies access to expert advice and know-how of other people. Thus, the trainers within positions P1 and P2 are able to access these kinds of learning resources internally, but do not exchange them with members of the other positions. From the advice-giving interactions, however, it appears that position P2 gives advice to position P1. The arrow pointing from P1 to P2 in the transposed reduced graph means that P1 has access to the advice provided by P2. This is consistent with the actor attributes, where trainers constituting position P1 are generally more junior, younger, and with fewer years of service compared to their colleagues in position P2. Thus, it is reasonable that trainers in position P2 give advice to their colleagues in position P1.

The dynamic of the trainers' structure of knowledge sharing and learning, therefore, seems to centre on positions P1 and P2. Potentially, the construction and sharing of knowledge and various other learning resources that may ensue from social interaction is likely to come from the internal interactions as well as the mutual interactions between positions P1 and P2.

Although it was found earlier that the position model reflects the formal stratification of trainers into ranks and grades, the positions identified are not structured hierarchically in accordance with the level of the ranks that each position represented. Rather, the formal hierarchical structure of seniority translates into a core-periphery configuration in terms of knowledge exchange. In this case, positions P1 and P2 constitute the core, while P3 and P4 are the periphery. Although this positional interaction is not exactly similar to the standard core-periphery structure, Borgatti and Everett (1999) refer to such a configuration as an extreme type of core-periphery structure. In a standard core-periphery model, such as the one found by Brieger (1976) among biomedical researchers, or image E in White, Boorman and Brieger (1976, p. 744), the core positions interact with high intensity, and the intensity decreases gradually toward the periphery. The core-periphery model observed here is one in which there is a high level of interaction in the core, but no interaction between the periphery and the core, nor within the periphery.

Consequently, and surprisingly, the senior trainers who are commonly regarded as the centre of the training profession turn out to be at the periphery of the knowledge sharing systems. Actors in position P3, despite having more experience, do not provide as much benefit to the system as would be expected, nor do they appear to gain learning benefits from the system. Useful experiences, tacit knowledge and other resources that may be beneficial for the more junior trainers as well as other senior colleagues tend to be confined to the members of P3.

Social network analysts propose different typologies for characterising linkages that exist within and between positions, for example, the typology of positions consisting of isolate, receiver, transmitter and carrier (Harary, Norman *et al.*, 1965), or the typology of network positions containing isolate, primary position, sycophant and broker (Burt, 1976). Harary's *et al* (1965) typology does not consider self ties while Burt's does. Marsden (1989) proposes a more detailed typology by combining those designed by Harary *et al.* (1965) and Burt (1976), resulting in eight different types of roles.

For the current analysis, Burt's typology was found to be most relevant. It is simple yet quite meaningful for characterising the interactions and the flow of learning resources within and between the identified positions. Such characterisation of positions may be applied beyond the data in this study. Thus, to explore further the positional structure of the networks, that is, the profile of each position and the tendency for each position to send and receive ties, the identified position model will be examined in light of Burt's (1976) typology of positions as can be seen in Figure 8.6.

Burt (1976) defined a primary position as a set of actors who give their nominations to actors with whom they are structurally equivalent, and who receive a non-negligible proportion of nominations from actors in the network as a whole. An isolate position is a set of actors who also give most of their nominations to actors with whom they are structurally equivalent, but receive no nominations from actors in the network who are not structurally equivalent with them. Sycophant and broker positions are occupied by actors who give their nominations to the prestigious actors in the primary positions but do not have their nominations reciprocated. The difference between the two is that whereas a broker position receives a non-negligible proportion of nominations from actors in the network as a whole, a sycophant does not.

Proportion of ties within position		Proportion of ties given to position: ~.0	Proportion of ties given to position: >.0
	≥.5	Isolates	Primary Position
	≤.5	Sycophant	Broker

Adapted from Burt (1976, p. 107)

Figure 8.6. Burt's typology of positions

Figure 8.7 presents the patterns of relations within and between four positions using Burt's typology. The cell contents are expressed as percentages and should be read as the ratio of all nominations made by actors in the row positions to the actors in the column positions. For example, in the communication relation, of all nominations made by the actors in position P1, 19 percent are given to others within the same position, 42 percent to actors who belong to position P2 and 38 percent to actors in the residual category. The column totals indicate the ratio of all nominations made in the system received by the column positions. For example, of all nominations made by all actors in the communication relation, position P1 receives 29 percent of them, position P2 receives 53 percent, position P3 receives none, and position P4 receives 2 percent. It is important to note that actors in the residual category are included in this analysis because they contribute to the proportion of ties received by actors in each position from the whole system.

Communication Relation

	P1	P2	P3	P4	Residual	Total
P1	19	42	0	0	38	100
P2	28	64	0	0	8	100
P3	0	0	0	0	0	0
P4	0	0	0	0	0	0
Residual	44	28	0	8	20	100
Total	29	53	0	2	17	100

Collaboration Relation

	P1	P2	P3	P4	Residual	Total
P1	20	44	0	0	36	100
P2	18	74	0	0	8	100
P3	0	0	0	0	0	0
P4	0	0	0	0	0	0
Residual	47	21	0	11	21	100
Total	26	52	0	2	20	100

Advice-seeking Relation

	P1	P2	P3	P4	Residual	Total
P1	23	31	0	0	46	100
P2	4	89	0	0	7	100
P3	0	0	0	0	0	0
P4	0	0	0	0	0	0
Residual	43	21	0	7	29	100
Total	19	57	0	2	22	100

Advice-giving Relation

	P1	P2	P3	P4	Residual	Total
P1	43	14	0	0	43	100
P2	14	86	0	0	0	100
P3	0	0	0	0	0	0
P4	0	0	0	0	0	0
Residual	33	0	0	0	67	100
Total	21	65	0	0	15	100

Figure 8.7. Patterns of relations within and between positions in the GTC

It appears that all positions demonstrate consistent patterns of interactions across the four relations (Table 8.4). For example, for all relations, actors in position P2 give the majority of their nominations to those with whom they are structurally equivalent, and receive the majority of nominations from the system.

Clearly, P2 is a “primary position”. Actors in position P2, communicate with, collaborate with, seek advice from and give advice to most of the other actors within position P2. At the same time, these actors are also regarded by most of the network members as communication partners, collaboration partners and sources of advice who do not shy away from seeking advice from others. Actors in this position, by virtue of their position in relation to others in the networks, are able to benefit from access that they have to learning resources flowing through the networks.

Position P1 might be regarded as a “broker” position. Actors in this position receive non-negligible nominations from other actors in the system, but give most of their nominations to others who are not structurally equivalent to them. The proportion of ties received by actors in position P1 from the system ranges from 19 percent to 29 percent. However, more than 50 percent of all nominations made by actors in position P1 are given to the occupants of another position and to the nonconformists who belong to the residual category, rather than to those who are in the same position as they are.

This is consistent with the trainers' attributes in position P1 found earlier. Being relatively younger, new to the training profession, and having a lower level of education, actors in position P1 seems to be at the stage of absorbing learning resources by seeking as many opportunities as possible to gain experience through involvement in their professional practices. They access the opportunity structure by establishing interactions among themselves and with those in position P2, which, as will be revealed later, is occupied by middle rank trainers.

In light of the concepts of “legitimate peripheral participation” (Lave and Wenger, 1991) and “community of practice” (Wenger and Snyder, 2000b), actors in position P1 can be viewed as novice practitioners who are still at the periphery of the training profession, and in the process of moving toward the centre of their community of practice through actively involving in real practice and learning the craft of their profession. Taking the position of knowledge brokers puts them at the crossroads of knowledge flows, which can be highly instrumental for these trainers in the early stages of career development. The broker position identified earlier reflects the fact that actors in this position must give and take in order to survive in their early public service training career. The broker position may also provide them with maximum exposure to the knowledge and practices of their profession.

The characteristics of positions P3 and P4 are almost identical in all relations. Actors in both positions have neither internal interactions nor interactions with members of other positions. The only difference is that actors in position P3 receive no nominations from anywhere, whereas those in position P4 receive a few from actors in the residual category. However, the proportion of nominations from the whole system which are directed to position P4 is negligible (2%). Even if the 2 percent nominations received from the system is regarded non-negligible, P4 still would not qualify a "broker" position because actors in it do not give any nomination to any other actors in the system. Therefore, both positions are more appropriately labelled "isolates". Table 8.4 summarises the typology of positions in the GTC network.

Table 8.4. Typology of positions for the four relations in the GTC

Position	Communication	Collaboration	Advice-seeking	Advice-giving
P1	Broker	Broker	Broker	Broker
P2	Primary	Primary	Primary	Primary
P3	Isolate	Isolate	Isolate	Isolate
P4	Isolate	Isolate	Isolate	Isolate

As can be seen in Table 8.4, the characterisation of positional structure in the GTC networks using Burt's typology is consistent with the image matrices and interpretations made using actors' attributes earlier. This provides a further justification for the hypothesised position model as being socially and structurally meaningful. Position P2 seems to be the centre of the knowledge exchanges and informal learning activities. Apart from having the largest number of members, actors in it have quite intensive exchanges of learning resources among themselves and serve as sources of knowledge and learning for the majority of actors in the system.

So far, positions have been inferred purely from the hypothetical model based on structural equivalence, which is a mathematical property of subsets of actors in a network (Wasserman and Faust, 1994). The position model has also been validated using actor attributes as external evidence. In addition, the model has been examined in light of Burt's typology of positions, which is consistent with interpretations using actor attributes. It is, therefore, reasonable to assume that the positional model identified has captured the substantive structural properties of the way trainers in the GTC relate and exchange learning resources.

In general, these results suggest that positions P1 and P2 play a pivotal role in, and constitute the core of, the informal learning and knowledge exchange in the GTC. Members of these positions are generally junior and middle rank trainers. Positions P3 and P4 are at the periphery of the learning system. Occupants of these positions are generally senior trainers, especially in position P3. This is contrary to a prevailing belief that the centre of the training activities is the senior trainers.

There are some factors that may affect the disengagement of the senior trainers from learning exchanges. Lack of incentives is one factor. In the previous regulations pertaining to trainers credit points (GOI, 1985) which affect trainers' promotions, one of the ways for the trainers to obtain credit points was by mentoring their more junior colleagues. This particular provision, however, has been excluded from the new regulations (see GOI, 1985; GOI, 2001a). In addition, the senior trainers may become less interested in engaging in knowledge exchange with their colleagues as they get closer to mandatory retirement age. As may be recalled from Table 8.3, their average age is 60 years old, thus they have a maximum of only five years left. Furthermore, the competitive environment may be a disincentive for exchanging knowledge for the senior trainers. As many junior trainers believe, the unwillingness of some senior trainers to exchange knowledge is a form of strategy for securing teaching assignments for themselves.

Senior trainers are also quite externally oriented. They have extensive connections with people from outside the GTC. As most people have the capacity to maintain only a limited number of relations, the senior trainers might maintain external relations at the expense of internal relations. On average, senior trainers have 17 external associates, compared to only 11 for middle rank trainers and 13 for junior trainers.

Regular Equivalence Based Positions in the GTC Networks

Regularly equivalent actors were detected using two of the widely used algorithms: REGE (White and Reitz, 1983), and the categorical version of REGE (CATREGE). Although the REGE algorithm was designed specifically to handle quantitative data, and CATRGE for categorical data, both algorithms are equally applicable for binary data (Borgatti and Everett, 1993). In this study, therefore, both algorithms are used and the results from each are compared to determine which one is more meaningful for further analyses.

Basically, the REGE algorithm initially classifies actors into sources (send only ties), repeaters (receive and send ties) and sinks (receive only ties). Next, it applies the same procedure to each of the categories found in the previous step. That is, it subdivides the actors in each category according to the type of actors (source, repeaters or sinks) in their neighbourhood. This process reiterates until no further category can be subdivided.

The two algorithms have been rigorously tested on various data with known structural properties (Doreian, 1988; Faust, 1988), and both have been reported to be reliable in capturing hierarchical type structures (ranked structures), where actors at each level of the hierarchy are clustered together. As an example, for the stylised graph in Figure 8.1, both REGE and GATREGE produced identical clusters as follows: {1}, {2, 3, 4} and {5, 6, 7, 8, 9}. However, for the more complex data at hand, the two algorithms appeared to yield different partitions.

The same multiple adjacency matrices (communication, collaboration, advice-seeking and advice-giving) for the GTC used for structural equivalence analysis were submitted to the CATREGE algorithm, implemented in UCINET 6 (Borgatti *et al.*, 2002). The results are not very informative, as can be seen in Figure 8.8. That is, only two levels are identified. At level 2, where actors who are most regularly equivalent are grouped together, it only identifies one cluster containing actors {20, 35, 36, 37, 194}. These are the same actors who occupy position P3 in the structural equivalence analysis earlier. At level 1, which aggregated actors who had lesser degrees of similarity, CATREGE produced a trivial blocking; that is, all actors were merged into a single cluster. Identical results were obtained when the data were converted to geodesic distances prior to analysis. Therefore, the result from CATREGE algorithm Is not sufficiently meaningful to interpret and, therefore, will not be analysed further.

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Number of unique bundles of relationships: 112

HIERARCHICAL CLUSTERING

                                               1                                               1
                           1 1 1 1 1 1 1 1 1 2 9 3 3 3 2 2 2 2 2 2 2 3 3 3 3 3 3 4 4 7 8 8 9 9 9
         1 2 3 4 5 6 7 8 9 0 1 2 3 5 6 7 8 9 0 4 5 6 7 3 4 5 6 7 8 9 0 1 2 3 4 9 0 1 4 8 9 0 1 1

                           1 1 1 1 1 1 1 1 1 1 4 3 3 3 2 2 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 4 4 4 4
Level    1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 4 2 3 4 0 1 2 3 4 5 6 7 8 9 0 1 5 6 7 8 9 0 1 2 3
-----    - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    2    . . . . . . . . . . . . . . . . . . . XXXXXXXXX . . . . . . . . . . . . . . . . . . . . .
    1    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
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Figure 8.8. Hierarchical clustering for GTC networks (categorical REGE)

The REGE algorithm produces more interesting results. It identifies several equivalent classes at different levels of similarity. The similarity matrix produced by the REGE algorithm can be seen in Appendix 6. As can be seen in the similarity matrix, some actors appear to be perfectly regularly equivalent, as indicated by the value 1.00 in the rows and columns where they intersected in the similarity matrix. However, besides having some perfectly equivalent actors, there are also some other actors who are not highly similar. In the hierarchical clustering of the regular equivalence similarity matrix in Figure 8.9, it is clearly shown that some actors can only be clustered together with the others at a very low level of similarity. Setting the bar too high, so that only those who are highly regularly equivalent are included, leaves an excessive number of actors unaccounted for. However, compromising the level of similarity by dropping the bar too low includes more actors but at the expense of allowing those who have lower degrees of similarity to be grouped together. Therefore, level 42.921, indicated by solid horizontal line across the diagram in Figure 8.9, seems to be inclusive enough without compromising the level of similarity too much.

At this level, five equivalent classes, or positions, can be identified: Position C1 {4, 11, 23, 39}, position C2 {1, 3, 5, 6, 7, 8, 9, 10, 12, 16, 17, 18, 19, 25, 27, 28, 29, 30, 31, 32, 33, 34, 40, 41}, position C3 {2, 13, 15, 24, 26, 74}, position C4 {88, 89} and position C5 {20, 35, 36, 37, 194}. Actors 90, 91, 191 are not included in any equivalent classes as their similarity is below the cut point chosen. Position C2 is much larger than the others, containing 24 actors, compared to only two actors in position C4, four actors in position C1, five actors in position C5, and 6 actors in position C3.

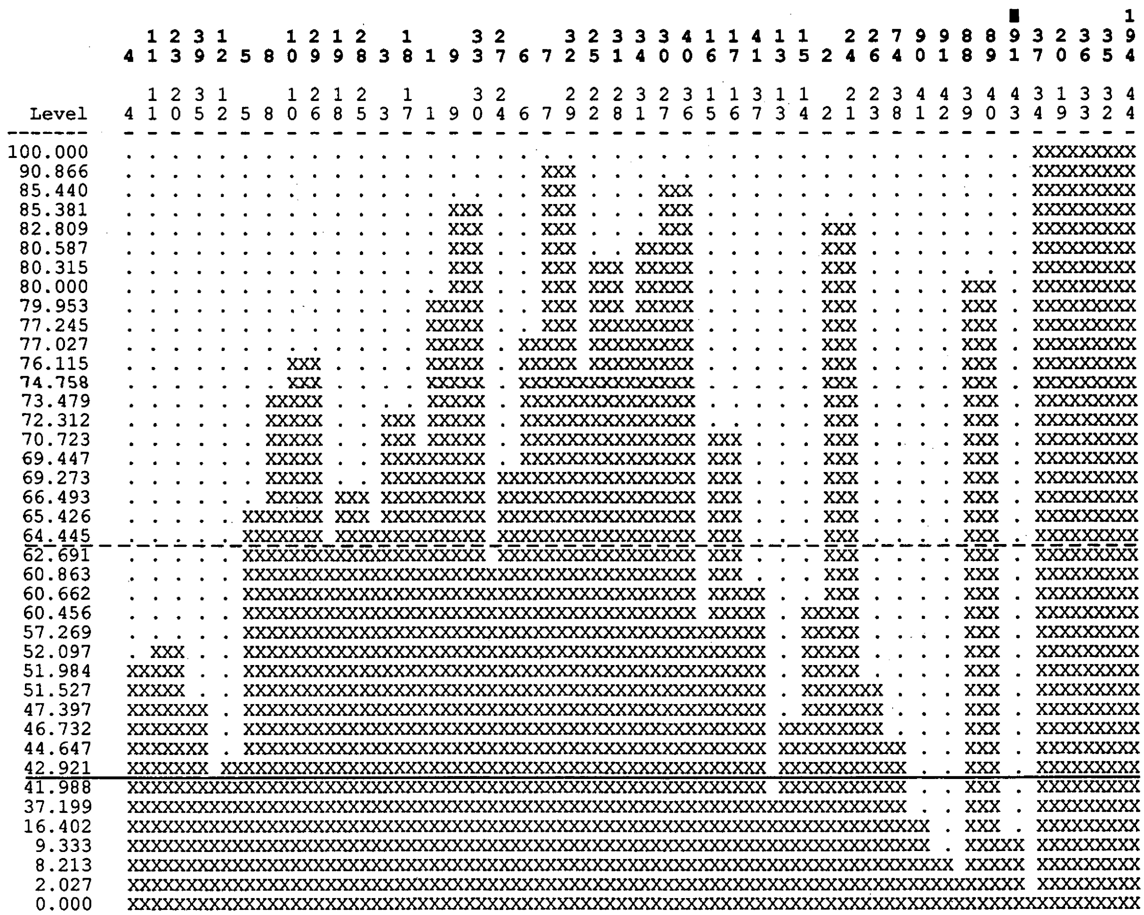


Figure 8.9. Hierarchical clustering for GTC networks (REGE algorithm)

At the level of similarity chosen above (solid line), the regular equivalence classes identified by the REGE algorithm produce some similar and some different clusters as compared to those identified in the structural equivalence analysis. Positions P3 and P4 in the structural equivalence analysis are preserved here and are assigned to positions C5 and C4 respectively. In addition, more actors are included in the clusters, leaving only three actors in the residual category, compared to 11 in the structural equivalence analysis. Position C2 merges almost all members of position P1, P2 and residual categories in the structural equivalence positions.

Unlike the positions identified in the structural equivalence analysis, those identified here do not seem to be associated with the trainers' ranks. As can be seen in Table 8.5, of the four actors in position C1, two of them are junior trainers and two others are middle rank trainers. The two junior trainers in this position constitute 18 percent of the total number of junior trainers in the GTC, and the other two middle rank trainers account for 9 percent of all middle rank GTC trainers who participated in the study. Position C2 is the largest, in which the greatest proportion of actors from each rank belong. This position contains four junior trainers, 14 middle rank trainers and five senior trainers. These numbers account for 36 percent, 64 percent and 46 percent of all junior, middle and senior trainers in the GTC respectively. In position C3, all ranks are also represented. Eighteen percent (2) of junior trainers, 14 percent (3) of middle rank trainers and nine percent (1) of senior trainers are included in this position.

Table 8.5. Classes of regularly equivalent actors by rank in the GTC

	Rank			
	Junior n (%)	Middle n (%)	Senior n (%)	Total N (%)
C 1	2 (18.18)	2 (9.09)	0 (0.00)	4 (9.09)
C 2	4 (36.36)	14 (63.64)	6 (54.55)	24 (54.55)
C 3	2 (18.18)	3 (13.64)	1 (9.09)	6 (13.64)
C 4	0 (0.00)	2 (9.09)	0 (0.00)	2 (4.55)
C 5	0 (0.00)	1 (4.55)	4 (36.36)	5 (11.36)
Residual	3 (27.27)	0 (0.00)	0 (0.00)	3 (6.82)
Total	11 (100.00)	22 (100.00)	11 (100.00)	44 (100.00)

As indicated earlier, positions C4 and C5 are the replicas of positions P4 and P3 respectively in the structural equivalence analysis. Trainers within these two positions are, therefore, quite homogeneous in terms of rank, where C4 contains middle rank trainers and C5 contains four senior trainers out of five members.

Although to some extent the occupants of the positions can be identified along rank lines, especially C4 and C5, as indicated, their divisions are not as clear cut as those in the structural equivalent analysis.

In terms of educational level, trainers with different educational levels are also mixed within each position. As can be seen in Table 8.6, trainers with undergraduate and those with Masters degrees are almost equal in number. Their number in each position is also about equal. In positions C3 and C4, the number of trainers with undergraduate and Masters degrees are exactly the same. In positions C1 and C5, the number of trainers with Masters degrees is three, only slightly higher than the one trainer with an undergraduate degree. In position C2, there are 13 trainers with undergraduate degrees and 10 trainers with Masters degrees. Thus, the trainers are not homogeneous in terms of the level of formal education within each of the identified positions.

Table 8.6. Classes of regularly equivalent actors by education in the GTC

	Educational Qualification			
	Undergraduate n (%)	Masters n (%)	PhDs n (%)	Total n (%)
C 1	1 (5.00)	3 (13.64)	0 (0.00)	4 (9.09)
C 2	13 (65.00)	10 (45.45)	1 (50.00)	24 (54.55)
C 3	3 (15.00)	3 (13.64)	0 (0.00)	6 (13.64)
C 4	1 (5.00)	1 (4.55)	0 (0.00)	2 (4.55)
C 5	1 (5.00)	3 (13.64)	1 (50.00)	5 (11.36)
Residual	1 (5.00)	2 (9.09)	0 (0.00)	3 (6.82)
Total	20 (100.00)	22 (100.00)	2 (100.00)	44 (100.00)

Table 8.7 shows the mean values of some other relevant actor attributes. In terms of age, there is a gradual increase from position C1 toward position C5. The tenure and the number of organisations joined also have a slight tendency to increase from C1 to C5. The mean values of all the other attributes, however, tended to fluctuate across the five positions.

Table 8.7. Mean attributes of regularly equivalent actors in the GTC

Personal Attributes	C1	C2	C3	C4	C5
Age	52.25 (5.91)	53.58 (7.90)	54.83 (5.12)	55.00 (0.00)	59.80 (3.35)
Tenure	4.25 (1.26)	5.29 (2.07)	4.17 (2.99)	4.00 (1.41)	6.00 (4.18)
N of Org joined	2.25 (1.50)	2.71 (2.03)	3.17 (2.04)	1.00 (0.00)	4.80 (5.26)
N of subjects	7.5 (3.87)	5.67 (2.44)	1.83 (1.17)	4.00 (1.41)	3.00 (1.22)
N of Training	6.5 (3.70)	6.67 (3.36)	4.33 (3.27)	3.00 (1.41)	5.40 (1.14)
N of Seminar	7.75 (2.87)	6.29 (3.37)	3.67 (3.27)	4.00 (0.00)	4.20 (1.30)
External assignments (%)	62.5 (15.00)	65.75 (20.32)	35.00 (32.71)	42.50 (3.54)	57.00 (36.50)

Note: Values in parentheses are standard deviations

Clearly, the regular equivalence model captured different aspects of the trainers' relational structure. The partitioning of the GTC trainers into positions could not be explained by the actors' sociodemographic attributes as was the case for positions defined by structural equivalence. The positions identified here could be emergent ones. Therefore, it was useful to consider further how these relations interact using a blockmodel technique.

Using the blockmodel technique, the adjacency matrix for each relation was blocked based on the clusters of regularly equivalent actors, so that actors who are regularly equivalent (occupy the same position) are put together in the same block. The blocked adjacency matrices can be seen in Figure 8.10. In general, it can be seen that the ties concentrate on where each block intersects with itself (especially position C2), indicating that there is a relatively high level of interactions within blocks.

In a block model based on regular equivalence (regular blockmodel), the criteria for determining oneblock and zeroblock are different from those used in a blockmodel based on structural equivalence (structural blockmodel). In a regular block matrix, a tie from block or position A to position B exists if each member of position A has a tie to at least one member of position B, and each member of position B has a tie from at least one member of position A. Such a block is commonly referred to as a regular block, that is, a block that "contains at least one arc in each row and in each column" (de Nooy *et al.*, 2005).

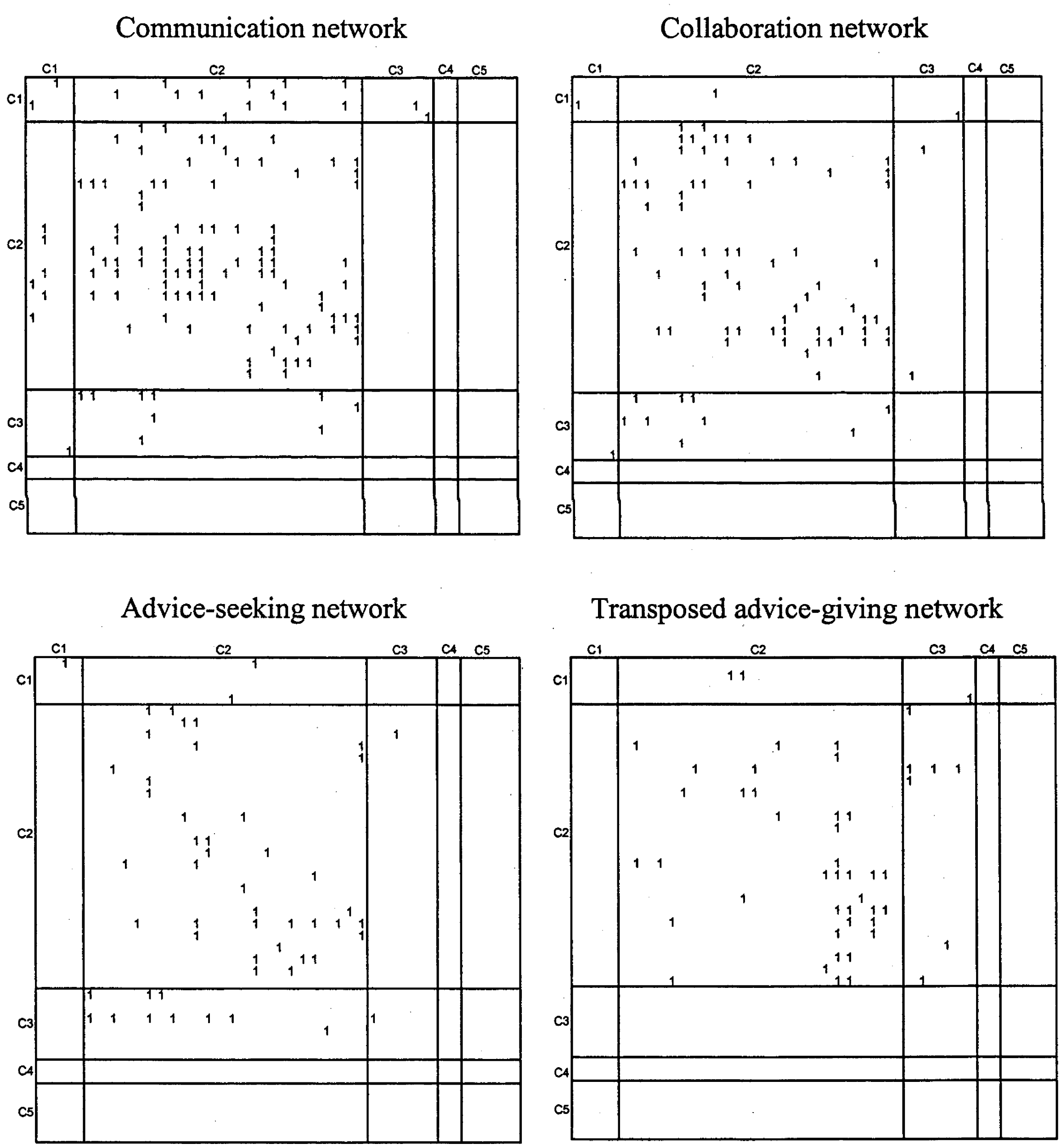


Figure 8.10. Blocked adjacency matrices for GTC (regular equivalence: 42.921)

Under the above criteria, none of the submatrices can be translated into a oneblock or regular block. As can be seen from the blocked adjacency matrices, the closest to realising the oneblock is the submatrix representing ties from positions C1 to C2 in the communication network. Each member of position C1 has at least one tie to a member of position C2. However, not every member of position C2 has a tie from a member of position C1. Under Batagelj's (1997) classification the block is a "row-regular". If an image matrix is constructed from each block in each network, they will all contain 0 in their cells. Even submatrices representing ties among actors within each block, which was the densest in all of the networks, do not qualify as a regular block.

Ideally, a positional structure should show some inter-positional interactions in accordance with the definition of the regular equivalence; that is, actors are regularly equivalent (occupying the same position) if they are related to other actors who are themselves regularly equivalent. It is obvious, however, that the identified model does not show any relation between positions.

This may be affected by the low level of similarity at which the positions were defined. Therefore, it was useful to try clustering the trainers at a higher level of similarity. It was expected that as the level of similarity is more refined, a more meaningful structure would emerge, although this would cause more actors to be excluded.

Level 64.445 (indicated by the dashed horizontal line in the diagram in Figure 8.9) seems to be the highest level of similarity which does not cause an excessive loss of cases. At this level, position C2 at the previous level is split into four clusters. Position C1 is excluded because all actors in it have similarity far below the new level. Positions C4 and C5 retain the same actors.

At this level, seven clusters are identifiable. The new position assignment is as follows: position C1 {5, 8, 10, 29}, position C2 {1, 3, 9, 18, 19, 27, 28, 33}, position C3 {6, 7, 25, 30, 31, 32, 34, 40} position C4 {16, 17}, position C5 {2, 24}, position C6 {88, 89}, and position C7 {20, 35, 36, 37, 194}. Thirteen actors (4, 11, 12, 13, 15, 23, 26, 39, 41, 74, 90, 91, and 191) are not included because they have lower levels of similarity.

Even at this higher level of similarity, however, there appears to be no strong association between the positions to which the trainers are assigned and their attributes. Trainers' sociodemographic profiles across positions can be seen in Table 8.8, Table 8.9, and Table 8.10.

As can be seen in Table 8.8, in terms of ranks, the GTC trainers with different ranks tend to occupy the same position. Only positions C6 and C7 display homogeneity of ranks.

Table 8.8. Higher level of regularly equivalent actors by rank in the GTC

	Rank			
	Junior	Middle	Senior	Total
Position	n (%)	n (%)	n (%)	n (%)
C1	2 (18.18)	2 (9.09)	0 (0.00)	4 (9.09)
C2	1 (9.09)	6 (27.27)	1 (9.09)	8 (18.18)
C3	1 (9.09)	4 (18.18)	3 (27.27)	8 (18.18)
C4	0 (0.00)	2 (9.09)	0 (0.00)	2 (4.55)
C5	1 (9.09)	1 (4.55)	0 (0.00)	2 (4.55)
C6	0 (0.00)	1 (4.55)	4 (36.36)	5 (11.36)
C7	0 (0.00)	2 (9.09)	0 (0.00)	2 (4.55)
Residual	6 (54.55)	4 (18.18)	3 (27.27)	13 (29.55)
Total	11 (100.00)	22 (100.00)	11 (100.00)	44 (100.00)

In Table 8.9 it can be seen that the distribution of trainers into positions by educational level also tends to be heterogeneous. Apart from position C1 and C5, which are occupied only by trainers with undergraduate qualification, all other positions contain a combination of trainers with different levels of education.

Table 8.9. Higher level of regularly equivalent actors by education in GTC

	Educational Qualification			
Position	Undergrad n (%)	Masters n (%)	PhD n (%)	Total n (%)
C1	4 (20.00)	0 (0.00)	0 (0.00)	4 (9.09)
C2	5 (25.00)	3 (13.64)	0 (0.00)	8 (18.18)
C3	2 (10.00)	5 (22.73)	1 (50.00)	8 (18.18)
C4	1 (5.00)	1 (4.55)	0 (0.00)	2 (4.55)
C5	2 (10.00)	0 (0.00)	0 (0.00)	2 (4.55)
C6	1 (5.00)	3 (13.64)	1 (50.00)	5 (11.36)
C7	1 (5.00)	1 (4.55)	0 (0.00)	2 (4.55)
Residual	4 (20.00)	9 (40.91)	0 (0.00)	13 (29.55)
Total	20 (100.00)	22 (100.00)	2 (100.00)	44 (100.00)

Mean attributes of trainers presented in Table 8.10 also show little regularity. There is no consistency in the order of the mean values of attributes across the seven positions. Thus, these attributes cannot explain why certain trainers are similar in terms of regular equivalence.

Table 8.10. Mean attributes of higher regularly equivalent actors in GTC

Position	Age in years	Tenure in years	N. of org. joined	N. of subjects taught	N. of training attended	N. of seminars attended	Percent of External assignments
C1	47.00	3.75	2.75	5.25	7.50	7.00	82.50
	(11.34)	(1.26)	(2.87)	(1.71)	(1.73)	(3.56)	(15.55)
C2	52.38	5.13	1.75	6.50	8.13	7.25	71.63
	(8.28)	(3.23)	(0.71)	(2.67)	(2.10)	(4.17)	(16.42)
C3	53.38	5.38	3.38	5.38	4.13	5.25	55.00
	(6.82)	(3.11)	(2.20)	(1.85)	(3.27)	(2.76)	(23.75)
C4	54.50	4.50	3.50	8.00	6.00	3.50	50.00
	(0.71)	(0.71)	(3.54)	(2.83)	(0.00)	(0.71)	(0.00)
C5	55.50	7.00	1.00	1.50	3.50	2.50	25.00
	(3.54)	(4.24)	(0.00)	(2.12)	(0.71)	(2.12)	(35.36)
C6	59.80	6.00	4.80	3.00	5.40	4.20	57.00
	(3.35)	(4.18)	(5.26)	(1.22)	(1.14)	(1.30)	(36.50)
C7	55.00	4.00	1.00	4.00	3.00	4.00	42.50
	(0.00)	(1.41)	(0.00)	(1.41)	(1.41)	(0.00)	(3.54)

Note: Values in parentheses are standard deviations

In general, therefore, there is no clear pattern of association between the assignment of trainers to positions at level 64.445 of regular equivalence and their attributes. At most, there are only three positions that seem to demonstrate specific features in terms of the attributes of trainers in them. Position C1 appears to be occupied by novice trainers (novice learners) who are youngest, have the least number of years as trainers, the lowest level of education and are in the lowest ranks. These trainers seem to be very active in seeking learning opportunities by attending many training programs and seminars. They are also the highest in terms obtaining teaching assignments in other training institutions, accounting for 85 percent of their total teaching activities. Position C6 seems to be occupied by experienced trainers. They are the oldest, the most senior, have the longest experience as trainers and high levels of education. They also associate with the most informal organisations and get many external teaching assignments. The profiles of trainers in position C7 are somewhere between those in positions C1 and C6 in terms of experience in the training profession. However, it is important to note that the homogeneity of attributes within these three positions is not as clear cut as that in the positions based on structural equivalence.

Despite the absence of clear associations between position assignment and attributes under this higher level of regular equivalence, it is worth examining further whether the positions identified purely on the basis of the trainers' pattern of interconnections reflect the intuitive notion of position embodied in the concept of regular equivalence itself.

As can be seen in Figure 8.11, the existing relations still tend to be dense across the diagonals, indicating that regularly equivalent actors tend to interact among themselves and learn from one another. However, in these regular equivalence based blocks, the main interest is in the interactions between blocks. The existence or absence of ties within each block does not have much effect on the definition of positions from regular equivalent point of view.

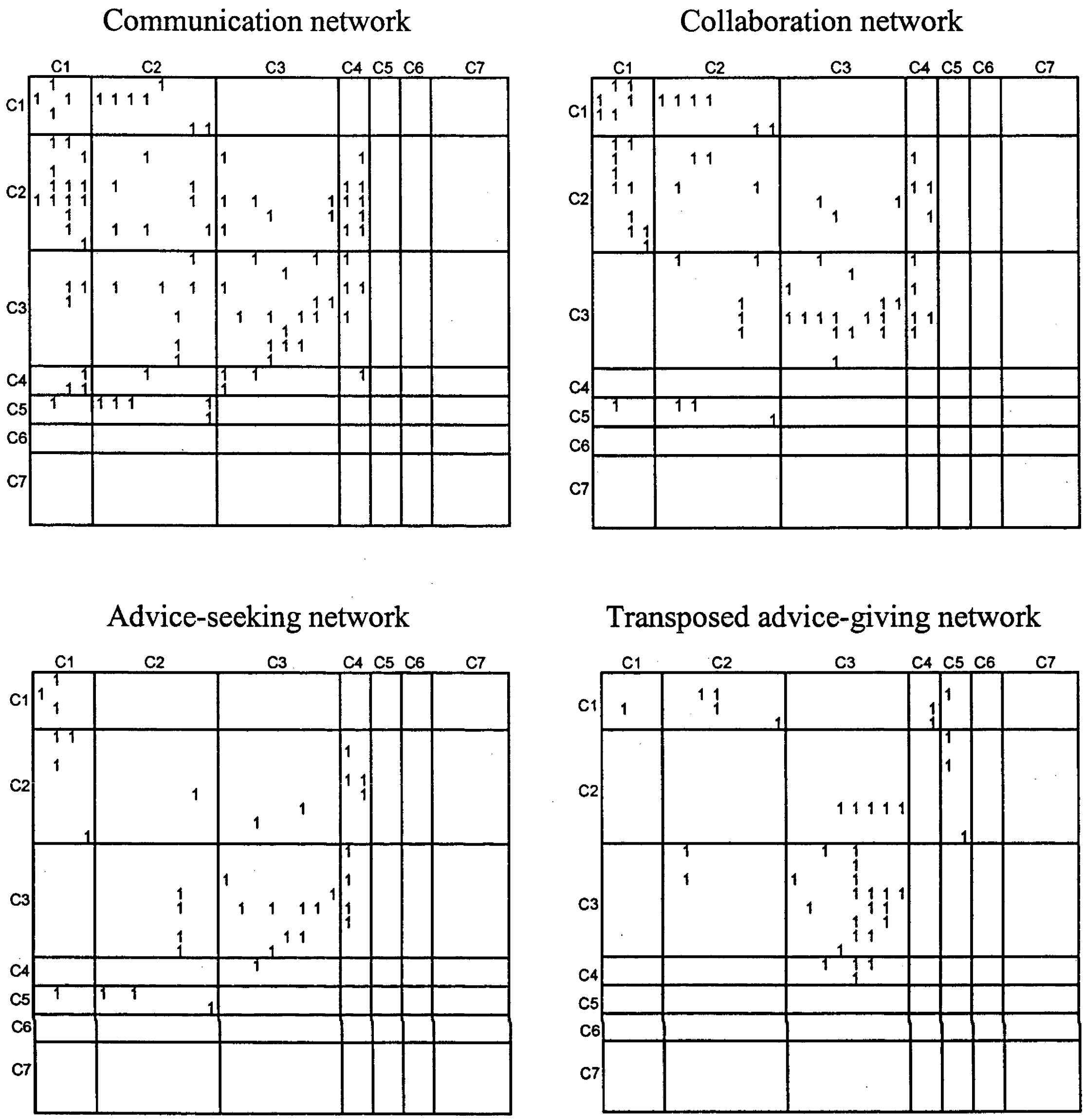


Figure 8.11. Blocked adjacency matrices for GTC (regular equivalence: 64.445)

Based on the criteria for a perfect regular block, the only inter-positional tie that can be identified from the blocked adjacency matrices is that from position C2 to position C1 in the communication network. It can be seen that each member of position C2 has at least one tie to a member of position C1, and each member of position C1 has at least one tie from a member of position C2. The dense blocks are generally those representing ties among members of the same blocks.

It is important to reiterate, however, that ties within the same position do not matter too much in regular equivalence based position analysis. The main concern is the ties between positions that actually define the roles of the trainers in each position towards those in the other position. Intuitively, a position can only be defined on the basis of its members' relations with members of other positions. As illustrated earlier, from a regular equivalence point of view, "doctor" as a position is only meaningful because the doctors work with nurses and treat patients, rather than because they associate with other doctors. In reality, they may be unrelated and working in different hospitals or clinics. They do not have to work together to be recognised as occupying the socially recognised position of doctor.

From the blocked adjacency matrices in Figure 8.11, it can be seen that even at higher level of similarity, there seems to be a lack of positional structure that adheres to the regular equivalence principles. It can be assumed that in terms of knowledge exchange or learning relations considered here, trainers do not exhibit the notion of positions that is embodied in the concept of regular equivalence. Regular equivalence, as described earlier in this chapter, is very accurate in identifying known positions entailing hierarchical structure. Such a structure, however, might not exist in a functional based profession such as trainers. In the Indonesian public service systems, one of the basic ideas in establishing functional positions, such as trainers, is to provide career opportunities for public servants outside the formal hierarchy of government bureaucracy.

Modelling the Structure of Positions for the CTU Trainers

The types and the number of relations investigated in the Company Training Unit (CTU) and the Government Training Centre (GTC) are similar. Therefore, the same methods and procedures were applied in modelling the structure of positions in the CTU networks. The procedures have been described in detail as part of the positional analysis for the GTC. The discussion in this section, therefore, focuses mainly on the analysis of the data itself.

Structural Equivalence Based Positions in the CTU Networks

For structural equivalence analysis, the Pearson product moment correlation coefficient was used as a measure profile similarity, applied simultaneously on the rows and columns of the matrix representing each relation, including their transposes. The correlation table can be seen in Appendix 6. Single link hierarchical clustering was imposed on the correlations to partition actors into equivalence classes. Both the correlation and the hierarchical clustering were done using UCINET 6 (Borgatti *et al.*, 2002). The partitioning of CTU trainers into equivalent classes can be seen in Figure 8.12.

As evident from the hierarchical clustering, the trainers merge into three subsets. Despite this tendency, some actors, such as actors 9, 21 and 31, have quite distinct patterns of relations and could only be included in the existing positions at low level of structural equivalence. The criterion level 0.3059 (indicated by a horizontal line in Figure 8.12) was chosen as a cut-off point as it is inclusive enough at a reasonable level of structural equivalence. Thus, a 3-position model was adopted for the CTU networks.

As can be seen in Figure 8.12, the sizes of the positions are quite unbalanced. There are nine actors in position B1 {1, 2, 3, 4, 5, 6, 26, 27, 28}, six in position B2 {7, 8, 10, 11, 12, 29}, and 13 in position B3 {13, 14, 15, 16, 17, 18, 19, 20, 22, 23, 24, 25, 30}. Following Burt's (1976) approach, actors 9, 21 and 31, who do not belong to any of these positions because of having similarity below the threshold level, are grouped into a residual category.

```
            [redacted]  2             2 2 2 1 1 1 1 1 2 2 2 2 1 1 2 3 3
Level       9 0 7 8 1 2 9 7 6 4 3 2 1 5 6 8 1 3 7 9 6 8 0 3 4 2 5 4 5 0 1
-------     - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
 0.9239     . . . . . . . . . . . . . . . . . . . . . XXX . . . . . . . .
 0.7417     . . . . . . . . . . . . XXX . . . . . . . XXX . . . . . . . .
 0.5972     . . . . . . . . . . . XXXXX . . . . . . . XXX . . . . . . . .
 0.5444     . . . . . . . . . . XXXXXXX . . . . . . . XXX . . . . . . . .
 0.4770     . . . . . . . . . . XXXXXXX . . . . . . . XXX XXX . . . . . .
 0.4577     . . . . . . . . . . XXXXXXXXX . . . . . . XXX XXX . . . . . .
 0.4564     . . . . . . . . . XXXXXXXXXXX . . . . . . XXX XXX . . . . . .
 0.4445     . . . . . . . . . XXXXXXXXXXX . . . . . . XXX XXX . . XXX . .
 0.4347     . . . . XXX . . . XXXXXXXXXXX . . . . . . XXX XXX . . XXX . .
 0.4305     . . XXX XXX . . . XXXXXXXXXXX . . . . . . XXX XXX . . XXX . .
 0.4160     . . XXX XXX . . . XXXXXXXXXXXXX . . . . . XXX XXX . . XXX . .
 0.4086     . . XXX XXX . . . XXXXXXXXXXXXX . . . . . XXXXXXX . . XXX . .
 0.4061     . . XXX XXX . . . XXXXXXXXXXXXX . . . . XXXXXXXXX . . XXX . .
 0.4025     . . XXX XXX . . . XXXXXXXXXXXXX . . . . XXXXXXXXX . XXXXX . .
 0.4024     . . XXX XXX . . . XXXXXXXXXXXXX . . . . XXXXXXXXX XXXXXXX . .
 0.3965     . . XXX XXX . . . XXXXXXXXXXXXX . . . . XXXXXXXXXXXXXXXXX . .
 0.3912     . . XXX XXX . . . XXXXXXXXXXXXX . . . XXXXXXXXXXXXXXXXXXX . .
 0.3783     . . XXX XXX . . XXXXXXXXXXXXXXX . . . XXXXXXXXXXXXXXXXXXX . .
 0.3741     . . XXXXXXX . . XXXXXXXXXXXXXXX . . . XXXXXXXXXXXXXXXXXXX . .
 0.3599     . . XXXXXXX . . XXXXXXXXXXXXXXX . . . XXXXXXXXXXXXXXXXXXXXX .
 0.3508     . . XXXXXXX . . XXXXXXXXXXXXXXX . . XXXXXXXXXXXXXXXXXXXXXXX .
 0.3413     . XXXXXXXXX . . XXXXXXXXXXXXXXX . . XXXXXXXXXXXXXXXXXXXXXXX .
 0.3293     . XXXXXXXXX . XXXXXXXXXXXXXXXXX . . XXXXXXXXXXXXXXXXXXXXXXX .
 0.3064     . XXXXXXXXXXX XXXXXXXXXXXXXXXXX . . XXXXXXXXXXXXXXXXXXXXXXX .
 0.3059     . XXXXXXXXXXX XXXXXXXXXXXXXXXXX . XXXXXXXXXXXXXXXXXXXXXXXXX .
 0.2859     . XXXXXXXXXXX XXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXX .
 0.2288     . XXXXXXXXXXX XXXXXXXXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 0.2211     . XXXXXXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 0.2038     . XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
-0.0081     XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

              └─── B2 ──┘ └──── B1 ─────┘   └──────── B3 ────────┘
```

Figure 8.12. Single link hierarchical clustering of correlation for CTU

In the discussion of positional structure for the GTC networks, attributes of actors were useful in providing interpretations and external validation for the identified position model. Therefore, it is also useful to illuminate the positions model identified for the networks in the CTU using actor attributes. Table 8.11, Table 8.12, Table 8.13, and Table 8.14 show relevant actor attributes.

An examination of the distribution of actors by work unit shows a clear pattern of association. Description of work units can be found in the section on Organisational Contexts in Chapter 8. The data suggests that trainers who belong to the same work unit in the CTU happen to behave similarly with regard to how they interact with one another. As shown in Table 8.11, seven out of nine actors in position B1 are from work unit A. The seven actors from unit A constitute the total number of actors in this unit. In other words, all actors in unit

A are structurally equivalent and belong to position B1. In position B2, all actors are from unit B and none from the other units. In position B3, 12 out of 13 actors are trainers from unit C, and these 12 actors represent 92 percent of all actors in this unit. Thus, it appears that trainers who are assigned to the same unit also demonstrate homogeneity in relation to other actors within their unit.

Table 8.11. Classes of structurally equivalent actors by work unit in the CTU

	Work Unit					
	A	B	C	D	E	Total
Position	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
B1	7 (100.00)	0 (0.00)	0 (0.00)	1 (33.33)	1 (100.00)	9 (29.03)
B2	0 (0.00)	6 (85.71)	0 (0.00)	0 (0.00)	0 (0.00)	6 (19.35)
B3	0 (0.00)	0 (0.00)	12 (92.31)	1 (33.33)	0 (0.00)	13 (41.94)
Residual	0 (0.00)	1 (14.29)	1 (7.69)	1 (33.33)	0 (0.00)	3 (9.68)
Total	7 (100.00)	7 (100.00)	13 (100.00)	3 (100.00)	1 (100.00)	31 (100.00)

Other attributes within each position show only little or no homogeneity. In Table 8.12, for instance, the distribution of actors by education across positions tends to be equal. Of the 20 trainers with undergraduate qualifications, 35 percent belong to position B1, 10 percent to B2, and 45 percent to position B3. Of the 10 trainers with Masters degrees 20 percent are in position B1, 30 percent in position B2, and 40 percent in position B3. The only trainer with a PhD degree is located in position B2.

Table 8.12. Classes of structurally equivalent actors by education in the CTU

	Educational Qualification			
	Undergraduate	Masters	PhD	Total
Position	n (%)	n (%)	n (%)	n (%)
B1	7 (35.00)	2 (20.00)	0 (0.00)	9 (29.03)
B2	2 (10.00)	3 (30.00)	1 (100.00)	6 (19.35)
B3	9 (45.00)	4 (40.00)	0 (0.00)	13 (41.94)
Residual	2 (10.00)	1 (10.00)	0 (0.00)	3 (9.68)
Total	20 (100.00)	10 (100.00)	1 (100.00)	31 (100.00)

As can be seen in Table 8.13, the distribution of actors by rank does not lean toward any particular position. The four junior trainers, for instance, are distributed almost equally across positions. The only observable pattern is that half of the 22 senior trainers are in position B3 and 60 percent of the five training experts are in position B1. However, a large proportion of trainers from other ranks also belong to these positions. For example, apart from the senior trainers in position B3, 25 percent and 20 percent of junior trainers and training experts respectively are also represented.

Table 8.13. Classes of structurally equivalent actors by rank in the CTU

	Rank			
Position	Junior n (%)	Senior n (%)	Training expert n (%)	Total n (%)
B1	1 (25.00)	5 (22.73)	3 (60.00)	9 (29.03)
B2	1 (25.00)	4 (18.18)	1 (20.00)	6 (19.35)
B3	1 (25.00)	11 (50.00)	1 (20.00)	13 (41.94)
Residual	1 (25.00)	2 (9.09)	0 (0.00)	3 (9.68)
Total	4 (100.00)	22 (100.00)	5 (100.00)	31 (100.00)

Table 8.14 also indicates that actors in each of the positions are not homogeneous in terms of their attributes. Rather, they are distributed almost equally to each position. For example, the average age of trainers in all positions is about 40 years old. The other attributes demonstrate the same trend.

Table 8.14. Mean attributes of structurally equivalent actors in the CTU

Personal Attributes	B1 Mean (Std Dev)	B2 Mean (Std Dev)	B3 Mean (Std Dev)
Age	39.67 (4.27)	40.17 (4.31)	40.25 (2.05)
Tenure	9.33 (5.02)	13.83 (9.17)	15.50 (5.11)
N. of subjects taught	5.44 (2.51)	7.17 (2.64)	5.75 (2.73)
N. of training attended	5.11 (3.02)	9.00 (6.45)	4.50 (3.61)
N. of seminar attended	2.00 (1.22)	6.50) (11.52	1.92 (1.68)
N. of organisations Joined	2.00 (1.50)	3.67 (2.50)	5.58 (7.98)

Note: values in parentheses are standard deviations

The position model in the CTU, thus, seems to align primarily with work units. As actors are positioned into structurally equivalent sets on the basis of their learning and knowledge sharing relations, it is also likely that general knowledge that could be beneficial to trainers in other units is confined within the disparate positions, hence within the different work units. The highly specialised areas of expertise of trainers within each unit might affect the absence of ties between positions.

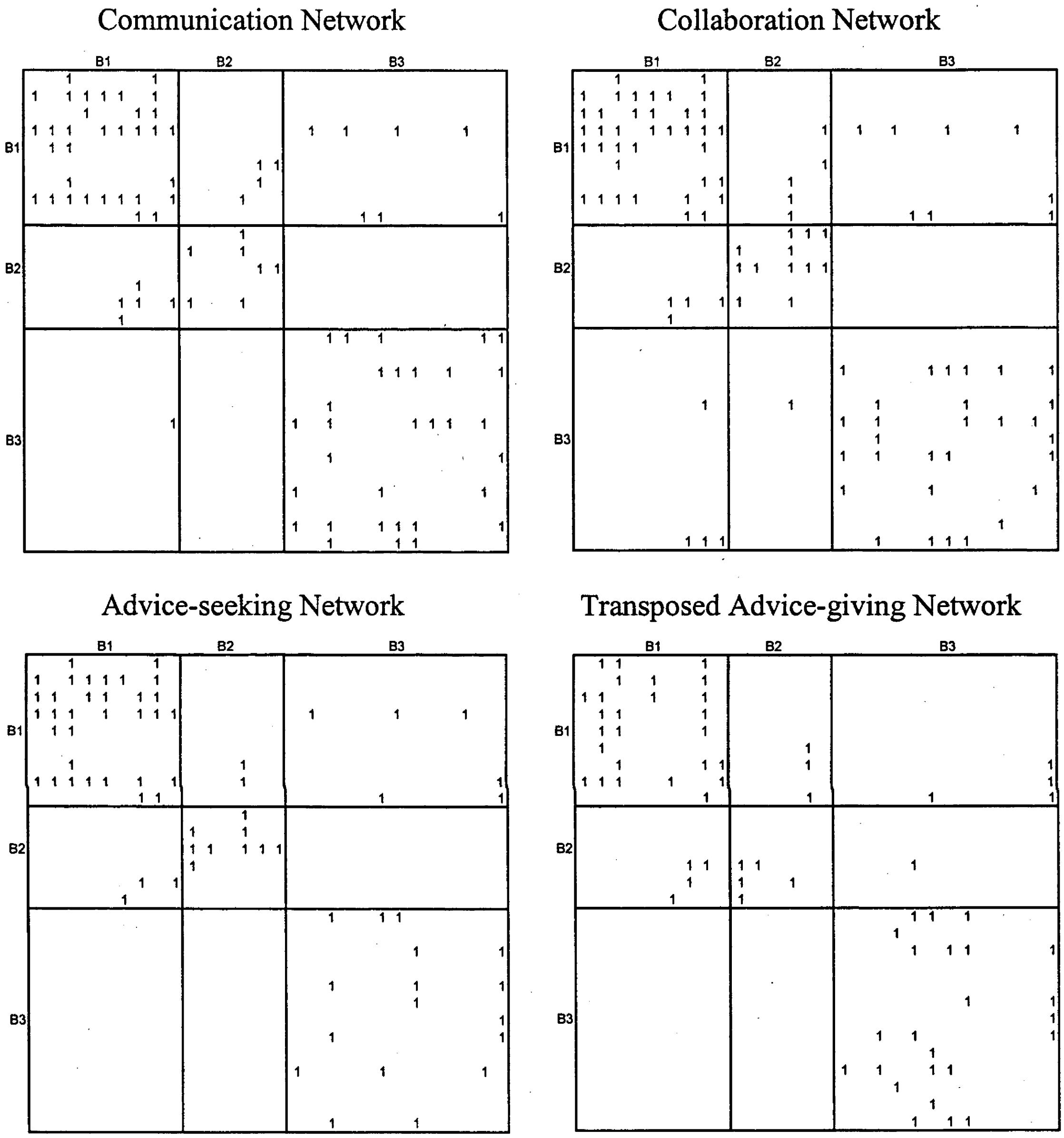


Figure 8.13. Blocked adjacency matrices for CTU (structural equivalence)

Using the block transformation procedure in the UCINET 6 (Borgatti *et al.*, 2002), the original adjacency matrix for each relation was permuted based on the 3-position model identified by the structural equivalence analysis. The blocked adjacency matrix for each relation is shown in Figure 8.13.

It is immediately apparent, even from a visual inspection, that the ties concentrate on the diagonals, suggesting that there is a high level of within position interaction. This is confirmed by the density table in Figure 8.14.

Communication Relation
Overall density: 0.113

	B1	B2	B3
B1	0.458	0.074	0.060
B2	0.093	0.233	0.000
B3	0.009	0.000	0.199

Collaboration Relation
Overall density: 0.131

	B1	B2	B3
B1	0.528	0.093	0.068
B2	0.074	0.400	0.000
B3	0.034	0.013	0.186

Advice-seeking Relation
Overall density: 0.089

	B1	B2	B3
B1	0.458	0.037	0.051
B2	0.056	0.300	0.000
B3	0.000	0.000	0.109

Transposed Advice-giving Relation
Overall density: 0.084

	B1	B2	B3
B1	0.361	0.074	0.000
B2	0.056	0.167	0.000
B3	0.034	0.013	0.154

Figure 8.14. The density tables for the four relations involving CTU trainers

The cell entries in the density tables indicate the proportion of potential ties from the row positions to the column positions that are actually present. The overall density index shown above each density table refers to the density of the corresponding adjacency matrix. As can be seen, the blocks are generally sparse. Some true zeroblocks are observed but there is no instance of true oneblock. The values in the diagonal cells are distinctly larger than those in other cells, indicating a concentration of internal interaction within the three positions. More specifically, the density of ties within each position for all relations is highest in position B1, followed in descending order by position B2 and position B3.

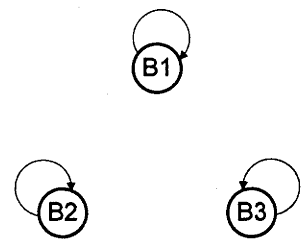
The high level of interaction within positions and the absence of ties between positions suggest strong overlap between positions and work units. It is important to note, however, that the work unit is only a surrogate for a more substantive attribute, that is, area of expertise. In other words, the position model seems to capture knowledge niche, that is, the units' areas of service delivery or trainers' areas of expertise. Trainers in this institution are divided into different units on the basis of their disciplines or areas of expertise. This appears rational for a company that operates in a competitive environment. That is, a synchronisation of employees' expertise with the objectives and service delivery specialisation of the organisation or work units is very important for their survival. The highly specialised areas of work in which the trainers in different positions are engaged may also explain the absence of inter-positional ties.

The matrices and the reduced graphs in Figure 8.15 simplify the structure of the positions, highlighting the kind of interaction that exists within or between the positions. The values in the density tables were converted into oneblock and zeroblock using α criterion, a value of which is equal to the overall density of each relation shown above each density table. The value of a cell in the image matrix for a relation is "1" if the value of the corresponding cell in the density table is greater than or equals the α criterion for that relation and "0" otherwise.

The image matrices and the reduced graphs show identical structures of positions across the four relations. For each matrix, all diagonal entries are filled with "1" and all the other entries with "0". This translates into an imploded relationship structure in the corresponding reduced graphs, in which each position has a reflexive tie. No other tie is observed. The absence of inter-positional ties does not mean there are no important findings to be made regarding the observed positional structure. According to de Nooy *et al.* (2005), external and internal relations are equally important in the concept of equivalence.

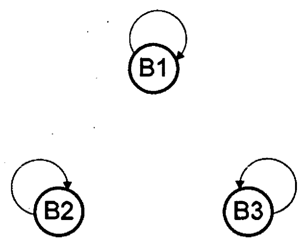
Communication Relation

	B1	B2	B3
B1	1	0	0
B2	0	1	0
B3	0	0	1



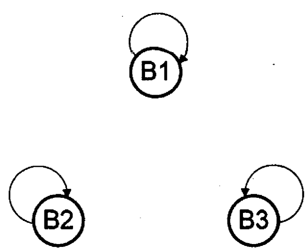
Collaboration Relation

	B1	B2	B3
B1	1	0	0
B2	0	1	0
B3	0	0	1



Advice-seeking Relation

	B1	B2	B3
B1	1	0	0
B2	0	1	0
B3	0	0	1



Transposed Advice-giving Relation

	B1	B2	B3
B1	1	0	0
B2	0	1	0
B3	0	0	1

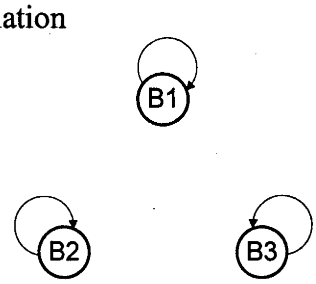


Figure 8.15. The image matrices and reduced graphs for the CTU networks

Such a structure is widely known as a "cohesive subgroup", or in White *et al.* (1976) as a reflexive clique. According to Wasserman and Faust (1994), such an image could represent an endogamous system (all ties exist within subsets) or homophily (all choices are between actors with similar characteristics). In the context of knowledge sharing, each of the identified positions could represent a knowledge cluster. It is, therefore, beneficial to see if there are plausible explanations for this observed positional structure.

Communication Relation

	B1	B2	B3	Residual	Total
B1	70	9	15	6	100
B2	42	58	0	0	100
B3	3	0	86	11	100
Residual	0	10	80	10	100
Total	37	11	44	8	100

Collaboration Relation

	B1	B2	B3	Residual	Total
B1	70	9	15	6	100
B2	25	75	0	0	100
B3	10	3	74	13	100
Residual	0	15	77	8	100
Total	38	16	39	7	100

Advice-seeking Relation

	B1	B2	B3	Residual	Total
B1	77	5	14	5	100
B2	25	75	0	0	100
B3	0	0	80	20	100
Residual	0	14	71	14	100
Total	44	15	33	9	100

Advice-giving Relation

	B1	B2	B3	Residual	Total
B1	87	13	0	0	100
B2	38	63	0	0	100
B3	12	3	73	12	100
Residual	0	0	100	0	100
Total	42	13	40	5	100

Figure 8.16. Patterns of relations within and between positions in the CTU

Based on Burt's (1976) typology (discussed earlier), every position constitutes a "Primary Position", which is consistent with the homogeneity of the position structure across all relations as shown in the image matrices and reduced graphs in Figure 8.15. As can be seen in Figure 8.16, all positions receive non-negligible nominations (ranging from 11 to 44 percent) from the system as indicated by the column totals. Therefore, none of the positions is an isolate or a sycophant. Even position B2, which received the fewest number of nominations from the system, cannot be regarded an isolate or a sycophant. All diagonal entries have exceptionally high values (ranging from 58 percent to 87 percent), suggesting that actors who are structurally equivalent (belonging to the same position) display more interest in one another than in the members of the other positions.

Regular Equivalence Based Positions in the CTU Networks

Similar to the data for the GTC, it appears that the CATREGE algorithm did not produce meaningful clusters of regularly equivalent actors. As can be seen in Figure 8.17, CATREGE produced trivial blocking, where all actors were put in one block. Without other blocks to which the existing block can be related, no meaningful structure of positions can be defined.

[redacted]

```
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Number of unique bundles of relationships: 111

HIERARCHICAL CLUSTERING

                            1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
        1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1

                            1 1 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 2 2 3 3
Level   1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1
-----   - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
    2   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
    1   XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
```

Figure 8.17. Hierarchical clustering for CTU networks (CATREGE algorithm)

The REGE algorithm produced more interesting partitions. The similarity matrix produced by the REGE algorithm for the CTU networks can be found in Appendix 6. As can be seen in Figure 8.18, the trainers are divided into several equivalent classes at different levels of similarity. The similarity level of 56.913

(solid horizontal line in the hierarchical cluster in Figure 8.18) provides an ideal cut off, at which trainers are divided into three approximately regularly equivalent classes or positions. Using similarity levels higher than this tends to result in partitioning trainers into many small clusters, each containing only a pair of actors. It also causes an excessive loss of cases. In contrast, choosing a lower level of similarity tends to merge all the actors into fewer clusters, containing actors who have lesser degrees of similarity.

```
            [redacted]    1 2 1 1   1 1 1 2 2   2 2 2 2 1 3     1 2     3
          9 7 8 0 5 7 8 0 9 1 2 6 4 5 9 3 8 4 1 2 7 4 6 0 2 3 3 6 5 1 1

            1 1 2 2     1 2 1 1   1 1 1 2 2   2 2 2 2 1 3     1 2     3
 Level    9 7 8 0 5 7 8 0 9 1 2 6 4 5 9 3 8 4 1 2 7 4 6 0 2 3 3 6 5 1 1
------    - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - -
98.446    . . . . . . . . . . . . . . . . . . . . . . . . . . . . XXX .
97.229    . . . . . . . . . . . . . . . . . . . . . . . . XXX . . XXX .
97.076    . . . . . . . . . . . . . . . . . . . . . . . . XXX . . XXXXX
96.121    . . . . . . . . . . . . . . . . . . . . . . . . XXX XXX XXXXX
95.876    . . . . . . . . . . . . . . . . . . . . . . . . XXXXXXX XXXXX
95.516    . . . . . . . . . . . . . . . . . . . . . . XXX XXXXXXX XXXXX
95.140    . . . . . . . . . . . . . . . . . . . . . . XXX XXXXXXXXXXXXX
95.109    . . . . . . . . . . . . . . . . . . . . . XXXXX XXXXXXXXXXXXX
94.894    . . . . . . . . . . . . . . . . . . . . . XXXXXXXXXXXXXXXXXXX
94.462    . . . . . . . . . . . . . . . . . . . . XXXXXXXXXXXXXXXXXXXXX
92.308    . . XXX . . . . . . . . . . . . . . . . XXXXXXXXXXXXXXXXXXXXX
88.976    . . XXX . . . . . . . . . . . . . . . XXXXXXXXXXXXXXXXXXXXXXX
86.933    . . XXX . . . . . . . . . . . . . . XXXXXXXXXXXXXXXXXXXXXXXXX
86.316    . . XXX . . . . . . . . . . . . . XXXXXXXXXXXXXXXXXXXXXXXXXXX
82.829    . . XXX . . . . . . . . . . . . XXXXXXXXXXXXXXXXXXXXXXXXXXXXX
79.112    . . XXX . . . . . . . . . . . XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
77.869    . . XXX . . . . . . . . . XXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
77.747    . . XXX . . . . . . . XXX XXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
75.862    . . XXX . . . . . XXX XXX XXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
75.761    . . XXX . . . . . XXX XXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
71.000    . . XXXXX . . . . XXX XXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
70.188    . . XXXXX . . . . XXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
68.026    . . XXXXX XXX . . XXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
66.760    . . XXXXX XXX . . XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
63.725    . . XXXXX XXX . XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
57.485    . . XXXXX XXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
56.913    . XXXXXXX XXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
44.767    . XXXXXXX XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
36.631    . XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
 7.855    XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
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Figure 8.18. Hierarchical clustering for CTU networks (REGE algorithm)

At this level, three clusters can be identified: D1 {17, 18, 20, 25}, D2 {7, 8, 10} and D3 {1, 2, 3, 4, 5, 6, 11, 12, 13, 14, 15, 16, 19, 21, 22, 23, 24, 26, 27, 28, 29, 30, 31}. Actor 9 joins all the others actors as a single cluster at the lowest level of similarity, and therefore cannot be included in any of these positions.

Having adopted a position model, it is useful to evaluate whether these positions coincide with some characteristics of the CTU trainers. In this case, the positions were compared with actors' attributes to see if these attributes are homogeneous within each of the positions.

As can be seen in Table 8.15, trainers in position D1 and D2 seem to be homogeneous in terms of work unit. Position D1 is occupied by trainers from department C, and position D2 by trainers from department B. Position D3, however, contains a mixture of trainers from different departments. It contains all the seven trainers from Department A, all three trainers from department D and the only trainer from department E, together with more than half of the trainers from department C. Thus, this position model does not have a clear association with the trainers' work unit, as is the case for structural equivalence based positions.

Table 8.15. Classes of regularly equivalent actors by work unit in the CTU

	Work Unit					
	A	B	C	D	E	Tot
Position	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
D1	0 (0.00)	0 (0.00)	4 (30.77)	0 (0.00)	0 (0.00)	4 (12.90)
D2	0 (0.00)	3 (42.86)	0 (0.00)	0 (0.00)	0 (0.00)	3 (9.68)
D3	7 (100.00)	3 (42.86)	9 (69.23)	3 (100.00)	1 (100.00)	23 (74.19)
Residual	0 (0.00)	1 (14.29)	0 (0.00)	0 (0.00)	0 (0.00)	1 (3.23
Total	7 (100.00)	7 (100.00)	13 (100.00)	3 (100.00)	1 (100.00)	31 (100.00)

In terms of educational level, trainers with different levels of education are mixed within each cluster. As shown in Table 8.16, in position D1, trainers with undergraduate and Masters degrees are both represented. Although in position D1 there are three trainers with undergraduate degrees compared to only one trainer with Masters degree, by proportional basis the difference is small. In position D2, there are only three actors, each with a different level of educational attainment. In position D3, trainers with undergraduate and Masters degrees are represented almost equally on proportional basis. Thus, trainers' level of education is not homogeneous within each position.

Table 8.16. Classes of regularly equivalent actors by education in the CTU

	Educational Qualification			
Position	Undergraduate n (%)	Masters n (%)	PhD n (%)	Tot n (%)
D1	3 (15.00)	1 (10.00)	0 (0.00)	4 (12.90)
D2	1 (5.00)	1 (10.00)	1 (100.00)	3 (9.68)
D3	15 (75.00)	8 (80.00)	0 (0.00)	23 (74.19)
Residual	1 (5.00)	0 (0.00)	0 (0.00)	1 (3.23)
Total	20 (100.00)	10 (100.00)	1 (100.00)	31 (100.00)

Grade or rank does not provide meaningful information either. As can be seen in Table 8.17, ranks of trainers are not homogeneous within each position. For example, although there is a high proportion of senior trainers in position D3, junior trainers and training experts are also present. In fact, all of the training experts and 25 percent of the junior trainers belong to this position. Positions D1 and D2 are also shared by junior and senior trainers.

Table 8.17. Classes of regularly equivalent actors by rank in the CTU

	Rank			
Position	Junior n (%)	Senior n (%)	Training expert n (%)	Total n (%)
D1	1 (25.00)	3 (13.64)	0 (0.00)	4 (12.90)
D2	1 (25.00)	2 (9.09)	0 (0.00)	3 (9.68)
D3	1 (25.00)	17 (77.27)	5 (100.00)	23 (74.19)
Residual	1 (25.00)	0 (0.00)	0 (0.00)	1 (3.23)
Total	4 (100.00)	22 (100.00)	5 (100.00)	31 (100.00)

The mean values of some quantitative attributes of trainers in Table 8.18 are not very different across the three relations. The only marked difference is in the number of training sessions and seminars that trainers within each position attended. Trainers in position D2 attended 12 training programs on average, compared to only two for those in position D1 and only about five for those in position D3. In terms of seminars attendance, trainers in position D2 attended 11 seminars on average compared to only about two for trainers in position D1 and D3. This lack of differentiation of attributes across the positions suggests that these attributes are not adequate to explain the positional assignment.

Table 8.18. Mean attributes of regularly equivalent actors in the CTU

Attributes	D1 Mean (Std. Dev.)	D2 Mean (Std. Dev.)	D3 Mean (Std. Dev.)
Age	39.75 (0.50)	42.00 (6.00)	40.04 (3.11)
Tenure	12.50 (6.86)	12.33 (7.02)	13.91 (7.59)
N of Org joined	2.67 (1.53)	3.67 (3.79)	2.83 (2.01)
N of subjects	5.33 (1.53)	5.33 (0.58)	5.96 (2.87)
N of Training	2.00 (1.73)	12.33 (7.51)	5.35 (3.35)
N of Seminar	1.67 (1.53)	11.33 (16.17)	2.39 (2.48)

Thus, similar to the position model based on the regular equivalence for the GTC trainers, the results for the CTU trainers indicate that regularly equivalent positions are not associated with the various individual attributes of their incumbents which are considered.

Despite having no association with the attributes of actors, it is worth examining the interaction between these positions. The blocked adjacency matrix for each relation on which the interactions can be analysed is given in Figure 8.19.

From the blocked adjacency matrices, it is evident that no regular block indicating ties between positions can be identified. The majority of ties exist within position D3, which is the largest in terms of membership. Therefore, it is useful to examine whether a meaningful positional structure emerges if the positions are defined at a higher level of regular equivalence. This is despite the consequence of losing some actors whose similarity with the others is low.

A higher level of similarity at which a reasonable number of clusters can be identified is 75.862, which is indicated by a dashed horizontal line across the hierarchical clustering diagram in Figure 8.18. At this level, five clusters are identified, including D1 {18, 20}, D2 {11, 12}, D3 {6, 14}, D4 {15, 19} and D5 {1, 2, 3, 4, 5, 13, 16, 21, 22, 23, 24, 26, 27, 28, 30, 31}. Seven trainers have similarity below the cut off point and therefore cannot be included in the analysis. These trainers are 9, 17, 25, 7, 8, 10 and 29.

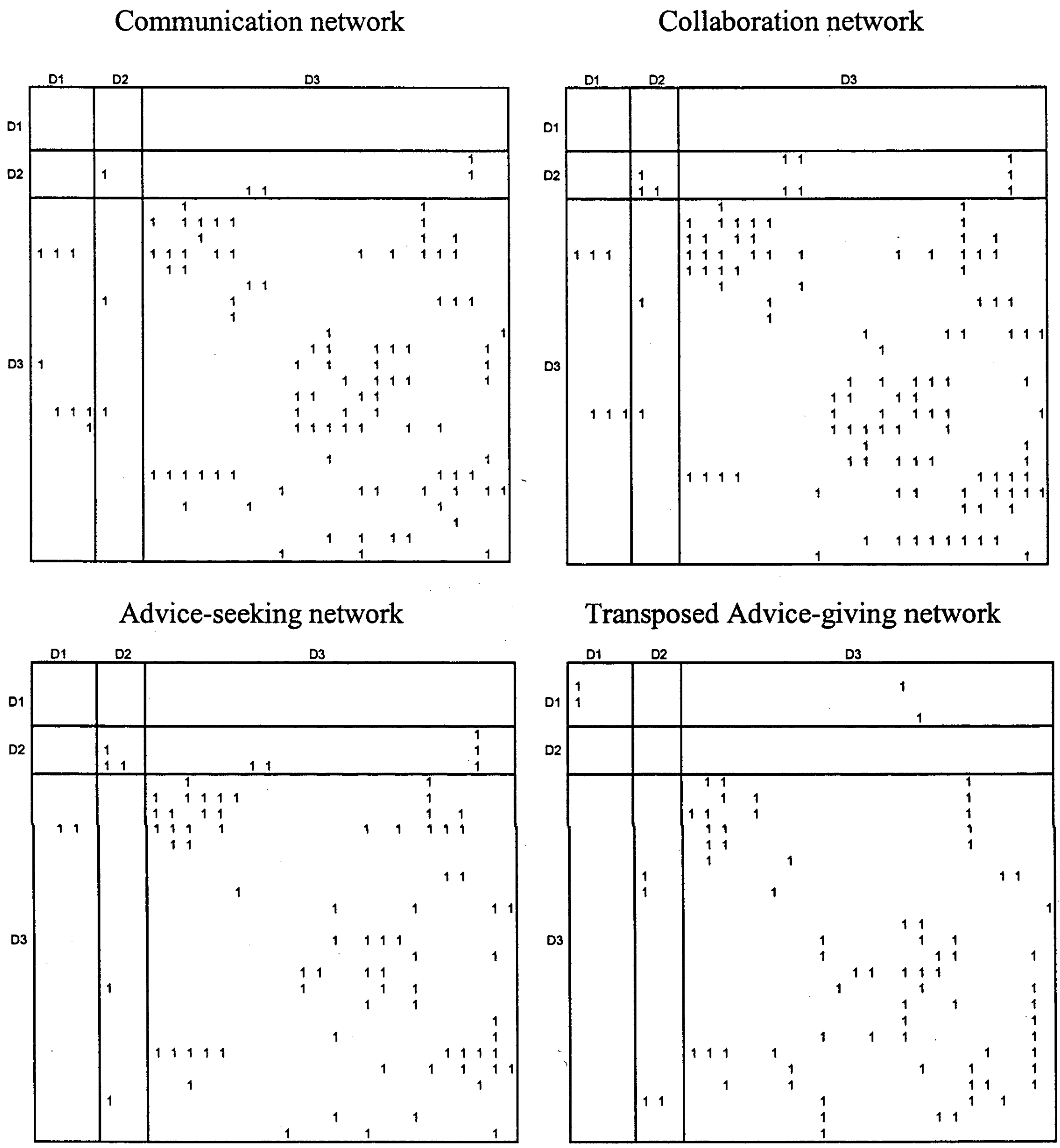

Figure 8.19. Blocked adjacency matrices for CTU (regular equivalence: 56.913)

At this level of refinement, some positions contain actors from the same work units. For example, it can be seen in Table 8.19 that positions D1 and D4 are occupied by trainers from department C, and position D2 by trainers from department B. However, positions D3 and D5 are shared by trainers from different departments.

Table 8.19. Higher level of regularly equivalent actors by work unit in the CTU

	Work Unit					
Position	A	B	C	D	E	Total
D1	0 (0.00)	0 (0.00)	2 (15.38)	0 (0.00)	0 (0.00)	2 (6.45)
D2	0 (0.00)	2 (28.57)	0 (0.00)	0 (0.00)	0 (0.00)	2 (6.45)
D3	1 (14.29)	0 (0.00)	1 (7.69)	0 (0.00)	0 (0.00)	2 (6.45)
D4	0 (0.00)	0 (0.00)	2 (15.38)	0 (0.00)	0 (0.00)	2 (6.45)
D5	6 (85.71)	0 (0.00)	6 (46.15)	3 (100.00)	1 (100.00)	16 (51.61)
Residual	0 (0.00)	5 (71.43)	2 (15.38)	0 (0.00)	0 (0.00)	7 (22.58)
Total	7 (100.00)	7 (100.00)	13 (100.00)	3 (100.00)	1 (100.00)	31 (100.00)

In terms of educational level, as shown in Table 8.20, only positions D1 and D4 are homogeneous, containing only trainers with undergraduate qualifications. The other positions contain trainers with different levels of educational qualifications.

Table 8.20. Higher level of regularly equivalent actors by education in the CTU

	Educational Qualification			
	Undergraduate	Masters	PhD	Total
Position	n (%)	n (%)	n (%)	n (%)
D1	2 (10.00)	0 (0.00)	0 (0.00)	2 (6.45)
D2	1 (5.00)	1 (10.00)	0 (0.00)	2 (6.45)
D3	1 (5.00)	1 (10.00)	0 (0.00)	2 (6.45)
D4	2 (10.00)	0 (0.00)	0 (0.00)	2 (6.45)
D5	11 (55.00)	5 (50.00)	0 (0.00)	16 (51.61)
Residual	3 (15.00)	3 (30.00)	1 (100.00)	7 (22.58)
Total	20 (100.00)	10 (100.00)	1 (100.00)	31 (100.00)

Table 8.21 shows the distribution of CTU trainers by rank into different positions. Positions D1, D2, D3 and D4 are all occupied by senior trainers. However, position D5 contains trainers with different ranks.

Table 8.21. Higher level of regularly equivalent actors by rank in the CTU

	Rank			
	Junior	Senior	Training	Total
Position	n (%)	n (%)	expert n (%)	n (%)
D1	0 (0.00)	2 (9.09)	0 (0.00)	2 (6.45)
D2	0 (0.00)	2 (9.09)	0 (0.00)	2 (6.45)
D3	0 (0.00)	2 (9.09)	0 (0.00)	2 (6.45)
D4	0 (0.00)	2 (9.09)	0 (0.00)	2 (6.45)
D5	1 (25.00)	11 (50.00)	4 (80.00)	16 (51.61)
Residual	3 (75.00)	3 (13.64)	1 (20.00)	7 (22.58)
Total	4 (100.00)	22 (100.00)	5 (100.00)	31 (100.00)

Thus, in terms of the categorical attributes, only positions D1 and D4 demonstrate consistency in that their occupants are all senior trainers from department C who have undergraduate qualifications. However, in terms of quantitative attributes shown in Table 8.22, trainers from these two positions are not very distinct from those in the other positions.

Table 8.22. Mean attributes of higher regularly equivalent actors in the CTU

Attributes	D1	D2	D3	D4	D5
Age	40.00	38.50	39.50	41	40.31
	(0.00)	(0.71)	(3.54)	(1.41)	(3.52)
Tenure	17.50	22.50	15.00	13	13.63
	(0.71)	(0.71)	(2.83)	(5.66)	(7.77)
N. of subjects taught	4.50	8.00	5.50	7.00	5.31
	(0.71)	(2.83)	(2.12)	(1.41)	(2.87)
N. of training attended	1.50	3.50	7.50	1.50	5.50
	(2.12)	(0.71)	(3.54)	(0.71)	(3.33)
N. of seminars attended	1.50	1.50	3.50	2.00	2.44
	(2.12)	(0.71)	(2.12)	(2.83)	(2.80)
N. of organisations joined	2.00	3.00	2.50	6.00	2.31
	(1.41)	(0.00)	(0.71)	(4.24)	(1.66)

Note: Values in parentheses are standard deviations

In general, some positions contain actors with homogeneous attributes. However, some others do not show regularity of membership in terms of actors' attributes. Therefore, despite being defined at higher level of regular equivalence, the position model cannot be justified in terms of the attributes of actors involved.

It is now useful to examine whether the position model adopted at this finer level of equivalence captures the inherent structure relating CTU trainers to one another. Figure 8.20 shows the blocked adjacency matrix for each relation in which the ties between positions can be observed.

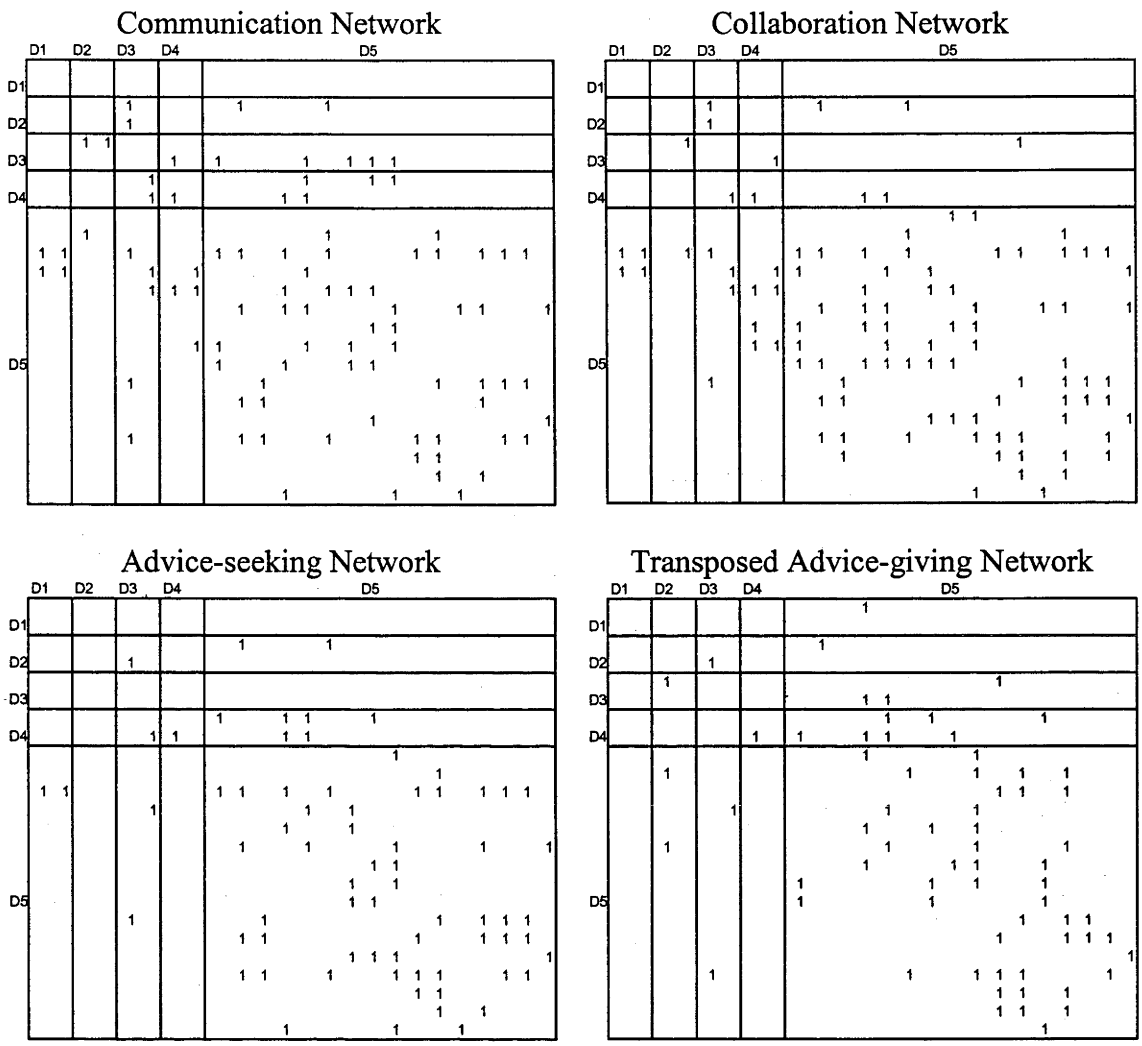

Figure 8.20. Blocked adjacency matrices for CTU (regular equivalence: 75.862)

In all matrices, the ties still tend to concentrate along the diagonal entries. This suggests that trainers within the same position have a tendency to interact with one another, instead of with trainers in other positions. A closer examination of each block indicates that a regular block, that is, a block which has at least a 1 in all of its rows and columns, does not exist. Thus, even at this higher level of regular equivalence there is no interaction between positions. It appears that the intuitive idea of position being defined by the interaction of its members with members of other positions is not observable in the patterns of CTU trainers' relations.

Characteristics of the Position Models

Two approaches in modelling the structure of positions in the GTC and CTU have been applied. The structural equivalence concept found positional models with meaningful interpretations for each organisation. Each model reflects the dominant organisational arrangements. The 4-position model adopted for the GTC aligns with trainers' formal ranks and grades. This is reasonable given the hierarchical nature of the way public service trainers are organised and managed. Seniority is highly emphasised (see, for example, Rohdewohld, 1995) and is very important in many respects. As MacAndrews (1986, p. 31) notes, "seniority and age play an important part in all relationships" in Indonesia bureaucracy. In relation to training careers, rank determines the kinds of training programs in which a trainer can teach, or the ones which they can attend. Seniority also determines career promotion, salary entitlements and bonuses. Virtually all other activities (see Appendix 5) are determined by rank. In the end, it affects how public servants behave and relate to one another. Therefore, it is reasonable to expect that the system of seniority permeates the trainers' learning and knowledge sharing patterns. The positional interactions form a core-periphery structure where middle rank trainers and junior trainers occupy the core and the senior trainers are at the periphery.

The 3-position model showing cohesive subgroups for the CTU trainers seems to capture the division of the trainers into different training units. That could also mean that the positions correspond to the trainers' activities or areas of specialisation.

The alignment of the proposed models with the actors' attributes, however, is not taken to mean that the former is caused by the latter. Rather, the attributes are used to validate the idea that the position models are not random structures but have some concrete sociological significance. In general, the structural equivalence model appears to produce quite interpretable results in characterising the relational structure that entails learning and knowledge exchanges.

The regular equivalent based blockmodel, however, does not appear to identify a meaningful position model. Despite defining block models at different levels of similarity, the results consistently show position assignments which are inconsistent with the intuitive notion of position that the regular equivalence is intended to capture. In this case, the identified position models do not demonstrate inter-position interactions. That is, a position is defined by its relations with other positions. Neither can these models be interpreted using some relevant actor attributes.

This is surprising given that regular equivalence is more flexible. Some authors argue that regular equivalence is more often found in a given network (Ferligoj, Doreian *et al.*, n.d.). The strength of structural equivalence in detecting positional structures in the data examined could be related to the nature of learning and knowledge exchange processes, which are affected not only by structural conditions but also by non structural factors such as proximity. As Borgatti and Everett (1992) argue, structural equivalence is more appropriate when the relations measured resemble infectious types of mechanisms. This is related to the principle behind structural equivalence in which structural factors are confounded with non-structural factors such as proximity.

As this study is concerned with knowledge sharing and learning within networks of informal social relations, both structural and non-structural factors are important to consider. Effective exchange and sharing of learning resources rely very much on structural similarity, that is, on how actors are connected to one another as well as on person-to-person transmissions, that is, with whom actors are connected and how close these connections are. For example, two trainers who occupy the same position according to the regular equivalence definition may never interact with each other because they are located at different units or office locations within an organisation. Theoretically, the two trainers cannot learn from or exchange knowledge with one another. Even if they could reach each other through intermediaries or indirect links, the effectiveness of this would not be as high as when they are directly or closely connected. Thus, in the process of learning, people are in essence infected by the ideas, beliefs or the actions of other people with whom they are in contact.

The kinds of knowledge involved in informal learning and knowledge sharing also require proximity for effective transmission. The training profession is rich in tacit knowledge. In practicing their professional activities, much of the knowledge that the trainers use is implicit. Such knowledge is difficult to exchange and it tends to stay within individuals because it is complex, personal, actionable and not easily explicated. It is a condensed type of knowledge that has been developed overtime through practices, as well as trial and error, and synthesis. The exchange of such complex knowledge requires proximity and cohesion. At an organisational level of knowledge transfer, Hansen (1999) found that complex knowledge requires strong ties to transfer across departmental boundaries. Proximity, which is built into the assumption of structural equivalence, may be regarded as an indication of tie strength. Thus, proximity and cohesion, which are embodied in structural equivalence, are important elements in learning process.

Therefore, the intuitive idea of position encapsulated in the concept of structural equivalence appears stronger than regular equivalence for capturing the positional structure inherent in the way trainers exchange knowledge and learn from one another.

It is important to note that there are two groups of GTC trainers who are consistently identified as separate positions at any level of similarity, based on structural equivalence as well as on regular equivalence. These actors belong to positions P3 and P4 in the structural equivalence analysis. Trainers in position P3 are identified as a separate cluster due to their similarity as isolates. Under the structural equivalence definition isolates are regarded as similar, that is, vacuously similar. Those in position P4 are grouped together because they are in a separate part disconnected from of the main region of the GTC network. Under regular equivalence analysis, trainers in each of these two groups remain together.

It is also necessary to recognise that four of five trainers in position P3 in the GTC were not interviewed; thus, they did not make nominations. One could argue that here being isolates is affected by the data collection procedure. Although that might be the case, it could also be argued that these trainers do have a tendency to be true isolates, as they could have received nominations from their colleagues but in fact were not nominated by any other trainers. For example, actor 35, a member of position P3, was interviewed, but did not nominate any internal actors, nor was he nominated by any of the internal actors. Instead, this actor named many external associates. As a comparison, three trainers in the CTU were not interviewed, but were not identified as isolates because they received nominations from some of their colleagues. Thus, the four trainers in position P3 seem to demonstrate similar behaviour and seem to be true isolates. Hence, their positional assignment, to some extent, reflects their actual relational characteristics.

It is important to consider this group as its members are homogeneous in terms of sociologically meaningful attributes, such as being in the highest ranks, being oldest, and having high level of educational attainment. Recognising their importance, it was decided to include them in the analysis, despite the fact that they could not be interviewed.

In conclusion, a blockmodel approach was useful in examining the positional structure inherent in the trainers' networks of learning and knowledge sharing relations. Structural equivalence based blockmodels produced the most interesting results. It assigned the GTC trainers into positions along their rank lines, forming 'core-periphery' configurations. The CTU trainers were allocated along their work units or areas of specialisation, forming 'cohesive subgroups' structures. These divisions are meaningful as they reflect the dominant factors, through which trainers in each institution are normally organised.

Because it is less stringent in its definition of equivalence, regular equivalence was also expected to produce meaningful position models. However, it did not identify meaningful structures that could be validated by available actor attribute data. Moreover, the identified positions did not reflect any structural features which were consistent with the underlying notion of position embodied in the definition of regular equivalence. This seems to reflect the nature of the social relations examined. The flow of knowledge and other learning resources embedded in the networks is highly influenced by not only structural factors but also proximity. Structural equivalence is not purely structural, therefore able to capture the element of proximity from the trainers' relational systems. Regular equivalence, in contrast, is a purely structural concept and does not take into account proximity.

Nevertheless, it should be recognised that this study is only based on two groups of trainers. More studies are required before it can be concluded that structural equivalence is more appropriate for analysing positions in knowledge exchange networks. In addition, more studies are required before it can be concluded that the structures identified in this study reflect the features of learning relations beyond the two cases to members of other types of educational institutions, for example, school teachers, university professors or adult educators.

The identified positional structures contribute to a better understanding of the positions and the dynamics within and between the positions. This could contribute to designing better strategies for supporting the process of knowledge exchange and informal learning. For example, bridge-building to connect the core and the peripheral positions in the GTC and the disparate cohesive subgroups in the CTU may be required in order to foster cross fertilisation of ideas, and to improve the opportunity for the trainers to learn from one another.

CHAPTER NINE. THE COMPARATIVE ANALYSIS OF THE NETWORKS IN THE GTC AND THE CTU

In the previous chapters, various aspects of the networks in the Government Training Centre (GTC) and in the Company Training Unit (CTU) have been examined. The networks in the two markedly different organisations have some characteristics in common and also some features unique to each organisation.

This chapter is specifically aimed at comparing and contrasting, across the board, the various facets of the two groups of trainers. The chapter contains two main discussions. The first one deals with the learning features of the two groups of trainers, and the role that the social networks play in their learning process. In the second discussion the network features in the two organisations are compared and contrasted, covering the basic features of the networks as well as the more fundamental substructures of the networks based on cohesive and positional analysis.

The Nature of Informal Learning and Social Networks

Although the two groups of trainers work and learn in different environments, qualitative evidence obtained from in-depth interviews suggests that there is little difference between the two groups of trainers in their perceptions of social networks and their facilitative role in learning. In general, the social networks and informal learning are only tacitly recognised by the study participants. Their awareness is generally limited to their immediate connections or, in social network terms, to their local neighbourhoods. The broader structure of direct and indirect ties making up the wider network is only vaguely visible to the trainers and to others involved. This confirms one of the speculations made earlier in Chapter Four.

Generally, the trainers build their networks without learning purposes in mind. Consequently, their appreciation of the role of social networks in learning is rather low. Indeed, some trainers openly indicate that they do not like to be involved in informal interaction with their colleagues because this often leads to disagreement and friction.

However, the extent to which the trainers benefit from informal learning is revealed when they are asked about what they need to learn in order to perform in their tasks well, and about what motivates them to engage in continuous learning. Generally, the trainers in both organisations indicate more or less similar learning motivations. These include the unstructured nature of their work, the constant change in their areas of specialisation, lack of previous experience in teaching and instruction, and the need to maintain a positive self-image. The difference between the two groups is that for the GTC trainers, in addition to the above learning drives, they are also involved in informal learning in order to stay competitive and to be prepared for frequent unscheduled teaching assignments.

Areas which require trainers to learn informally are those which are specific in nature, and which are not, or cannot be, practically covered in a formal training program, or recurrent problem areas where immediate solutions are often required. Broadly, these include establishing rapport with training participants, motivating participants, and conflict resolution. In addition to these, GTC trainers also feel that they need to learn self-promotion and about local strategic issues that can help them stay competitive.

As a matter of fact, some of these areas are normally included in the formal training programs. However, the trainers indicate that the training programs they attended are too theoretical and do not address many of the issues that they encounter in their real work. Therefore, they also learn these using self-access materials, such as books, newspapers, magazines, journals and the like. For the CTU trainers, they have access to virtually unlimited learning materials through the Internet. In addition, they learn how to deal with workplace issues though their exchanges with other people.

Although not every trainer is able to explicitly articulate the role of social networks in their informal learning, learning motivations and the areas that the trainers learn informally, as well as the way they carry out informal learning, strongly suggests that social networks play a facilitative role in their tacit knowledge acquisition.

Overall Network Characteristics

The level of network cohesiveness is reflected in several network measures, including the network *density*, *reachability*, *distance*, the extent to which the networks are fragmented into components, and the degree to which the networks are centralised around a few highly prominent actors.

The networks in the GTC are relatively larger than those in the CTU. The size of the networks is reflected by the cumulative number of actors who are nominated by the trainers. These include the targeted trainers (internal actors) from each organisation and others not targeted as participants but who are nominated by the targeted trainers (external actors). The method of determining who belongs in the networks was discussed in detail in Chapter 3. In the GTC, there are as many as 192 actors, of whom 44 (77%) are internal actors and the rest external actors (23%). In the CTU, there are only 135 actors; 31 (23%) of whom are internal actors and the remaining 104 (77%) external actors. This substantiates a supposition made in Chapter Four.

The main factor contributing to the greater number of people involved in the networks in the GTC is the larger population of targeted GTC trainers, who tend to nominate external rather than internal actors. As can be seen in Figure 9.1, GTC trainers have higher numbers of ties to external associates than to their own colleagues. This is further enhanced by the tendency of each trainer to have exclusive, rather than redundant, portfolios of external associates. Therefore, connections to these external actors expand the number of actors in the networks dramatically.

In both organisations, external actors appear to play important role, as indicated by the fact that a large proportion of external actors are nominated by each group of trainers. Apart from the ratio of external actors in the networks as a whole, their importance is also reflected in the actual number of ties connecting the trainers to their external associates. In both organisations, a large proportion of ties are directed to external actors. This is especially true for the GTC trainers where they collectively have more ties to their external associates than to their own colleagues. As clearly evident in Figure 9.1, of all the nominations made by GTC trainers in the different networks, the majority are directed towards external actors. Although CTU trainers direct slightly more ties to their own colleagues (especially in the communication, collaboration and advice-seeking networks), the proportion of ties that they have to their external associates is also quite large.

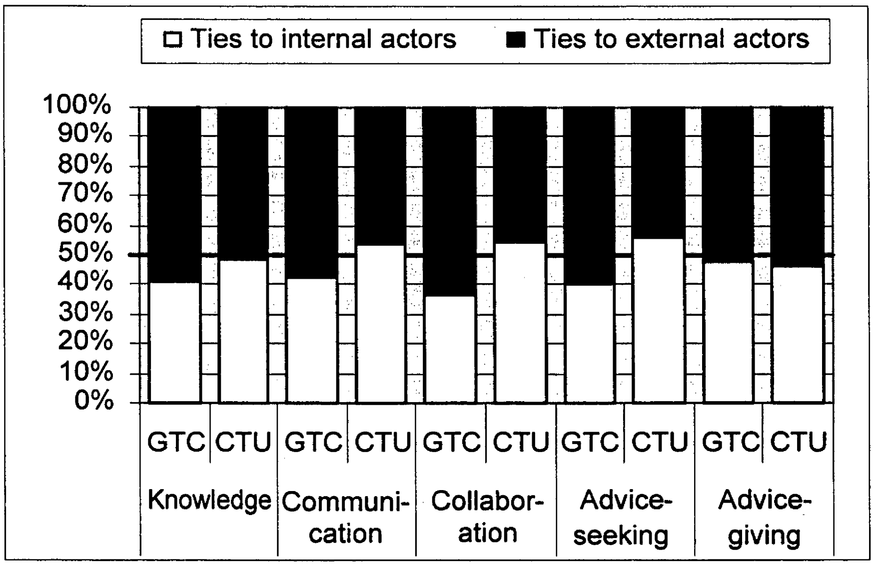

Figure 9.1. The proportions of ties to internal and to external associates

The importance of external actors is further evident from their proportion in the trainers' network neighbourhoods. On average, individual trainers in both organisations have more external than internal actors in their network neighbourhoods. The difference is particularly obvious in the GTC networks. As can be seen in Table 9.1, in general, the average number of external associates in the trainers' neighbourhood is greater than that of their internal associates. For the CTU trainers, however, there is a tendency for the individual trainers to associate slightly more intensively with their own colleagues, except in the knowledge and advice-giving networks.

However, despite both having extensive connections to external actors, the two groups of trainers differ in terms of the proportion of each external actor category with whom they associate. This seems to be influenced by the needs that arise from the nature of their activities and the service orientation of their organisations.

Table 9.1. Average number of external actors in network neighbourhoods

	GTC		CTU	
	Internal	External	Internal	External
Network	Avg (Std.Dev)	Avg (Std.Dev)	Avg (Std.Dev)	Avg (Std.Dev)
Knowledge	4.27 (3.56)	6.05 (3.40)	5.13 (3.31)	5.32 (3.34)
Communication	2.89 (2.94)	3.93 (3.27)	3.39 (3.13)	2.90 (2.33)
Collaboration	1.84 (2.21)	3.23 (3.76)	3.90 (3.43)	3.23 (2.89)
Advice-seeking	1.23 (1.58)	1.82 (2.63)	2.68 (2.68)	2.10 (2.23)
Advice-giving	1.11 (1.87)	1.23 (2.08)	2.52 (2.50)	2.94 (2.99)

In the GTC, trainers are connected, with more or less equal proportion, to organisationally external, professionally external, and both organisationally and professionally external actors. This is influenced by the fact that the GTC trainers need to interact with a wider variety of people to secure teaching assignments. In addition, the GTC trainers are also involved in a wider variety of activities besides teaching, such as research, planning, consulting and managing training programs. These various types of activities expose the trainers to a wider range of people with whom they might build learning relations. Another factor is related to the fact that the GTC trainers are relatively new compared to their counterparts in the CTU. Therefore, the relations with various people that they had established before becoming trainers can still continue to exist, although many of these old associates would now fall within the external actor category. Furthermore, the GTC trainers frequently exit and re-enter the training profession. This keeps them connected with many more and with a wider variety of external actors.

The CTU trainers, in contrast, interact with organisationally external actors (trainers from other organisations) less, accounting for only 4 percent of their relations. Rather, they are inclined to have contacts with people who are external to them organisationally and professionally (42%). These are primarily people who use their services, such as technicians and engineers within the CTU's parent company (professionally external), and employees in flight related businesses, including travel agencies, cargo and freight companies. Connections with their former, current and future customers provide valuable opportunities that help the CTU trainers learn how to improve their performance in line with the requirements of their clients. This reflects the more customer-oriented nature of CTU as a commercial organisation. This characteristic has been predicted in Chapter Four.

The networks in the CTU are generally more inclusive than were those in the GTC. As evident from Figure 9.2, except for the communication network, the other three networks are more inclusive in the CTU than in the GTC. The knowledge networks in both organisations have about the same level of inclusiveness, where about 98 percent of the actors are included in the network. The exceptionally high level of inclusiveness for the knowledge network reflects the fact that it combines the other four networks. Therefore, it is more useful to consider the difference between the other four uniplex networks.

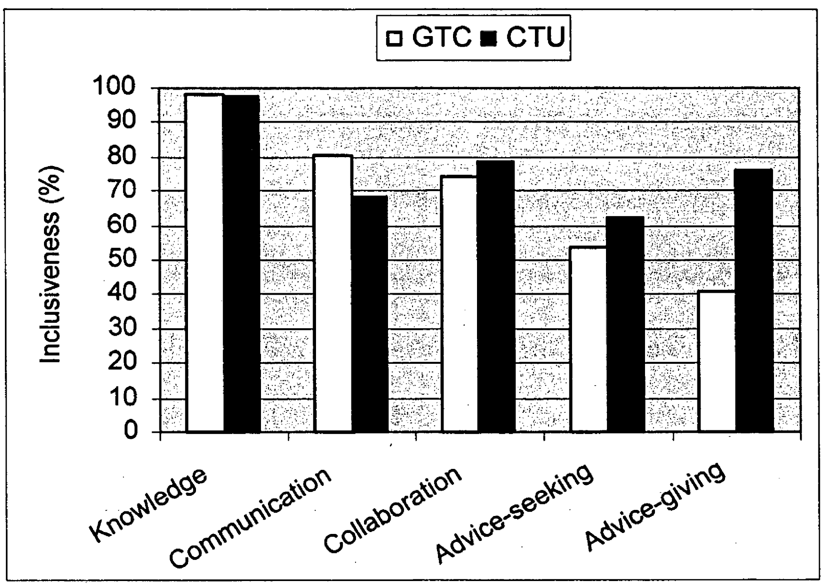

Figure 9.2. Inclusiveness of the networks in the GTC and the CTU

In the GTC, the inclusiveness of the communication and the collaboration networks stands out from that of the advice-seeking and advice-giving networks. For the CTU, the collaboration and the advice-giving networks appear to involve quite high proportions of actors. Difference in levels of inclusiveness of the networks in the two organisations reflects the relative importance of each network to each group of trainers.

For the GTC trainers, having a large number of teaching assignments is important because of their association with multiple benefits. Communication and collaboration are two types of relations which are instrumental in accessing teaching opportunities. Initial access to opportunity structures is often obtained from communication or collaboration partners. In addition, communication and collaboration relations are more naturally mutual, and therefore, do not necessarily incur costs or obligations to reciprocate. The advice-exchange relations, in contrast, involve exchanging learning resources the value of which the trainers are conscious of.

For CTU trainers, collaboration is a feature of their work, especially within units among trainers with similar areas of expertise. The high level of inclusiveness of their advice-giving network might be due to their less hierarchical rank system, rendering seniority less obvious or relevant. Therefore, the trainers are not reluctant to give advice even to their more senior colleagues. In addition, the emphasis on expertise rather than on seniority in the CTU may also contribute to trainers' confidence in providing advice in their area of expertise.

The networks in the CTU are slightly denser than those in the GTC, as can be seen in Table 9.2. The density of the networks in the CTU remains higher when measured in different ways, such as accounting for all actors and for internal actors only. The densities of the networks in the CTU are also higher in asymmetric and symmetric modes, as well as in raw and in adjusted density calculations (not shown in the table but can be found in Chapter 5). The relatively higher density of the networks in the CTU is also reflected in the average neighbourhood size of individual actors. On average, the CTU trainers have about ten personal associates, compared to nine for the GTC trainers. Despite the differences, the networks in both organisations are generally sparse.

Table 9.2. The density of the networks in the GTC and in the CTU

Networks	GTC		CTU	
	All actors	Internal actors only	All actors	Internal actors only
Knowledge	2.9	8.4	3.1	16.6
Communication	0.8	6.7	1.1	11.3
Collaboration	0.6	4.3	1.2	13.1
Advice-seeking	0.4	2.9	0.8	8.9
Advice-giving	0.3	2.6	0.9	9.4

Note: Density is expressed as percentage values, indicating the proportion of observed ties to possible number of ties

The sparse structures indicate that the networks in both organisations are not very effective spreaders of knowledge, because they lack the number of ties through which knowledge and other learning resources can disseminate. As the advice-seeking and the advice-giving networks are both very sparse, this suggests that practical advice which flows within such networks cannot spread widely within the systems. However, a sparse network structure can be efficient in spreading knowledge and learning resources as long it is has a high reachability; that is, it contains a high proportion of pairs of actors who can reach each other through paths of some length.

The extent to which a pair of actors in a network can reach each other is another characteristic which has implications for the level of cohesiveness of the network, hence the potential flow of information and other resources embedded in it. As anticipated in Chapter Four, Table 9.3, shows that the networks in the CTU, except for the knowledge network, are more reachable than those in the GTC in the sense that they contain larger proportions of reachable pairs of actors. This is true when considering all actors and internal actors only, as well as when ties are asymmetric and symmetrised. In fact, in symmetric mode, the knowledge network in the CTU is fully reachable when taking into account all actors and only internal actors. In addition, the communication network in the CTU is also fully reachable in symmetric mode and when only CTU trainers are considered. On the contrary, none of the networks in the GTC is fully traversable. This different degree of reachability suggests the likelihood that the learning resources will disseminate through the whole system is higher in the CTU than in the GTC.

Table 9.3. The reachability of the networks in the GTC and in the CTU

	GTC		CTU	
Networks	All actors	Internal actors only	All actors	Internal actors only
Knowledge asymmetric	31.2	49.6	21.0	79.2
Symmetric	77.7	59.7	100.0	100.0
Communication asymmetric	9.8	44.8	11.3	72.8
Symmetric	52.2	59.6	61.5	100.0
Collaboration asymmetric	4.2	20.6	12.7	73.2
Symmetric	40.3	46.6	43.3	93.5
Advice-seeking asymmetric	1.6	10.7	4.4	30.1
Symmetric	20.1	37.5	53.7	87.3
Advice-giving asymmetric	0.7	4.9	6.5	36.5
Symmetric	11.5	34.6	35.9	81.3

Note: The values indicate the percentages of all pairs of actors who can reach each other

Average distances among reachable actors in the GCT and CTU networks are not very different. In the CTU, the average distance in all of the networks considered is three steps. Similar average distances are found in the knowledge, collaboration and advice-seeking networks in the GTC. Average distances in the communication and advice-giving networks, however, appear to be slightly different in the two organisations. In the communication network in the GTC, the average distance is higher than that in the CTU (4 steps), while in advice-giving, it is lower in the GTC (2 steps).

For the GTC trainers' networks, the reachability seems to be affected by the geographical location of the trainers, as they are distributed to six different places. The level of competition also may contribute, especially to the low reachability among trainers who are not spatially separated. In the CTU, these characteristics are not found as they are all located in the same area.

The degree to which a network is fragmented into components can also affect the cohesiveness of the system and the capacity for information and learning resources to flow in it. In both organisations, the networks are fragmented into several strong components (tie direction considered) and weak components (tie direction not considered). When the strong components are examined, the majority are isolated single-actor components. The strong main components themselves are generally small. As can be seen in Table 9.4, none of the strong main components include half of the total number of actors. Overall, however, the main components of the networks in the CTU are more inclusive. Apart from the strong main component in knowledge network, all the others are more inclusive in the CTU than in the GTC. It is important to note that in both organisations, the strong main components in all the networks are occupied by internal actors. In none of the strong main components are the internal and external actors mixed together.

If the weak components are considered, the main components of the networks in the CTU, except that of the communication network, are more inclusive than those of the networks in the GTC. In fact, all of the actors in the knowledge network in the CTU are connected.

Table 9.4. The size of main components for the networks in the GTC and CTU

	Strong		Weak	
Network	GTC	CTU	GTC	CTU
Knowledge	77 (40.10)	24 (17.78)	168 (87.50)	135 (100.00)
Communication	26 (13.54)	23 (17.04)	138 (71.88)	89 (65.93)
Collaboration	11 (5.73)	22 (16.30)	121 (63.02)	106 (78.52)
Advice-seeking	7 (3.65)	8 (5.93)	86 (44.79)	81 (60.00)
Advice-giving	4 (2.08)	10 (7.41)	65 (33.85)	99 (73.33)

Note: The values in parentheses are the proportion of actors in the component to the total number of actors

Two points can be made regarding these component characteristics. First, as resources embedded in the network theoretically can only flow within connected components, the learning resources in the CTU are much more likely to disseminate to a larger proportion of members of the networks than those in the GTC. Second, as network resources flow more freely and easily within strong components (Scott, 1991b), neither group of trainers cant take maximum advantage of learning benefits from their extensive connections with external associates. However, this is only true if learning resources strictly flow in an asymmetric direction.

The networks in both organisations constitute fairly equal systems as indicated by the low level of overall network centralisations. None of the centralisation indices is close to 50 percent. Low centralisation suggests that knowledge circulating the network is distributed fairly evenly across all the actors. Thus, there is no particularly privileged group of actors that constitutes a knowledge hegemony. In both organisations, trainers are exposed to advantages or constraints from the networks at about equal intensity.

Overall, the networks in the two organisations are sparse and fragmented. Apart from network size, the indices of the networks in the CTU are higher than those in the GTC, for example, being more inclusive, denser and more reachable, and less fragmented. In addition, the CTU trainers are slightly more internally oriented than the GTC trainers. However, these differences are not large enough to suggest that the trainers in the two organisations are highly distinctive in terms of the basic network characteristics discussed so far.

Although the trainers do not seem to be consciously aware of the roles that people around them play in their learning to become better and more competent trainers, it appears from the data that they indeed learn a great deal from people who come from various organisational and professional backgrounds. That is, in-depth interviews with the study participants provide strong qualitative evidence suggesting that the role of people from outside the participants' profession and/or organisations is important in learning. The social network data provides even stronger evidence of the intensive and extensive involvement of external actors in the trainers' learning and knowledge sharing relations in the two organisations.

The structure of Cohesive Subgroups

Despite being sparse, each of the networks in both organisations contains cohesive subgroups in the core of the networks. These cohesive parts are characterised by strong and intense interconnections, in which ties are dense and actors closely-coupled.

Although the cliques in the GTC are slightly more numerous, larger in size, and overlap more, the cliques in the networks in both organisations may be regarded small and highly overlapping. The vast majority of them contain three members, the minimum number of members allowed by the clique definition used. As the clique structures were difficult to interpret, the analysis focused on the degree of clique overlap rather than on the structures themselves for purposes of identifying the cohesive parts of the networks. The degree of overlap was used as a basis for combining cliques into more comprehensible structures from which the cohesive subgroups that formed the core of each network could be revealed.

In general, the subgroup structures of the networks in the CTU are more inclusive than those in the networks in the GTC. As the subgroups are identified within the main connected region of each network, the inclusiveness indicates the ratio of actors who are part of the subgroup to the number of actors in the main region from which the subgroup comes. This suggests that the learning resources in the CTU networks, compared to those in the GTC networks, are likely to flow more freely and more quickly and reach a greater proportion of trainers. This is consistent with the overall degree of inclusiveness of the network involving all actors discussed earlier, where the CTU networks were found to be more inclusive than those of the GTC.

The primary unifying features of the subgroups in each of the organisations are different. As anticipated in Chapter Four, in the GTC, levels of education and rank constitute important characteristics that unify the trainers in the same cohesive subgroups. In the CTU, the work units (corresponding to areas of specialisation) and tenure are linked more strongly with subgroup memberships.

At the peripheries of the cohesive subgroups in both organisations, less integrated actors are found. Some are just 'hangers-on' but many others play vital intermediary roles on which the connectivity between the cohesive parts of the network depends. Some of these peripheral actors constitute the only bridge through which members of one subgroup are able to reach the members of other subgroups. Some other peripheral actors provide alternative pathways, thus helping to ensure that the trainers from different cohesive subgroups can communicate.

Not all subgroup structures are robust; some are vulnerable to collapse if certain actors (cut points) leave the networks. In both organisations, the sets of networks that have solid and weak structures are different. In the GTC, the communication and the collaboration networks are robust, while the others are prone to disconnection. On the contrary, in the CTU, the communication and the collaboration networks are more susceptible to fragmentation, while the other three networks (knowledge, advice-seeking, advice-giving) are more robust.

The Structure of Positions

In both organisations, the position models are best captured using the concept of structural equivalence. This concept identifies classes of equivalent actors which are sociologically meaningful as they correspond to relevant actor attributes. Because structural equivalence also take into account the cohesiveness of the networks, it is not surprising that the identified positions share similarities with the cohesive subgroups. The concept of regular equivalence, despite having a less stringent criterion and being favoured as a better method for identifying social positions, failed to produce meaningful position models for these data. Even after defining the positions at different levels of equivalence, the position models identified lack sociological meaning.

The structural equivalence position models in the two organisations are different in many respects. The level of similarity at which meaningful position models can be obtained produces different levels of inclusiveness. In this respect, the positional models in the CTU are more inclusive, incorporating 90 percent of the 31 trainers. In the GTC, only 75 percent of the 44 trainers can be included in the identified positions.

The emerging positional models in the two organisations reflect different characteristics. In the GTC, the 4-position model is the best one to characterise the positional structure pertaining to learning. The identified positions are associated with the trainers' grade. The position model forms a 'core-periphery' structure, where, surprisingly, the more junior trainers occupy the core, while the more senior trainers occupy the periphery of the learning system.

Burt's (1976) typology produces a coherent interpretation with the core-periphery structure above. The middle rank trainers play a 'primary' role in the network, in the sense that they nominate one another and are nominated by a considerable number of actors in the network. The junior trainers occupy 'broker' positions, which are facilitative for them in their early careers as such positions put them at the intersection of knowledge traffic. The more senior trainers are isolates, suggesting that they neither nominated nor were they nominated by the members of the other positions.

Substantively, this suggests that the middle rank trainers who occupy the core or the primary position are able to learn from one another and, at the same time, the trainers of different rank (mainly juniors) also learn from them. The junior trainers who jointly occupy the core also act as brokers, indicating that they must use a 'give and take' strategy in order to be accepted in the learning community. In this case, they learn from their colleagues who are more senior than themselves (mostly middle rank trainers) and, at the same time, other trainers learn from them. However, unlike the middle rank trainers, the junior trainers do not appear to learn from one another. The senior trainers tend to be individualists, and simply withdraw from the learning system.

The disengagement of the senior trainers from the collective learning processes is influenced by several factors, including a lack of incentives, a desire to express self-sufficiency, the existence of barriers to interaction due to the hierarchical organisation of the trainers' activities, and their withholding of information in order to stay competitive.

In the CTU, a 3-position model characterises the positions of the trainers best. This model seems to correspond to the trainers' areas of expertise. The position model reflects 'cohesive subgroups', where the trainers who are in the same position (mainly those having similar expertise) interact with one another more intensively than with their colleagues in the other positions (different areas of expertise). This is also consistent with Burt's (1976) typology, which characterises all of these positions as 'primary'. This suggests that the learning exchanges take place mainly among those who are in the same position; that is, among those specialising in the same area. Members of each position are also seen by some other members of the networks (members of other positions or those not belonging to any of the positions) as learning sources.

Thus, the position models based on patterns of social relations seem to capture salient contextual factors within which each of the two groups of trainers work. In this case, for the GTC trainers, their positions are influenced by the rank or grade structure which seems to be one of the most important aspects of the public service trainers' career. Accordingly, for the CTU trainers, the importance of being an expert in their area of specialisation is reflected in the network-based positions. This, again, confirms the predictions made earlier in Chapter Four.

In conclusion, the differences in organisational contexts seem to have a strong influence on some aspects of the networks such as on the shape of the networks, on those with whom the trainers are likely to associate, on the type of learning resources to which they are exposed, the frequency of interactions among network actors, and the degree to which networks are utilised as learning locales. The organisational environments include physical settings such as geographical distribution, and non-physical aspects such as work organisation, policies, regulations, and organisational culture.

The two groups of trainers have different orientations in building their external connections. The CTU trainers are inclined to build relations with their clients, which reflects the customer oriented nature of commercial organisations. GTC trainers, in contrast, associate with different external actor categories in about equal proportions due to the way their work is organised.

The cohesive subgroups and the position models in each organisation correspond to different sociologically relevant actor attributes. In the GTC, rank and grade are important unifying features that affect the trainers' division into subgroups and positions. In the CTU, the main unifying feature is the trainers' areas of specialisation. In addition, the position model in each organisation is consistent with the unifying features above. In the GTC, the position model forms a 'core-periphery' structure with the more junior trainers occupying the core and the more senior trainers located at the periphery. For the CTU, the position model resembles a 'cohesive subgroup' structure, reflecting the fact that the trainers with similar areas of expertise belong to the same position and interact with one another more intensively than with those with different specialisations.

There are also some basic network characteristics which do not seem to be affected by organisational environment, such as awareness of informal learning and social networks. The attributes of the networks such as density, reachability (especially in asymmetric mode), and centralisation are also relatively unaffected by the differences in organisational environment. The networks in the two organisations are generally sparse, not fully reachable, compartmentalised into components; but they constitute fairly balanced systems, providing the trainers with more or less equal access to knowledge and learning resources.

Finally, the findings in this research may be generalisable beyond the two groups of trainers observed. However, this requires a next step empirical study to verify this.

CHAPTER TEN. CONCLUSIONS: SUMMARY OF FINDINGS, THEIR IMPLICATIONS, AND NEXT STEPS

This study has examined networks pertaining to learning and knowledge-sharing, involving two groups of trainers from two different organisations in Indonesia. The study demonstrates the importance of informal learning for the trainers' development, and reveals that networks of informal social relations play an important role in making informal learning possible. The study also demonstrates the fruitfulness of social network approach as a study method for investigating the social environments within which informal learning processes take place, and as a management tool for leveraging social networks for employee development purposes in organisations.

This chapter is organised into three sections. The first section summarises the main findings, covering the evidence from qualitative analysis as well as from the formal social network analysis. The second section discusses the conceptual and practical implications of the findings. Finally, the third section addresses the limitations of this research and proposes some recommendations regarding possible directions for future studies of informal learning in modern organisations.

Summary of Key Findings

The Importance of Informal Learning and Social Networks

One conclusion that can be drawn from the literature is that informal learning through social networks is highly relevant to adult and professional learners such as the trainers. The literature suggests that informal learning plays a crucial instrumental role in human resource development, and it reportedly accounts for 70 to 90 percent of the total learning that people undertake (see Leslie *et al.*, 1997; Day, 1998; Low *et al.*, 2001). Nevertheless, informal learning has not received the level of recognition it deserves.

The lack of recognition of informal learning is primarily due to the difficulty in reconciling its flexible and intangible nature with the rational-legal principles that underscore today's bureaucratic organisations. Informal learning is open-ended, taken for granted, and often the learners themselves are unaware of undertaking it (Hager, 1998; Gorard, 1999; Livingstone, 2000). This makes informal learning difficult to measure, which contributes further to its incompatibility with bureaucratic organisations, hence the limited recognition of its importance. Formal training programs, in contrast, appeal more to bureaucratic organisations because they are more predictable, with explicitly prescribed timetables, venues, curricula and outcomes.

As expected, the empirical evidence indicates that the trainers' awareness of informal learning is indeed low. This is evident from the fact that the trainers who were involved in this study originally attributed their professional growth to the formal training programs that they had attended. However, through in-depth interviews, it was revealed that they also acquire and develop many of the crafts of their profession informally.

The trainers' awareness of social networks in which their informal learning activities are embedded is equally low. This is due to the implicit and taken for granted nature of informal social relations. The low level of awareness is evident from the discrepancy between how the trainers perceived their social networks and the actual network patterns that emerged from the analyses. In general, the trainers describe their social relations as open, intimate and mutual. However, results of the study suggest that their networks are sparse and disconnected. For one of the groups of trainers studied, their awareness of social network benefits is also obscured by the fact that they associate informal social connections with negative effects, such as nepotism and favouritism. This is indicated clearly in the trainers' common expression "*siapa dekat, dia dapat*", meaning those who are close to power get all the opportunities.

The literature suggests that the need to learn informally, despite low awareness and recognition, is driven by the nature of work which is increasingly dynamic (Torraco, 1999), by the tacit nature of knowledge required to do many jobs (Polanyi, 1958; Nonaka and Takeuchi, 1995), and by the character of adult learners who want to be in control of their learning (Cross, 1981; Schugurensky, 2000). The results of the study are consistent with these learning motivations. The trainers feel compelled to learn informally because of the nature of their work which is highly unstructured, constant changes in the subject matter of their teaching specialisations, the desire to maintain an image of competence, the need to fill knowledge and skill gaps, the need to stay competitive, and the requirement to be ready for any unanticipated teaching assignments.

To properly examine and better understand this implicit learning process, social and relational perspectives (Cross, 1981; Marsick, 1987; Taylor, 1997; Richter, 1998; Grootaert, 1999; Krebs, 1999; ID21, 2000; Barlas, 2001; Cross *et al.*, 2001b; Carley and Hill, n.d.), and a social network approach as a method of investigation are essential. The cognitivist perspective and the conventional study method focusing on actor attributes are not sufficient to characterise such hidden processes. As the present study has demonstrated, a social network approach has the capacity to reveal the structure of social relations in which intangible learning processes take place. It is useful in providing a fresh new perspective for understanding the structure of informal learning and knowledge sharing relations.

The Instrumental Social Relations

The results demonstrate that the trainers' learning processes are facilitated by access to impersonal knowledge repositories such as books, television, and newspapers. However, the results also unequivocally show that the trainers learn and access knowledge resources from other people. Thus, the findings clearly illustrate that social relations play a vital role in informal learning process. The findings reveal that the trainers' informal learning is embedded in multiplex social relations, consisting of communication, collaboration, advice-seeking and advice-giving relations. These four relations are sufficient to facilitate the flow of both explicit and tacit knowledge. Although this set of relations is not exhaustive, for the trainers under investigation they are important in facilitating access to and sharing of general information (communication), tacit knowledge (collaboration), and professional expertise or know-how (advice-giving and advice-seeking).

The Basic Network Features

Using a social network approach, the structure of these learning-related social relations is revealed. In general, the networks are quite large and have more or less equalitarian structures, but are sparse and unconnected. In addition, they have highly diversified memberships. Some of these characteristics constitute strengths but some others may be regarded as weaknesses.

The results of the study demonstrate that the context of the trainers' learning extends beyond their formally defined organisational and professional boundaries. As they were not restricted regarding who they could nominate, the number of actors grew from the 44 originally targeted trainers to 192 actors in the GTC, and from 31 to 135 in the CTU.

The large number of people from outside the targeted trainers is clearly indicated by three different measures. First, the overall number of external associates nominated by the two groups of trainers is larger than the number of the internal actors, that is, the group of trainers themselves. Second, the total number of ties from internal actors in each group to their external associates is also larger than that among the internal actors within each group. Third, the individual trainers' neighbourhoods contain more external than internal actors on average. Finally, the density of interconnections among the internal actors is not appreciably higher than that of the interconnections among all actors. This is consistent with Araujo's (1998) argument that locales of learning constitute networks of porous and fluid boundaries which transcend and bypass conventionally defined organisational boundaries.

The findings suggest that due to their sparse structures, the networks of learning and knowledge exchange relations are not very effective in spreading knowledge. In such sparse networks, there are not many ties through which learning resources can spread. Different measurement techniques and considerations consistently demonstrate that the networks are sparse.

However, the same characteristics also indicate that these networks can provide the trainers with rich learning resources, hence can potentially become vibrant loci for innovation, as they are likely to contain non-redundant and divergent information. The capacity of a sparse structure to facilitate the diffusion of novel ideas and to foster innovation has been suggested by some social scientists (see, for example, Granovetter, 1973; Burt, 1992; Krackhardt and Hanson, 1993; Krebs, 1998). As the number of ties connecting the trainers is limited, the possibility of redundant information circulating the networks is reduced. The likelihood of the networks containing non-redundant information is further increased by the fact that the trainers associate with a large number of external actors who come from various organisational and professional affiliations, and they are only weakly connected to the networks.

Results of the study demonstrate that the networks in both organisations constitute fairly even structures, as indicated by low centralisation indices in terms of degree, betweenness, and *closeness*. This suggests that the trainers tend to have quite equal opportunities to access one another's knowledge, hence to learn from one another.

The study also provides empirical evidence of some potential weaknesses in the network structures, which may become impediments to the effective distribution of learning resources. The component analysis demonstrates that the networks in both organisations are unconnected and contain a large number of isolates who form isolated single-actor components, rendering the reachability of the whole structure low. Those unconnected actors, either as isolated individuals or as isolated components, cannot benefit from the resources available in the networks, nor can the networks benefit from them. In addition, because the internal and external actors are separated into different strong components, the maximum benefit from having extensive connections to a potentially wide variety of ideas becomes less optimal.

The Internal Network Substructures

Examining the substructures within the networks provides a more refined view of the global structures of the networks. The structural features of the networks are examined in terms of cohesive-based and equivalence-based analyses. This analysis further reveals the existence of gaps within the network structures.

Cohesive Subgroups

Although the centralisation measures suggest that the networks constitute level structures, the results of a more in-depth subgroup analysis reveal that some trainers have more intense ties to one another than to the others, thus forming cohesive subgroups. The results demonstrate that the networks in both organisations contain subgroups, which form the core regions of the networks within which intensive exchange of learning resources can occur. Some of these core regions or cohesive subgroups have strong structures and some others are vulnerable to fragmentation if some of the actors leave.

The unifying features of these cohesive subgroups reflect the dominant characteristics in organisational arrangements. In the GTC, where the trainers are governed by the Indonesian public service system, rank and level of education are important attributes. Accordingly, subgroup members tend to be homogeneous in these respects. At an individual level, this suggests that the relatively more junior trainers have few opportunities to learn from their more highly educated colleagues and/or to tap the experience of their more senior colleagues. At a collective level, the GTC cannot maximise the capacity of its human resource, as organisational performance is not solely determined by the quality of individuals. Rather, a large part of performance lies in the overall patterns of interconnections among these individuals.

The CTU, which operates within a competitive commercial environment, requires its trainers to be highly specialised in particular areas. Therefore, trainers who are similar in their teaching specialisations tend to occupy the same cohesive subgroups. There is a lot more to teaching, however, than just a mastery of the subject in which one specialises. Therefore, this structural feature suggests that the CTU trainers do not get the maximum opportunity to learn other aspects of training activities, which could be useful for them irrespective of what subjects they specialised in, or in what unit they work.

It is surprising to find that actors who are peripheral to the cohesive subgroups or to the core regions contribute substantially to the integration of the core regions by playing a mediating or bridging role. In cases where subgroups are separated, peripheral actors often provide the only path through which resources might travel between the different subgroups. In the case where the cohesive subgroups are themselves overlapping, the peripheral actors provide alternative pathways that increase the probability of resources circulating between the core regions. Thus, despite being peripheral to the cohesive subgroups, they serve as glue that helps integrate the core region of the networks.

Positional Structure

Trainers' positions within the networks of learning and knowledge sharing were modelled using two concepts: structural equivalence (similarity in tie profiles) and regular equivalence (similarity in connections to similar others). For the organisations studied, structural equivalence appears to be more useful for modelling the trainers' positions. Although regular equivalence was expected to produce more meaningful position models, as it is less stringent in its definition, and more intuitive in capturing the notion of social positions, it failed to identify meaningful structures in these two organisations. The reason for this could be that learning and knowledge exchanges are influenced not only by the way actors are connected (structure), which underpins the concept of regular equivalence, but also by the others to whom actors are connected (proximity), which is an integral principle of structural equivalence (see Borgatti and Everett, 1992).

Results of the analysis based on structural equivalence demonstrate that the GTC trainers' positional structure is organised along their rank lines, forming a 'core-periphery' configuration (Brieger, 1976; White *et al.*, 1976), where relatively junior trainers occupy the core, while more senior trainers tend to be disengaged and stay at the periphery. In light of Burt's (1976) typology of positions, the junior trainers appear to play a knowledge 'broker' role, reflecting their need to get maximum access and exposure to the knowledge and skills that they require to survive in their early training career. The middle rank trainers form the 'primary' knowledge repository by actively engaging in knowledge exchange among themselves and with their junior colleagues. The senior trainers are 'isolates', disengaging from the learning system. This could reflect their sense of self-sufficiency in terms of the knowledge and skills that they require, and the lack of incentives for sharing their valuable experience in a competitive work environment.

In the CTU, the trainers are divided into positions along their work units, forming 'cohesive subgroups' (Wasserman and Faust, 1994) or 'reflexive cliques' (White *et al.*, 1976) structure. As CTU trainers are divided into work units based on their areas of teaching specialisation, each of the identified positions may also be considered as reflecting knowledge niche, and high division of labour in commercial organisations.

The attributes that the position members have in common appear to resemble those found in the cohesive subgroup analysis. One could argue that the similarity is due to the fact that a cohesive-based analysis and one based on structural equivalence both take into account proximity. However, it could also be argued that despite this, the two approaches are different in the inputs they analyse. The cohesive-based analysis examines each of the four relations separately. In contrast, the structural equivalence analysis considers all the four relations and both incoming and outgoing ties simultaneously. Thus, the similarity in results does not suggest that the two approaches measure the same thing. Rather, it shows that the attributes that unify the trainers are important factors in the way they were structured.

Comparative Analysis

The contrasting features of the two organisations appear to have a weak effect on the process of informal learning. The qualitative analysis indicates that in both organisation, informal learning drives, awareness of informal learning, the kinds of knowledge and skills they develop through informal learning, the role of social relations in informal learning are quite similar. However, the different features of the two organisations seem to affect the internal structural characteristics of the informal learning relations based on social network analysis. This is especially true of the unifying features that divide the trainers into different subgroups, both based on structural equivalence and regular equivalence.

Implications and Recommendations

It is hoped that this research will contribute to a better understanding of informal learning by conceptualising it as a social and a relational process. It offers a different perspective compared to the widely adopted cognitivist view, which conceives of learning as an individual process located inside the minds of individuals. Instead, this research has employed a social and relational perspective, and a social network approach as a method of investigation. A number of implications with regard to the research method and to the trainers' development can be drawn from the findings of this thesis.

Social Network Analysis as a Study Method and as a Management Tool

This study has demonstrated that a social network approach is able to reveal the structures of interpersonal relationships pertaining to learning. Being able to characterise the social networks helps us to understand the nature of such intangible structures better, and has substantial applied value. A social network approach, therefore, can be used as a research method to uncover the hidden structures of learning relations, and as a management tool to help harness social networks for human resource development purposes.

As a method of investigation, a social network approach can be used to uncover and to provide a better understanding of implicit structures of informal learning relations beyond a common sense level to the actual structure of interconnections among learners. Indeed, a social network approach can be used to study other intangible network-mediated processes so as to complement the current understanding, which has been dominated by methods which focus on characterising individuals on the basis of their attributes.

In practice, management can use a social network approach as a tool for understanding the informal networks that are hidden behind formal organisations. Krackhardt and Hanson (1993) argue that social networks can have negative effects on an organisation if managers do not know how to identify and direct them, and that managers are often misled by their superficial observations of the informal networks in their organisations, which may lead them to making faulty decisions or taking a wrong course of action.

Thus, understanding these implicit structures is an important step towards designing more comprehensive and effective strategies for developing organisational human resources in general, and for the trainers studied here in particular. Managers of training centres can use a social network approach to allocate organisational resources, which can result in greater benefits in terms of fostering informal learning and developing trainers, and to locate as well as anticipate problems and opportunities that may arise from the network structures. For instance, in the positional analysis in Chapter 7, it is evident that senior trainers in the GTC engage less in collective learning processes. To the extent that this preliminary study reflects the actual situation, the challenge then becomes to determine how to better tap the resources of the senior trainers.

The important strategic value of understanding of structure of social networks using a formal network approach has been demonstrated by Valente and colleagues in designing improved interventions, such as accelerating adoption in behavioural promotion programs (Valente and Davis, 1999), and in designing a more effective tobacco prevention program in schools (Valente, Hoffman *et al.*, 2003). They show the power of a social network approach in facilitating the optimal matching between opinion leaders and followers.

In addition, as knowledge is not distributed evenly within organisations, a social network approach can provide information to help synergise individuals' abilities by considering how the trainers are enmeshed in their informal networks. By understanding what an organisation's "x-ray" (Krebs, 1999), or what a "central nervous system" of an organisation (Krackhardt and Hanson, 1993) looks like, it may be possible for organisations to harness social networks for employee development purposes. For example, managers can pinpoint individuals or groups of individuals who may be overwhelmed with redundant information, or otherwise deprived of essential information. The managers can also optimise the role of individuals within the networks, for instance, by strengthening knowledge diffusion by mobilising those who can be categorised as senders, maintaining network integration through those who play bridging or boundary spanning roles, encouraging sharing for those who are mainly receivers and integrating those who are isolates so that they can contribute to the collective knowledge development, and at the same time receive benefits from the network.

Network Features

The results show that the structures of the trainers' networks are sparse. This has implications for what a network is capable of supporting. Borgatti (2005c) argues that sparse networks are not optimal for disseminating learning resources quickly because there are not many ties through which learning resources can spread, but that such a system has the capacity to support innovation because the probability of having redundant information circulating the network is low. Managers can use this information to make informed decisions as to whether strengthening the free flow of learning resources or supporting innovation should be prioritised.

The study also reveals that as a consequence of sparse ties, there exist gaps in the overall network structures, defined by geographical distance, rank, and areas of expertise. Thus, it may prove useful for the organisation to initiate bridge-building in order to connect or increase the level of connectivity among these separate or loosely linked clumps.

As there are gaps between geographically separated clusters, it could be beneficial to harness information and telecommunication technologies. This is especially useful because the geographically separated clusters may constitute pockets of very different knowledge and practice, and connecting them may yield new knowledge. In addition, exchanging trainers could facilitate the integration of the networks through weak ties. This is evident from a case where a trainer who had just moved from one of the GTC subsidiaries to the office headquarter plays a bridging role, linking his old and new colleagues.

Regarding the lack of ties between trainers of different ranks in the GTC, or between areas of expertise in the CTU, collaboration across different ranks or different specialisations could be strengthened, and mentoring could be encouraged through better reward systems. One such measure would be to amend the regulations governing the trainers' activities so that the division of tasks reflects the functional nature of the training profession, rather than the hierarchy of ranks, which is the case with the current system. In addition, the organisations could provide clear rewards to encourage senior trainers to engage in collective learning and to support their junior colleagues. Furthermore, the organisations could bridge gaps by creating conditions that would allow more serendipitous interactions to occur (see Monge and Contractor, 2003). Although formal or organised meetings are useful, they tend to make people communicate normatively at a superficial level. Informal and incidental meetings, in comparison, can bring out their tacit knowledge naturally.

The different network structures of the two different organisations demonstrate the idiosyncratic nature of social networks. This implies that management in an organisation should attempt to identify or map out the networks in their own organisation for accurate understanding of the potential strengths and weaknesses of informal learning networks among their employees. Using prototype model of comparable organisations' network structures could be misleading.

Learning Characteristics

The current model of trainer development, in particular, and human resource development in general, largely relies on formal classroom instruction.

The literature suggests that formal training programs can only deliver explicit knowledge effectively at a specific place and at a specific time. However, the trainers need to learn and develop tacit knowledge on an ongoing basis. They are compelled to do so by the nature of their work, the characteristics of the people they teach, and the fast changes in the subject matter of their teaching specialisation. Such learning often occurs within social networks. It is intangible, taken for granted, and therefore is not necessarily a conscious activity. Yet, it provides a large proportion of the knowledge and skills the trainers need to be able to carry out their tasks effectively.

Thus, the potential benefits of network configurations do not materialise automatically. It is up to the individuals, groups or organisations to exploit the opportunities that lurk behind the formal organisation structure. The inability, unwillingness or unawareness of the actors may render a well-configured network suboptimal. This suggests that an important step towards exploiting the benefits would be to leverage informal learning, nurture and cultivate the networks, recognise their important roles, raise awareness about them, provide incentives and opportunities to be involved in them, and integrate them into the human resource development strategy of organisations. In this manner, learning and working could take place simultaneously, thus allowing both tacit and explicit knowledge to flourish.

However, as Wenger and Snyder (2000a) suggest when referring to a specific type of social network called 'community of practice', there is a paradox here. While informal structures need to be left alone, they also benefit from cultivation. This study found evidence that there had been several failures to capitalise on informal relations after attempting to formalise them by appointing leaders, assigning responsibilities to members, and setting up timetables for meetings. Thus, it would appear that an intervention should not attempt to formalise the informal networks but rather to facilitate their growth and to remove obstacles that may impede their development.

In addition, the results of the qualitative analysis suggest that there is competition among the trainers in the GTC which, to some extent, impedes the exchange of learning resources. In this context it could be useful to provide highly rewarding collective benefits for sharing knowledge. Therefore, the organisations could go beyond the knowledge transfer paradigm to actual knowledge creation and sharing by shifting their focus from the narrow sense of training to the more encompassing collective learning.

Limitations and Future Directions

It is important to recognise that social networks and informal learning are two complex social phenomena, and that combining them in the present study presented some challenges. It is clear that additional research will be required before a complete understanding of these phenomena can be obtained. Nevertheless, what has been revealed in this exploratory study is an important starting point towards more rigorous analysis in the future. This study has raised several issues, which constitute promising avenues for those contemplating further studies along this line of enquiry.

The current study only involved two groups of trainers who were selected purposively. Therefore, the results cannot be used to infer characteristics of trainers in general in Indonesia. Similar studies could be conducted involving larger numbers of randomly selected trainers from disparate types of organisations and professions, for example, school teachers, academics or researchers in both public and private institutions. In addition, future studies could also involve groups from industrialised and less industrialised countries.

In this fashion, a wider range of comparisons would be possible and the results more generalisable.

It has been established that the boundaries of networks are porous, and that in particular the networks studied involve a sizeable number of external actors. Relational data and attributes were not collected from these external actors. Ties among them were constructed on the basis of knowledge of the interviewed trainers, referred to as a "cognitive social structure" (Krackhardt, 1987). Therefore, in the analysis of cohesive subgroups and positions, external actors could not be included. Such data would provide a more complete view of the characteristics of the trainers' networks. Future studies could be designed to interview all associates who are nominated by the initially targeted participants. In this case, future research might disregard organisation or group boundaries and endeavour to employ a link-tracing sampling such as a snowball (Goodman, 1961) or random walk (Klovdahl, 1989; Liebow *et al.*, 1995; McGrady *et al.*, 1995) design. In fact, the present study could be extended in this direction by interviewing the external actors already identified.

Another limitation of the current study is that it is cross sectional. Many studies have suggested that social network structures are dynamic; they change over time. Therefore, it would be beneficial to examine the durability of the networks by collecting data from the same groups of participants at several time points. Although the average "duration of relationships" reported in this study was quite long, implying stable networks, a longitudinal study could provide a more accurate indication of network stability. A longitudinal design, for example, could show wether the cohesive subgroups found in Chapter 6 and clusters representing positions in Chapter 7 constitute stable or volatile structures. In addition, it could also allow the researcher to examine how new recruits develop from novices to expert practitioners. This could provide validation, from a network perspective, of Lave and Wenger's (1991) theory of legitimate peripheral participation which assumes that novice practitioners evolve from being at the periphery towards the centre of their profession.

One of the main difficulties in studying informal learning, a reason why informal learning is undervalued, is the lack of available tools to measure the outcomes of an implicit process such as this. In an open-ended learning experience, such as in constructivism, the methods and results of learning are not easily measured and may not be the same for each learner (Mergel, 1998). Therefore, it would be useful for future studies to design systematic measurement instruments for informal learning outcomes, so that more rigorous analyses of associating the structural characteristics of the networks and the identified informal learning outcomes could be carried out. Having a reliable measurement of outcomes could also allow analyses, e.g. multiple regression analysis, to predict which network characteristics lead to particular informal learning outcomes. Similarly, a more systematic identification of network antecedents, such as specific environmental and individual characteristics, could also be beneficial. The network features that were observed to be similar across the two groups of trainers need to be verified through a study involving a wider variety of organisations from a wider range of contexts so that the degree to which these features are generalisable can be verified.

Finally, this study has discovered that informal learning is embedded in multiplex relations, consisting of communication, collaboration, advice-seeking and advice-giving. Although the role of other social relations was not precluded, time constraints did not allow an exploration of other possible relevant relations. Thus, future studies could consider a wider range of learning-related social ties, such as mentoring and friendship relations. In addition, would be beneficial to consider the kinds of relations beyond the traditional face-to-face interactions, such as those mediated by the Internet or other information and telecommunication technologies.

Final Words

Learning processes beyond the context of formal training programs need to be considered to fully understand how professional actors such as trainers learn and grow in their profession. Such informal learning contains a large proportion of tacit knowledge, which is actionable and is indispensable for the trainers in carrying out their tasks and in surviving in their careers. Therefore, fostering social networks in which informal learning thrives constitutes an important organisational investment, and is imperative for the success of developing the trainers and for organisational survival.

The social network paradigm can help in understanding the underlying patterns of social networks, so that management can design appropriate strategies to maximise their benefits. It should be noted, however, that any interventions should not be directed towards formalising the informal social networks because such efforts are likely to stifle their growth and their facilitative role.

It must also be emphasised that despite the important role that informal learning plays, it should not be seen as a replacement for the formal training program. Rather, the two should be seen as mutually complementary learning approaches. By supporting both, trainers and organisations are in the position to reap the benefits that each mode of learning provides.

Despite the limitations, this study has contributed to a cross-cultural understanding of social networks by providing evidence from an Indonesian context. It is hoped that the findings of this study will stimulate further interest in this area for more fruitful studies in the future.

APPENDICES

Appendix 1. Ethics (Human Subjects) Protocol

Privacy and Confidentiality Protection Measures

To protect the privacy of the study participants and the confidentiality of the information that they provided, a set of robust confidentiality protection procedures as recommended by Klovdahl (2001) was adapted, and was implemented in all stages of this study. This confidentiality protection consists of assumptions and procedures which were approved by the Human Research Ethic Committee of the Australian National University with protocol number 2002/93 before the study commenced:

1. Participants' information will be converted to anonimised form (de-identified) as soon as possible during the project. In the first instance, this involves segmentation of data collection protocols to keep identifying separate from other information.
2. Project personnel hired will be trained and made familiar with any relevant provision in the National Statement on Ethical Conduct in Research Involving Humans issued by NHMRC. Translation of relevant provisions in the national statement into Indonesian Language will be made available to research assistance as reference if necessary.
3. No identifying information will be shared outside the project. The number of project personnel who have access to identifying/linking information will be restricted to an absolute minimum.
4. Not connecting computer used for storing and processing raw data to any network
5. Never transferring files containing raw data (even encrypted) over the Internet
6. No data retained beyond the conclusion of the project will contain identifying information. Data will be de-identified and participants rendered anonymous (not re-identifiable at the earliest possible date)

Appendix 2. Data Collection Instruments

There are four types of data collection instruments, including Self-administered Questionnaire, Interview Schedule, Observation Guide and Document Analysis Guide.

The Self-administered Questionnaire was translated into Indonesian language before being distributed to the research participants. The Interview Schedule was used by the researcher as a guide so as to keep the interviews on track. The interviews were conducted in Indonesian language. The exact wording of the questions during the interview sessions, especially those in the open-ended section, is not necessarily identical to what is written in the Interview Schedule, or to its translation in Indonesian language.

The guides for observation and document analysis are also open-ended. The Observation Guide contains a planned observation activities focusing on events involving the study participants, in which their informal learning and social network phenomena could be observed. The Document Analysis Guide contains a list of document names, which were relevant to the topic under investigation.

QUESTIONNAIRE

This questionnaire is intended to collect data about yourself, your work and your professional activities. It will take about 20 to 30 minutes of your time to answer all the questions. The questionnaire is not part of any test or performance evaluation, but for research purposes only. Information that you provide will not be disclosed to third parties and will not be published in any form that contains identifying or linking information.

The researcher will be contacting you about collecting the questionnaire. Alternatively, when you attend the interview, you may hand it directly to the researcher on the interview day.

If you have any questions on how to fill out this questionnaire or regarding this research in general, please do not hesitate to contact the researcher on the following address and number:

Muhammad Firdaus
Jl. Letjend Mappaoddang H90
Makasar, Indonesia
Telephone: 0411 872444
Email: Muhammad.Firdaus@anu.edu.au

Questions concerning ethical issues can also be directed to the researcher at the address above, or directly to the Human Research Ethics Committee of the Australian National University:

c/o Sylvia Deutsch
Human Ethic Officer
Reasearch Services Office
The Australian National University
Telephone: +61 2 6125 2900
Fax : +61 2 6125 4807
Email: Sylvia.Deutsch@anu.edu.au

Interview No.:__________

A. Professional Activities

This section is about your membership in various groups or teams as well as your involvement in various professional activities as a trainer.

1. Do you currently participate in any of the following types of organisations, or groups? Please write down the name of group next to the relevant type that you participate in, then tick (✔) appropriate level of participation in any of the organisations' or groups' activities.

Type of group/ Organisation	Name of group or organisation	Level of participation (✔)			
		Most, if not all activities	Some activities	Few activities	None of the activities
Professional Association(s)					
Community association(s)					

Type of group/ Organisation	Name of group or organisation	Level of participation (✔)			
		Most, if not all activities	Some activities	Few activities	None of the activities
Religious Association(s)					
Sporting club(s)					
Special interest group(s)					
Ethnic association(s)					

Type of group/ Organisation	Name of group or organisation	Level of participation (✔)			
		Most, if not all activities	Some activities	Few activities	None of the activities
Charity or welfare organisation(s)					
Other(s) e.g. teamwork, project team					

2. What subjects do you teach? Please write the ones you teach most often first.

1. ______
2. ______
3. ______
4. ______
5. ______
6. ______
7. ______
8. ______
9. ______
10. ______

3. Have you attended formal training courses as part of your continuing professional development program? If so, please indicate the number of training programs that you have attended since you became a trainer. ☐

4. Among the training courses that you have attended, are there any that you think were exceptionally useful to your professional growth? If so, please explain why they were particularly useful.

5. Have you attended seminars or workshops as part of your training career? If so, please indicate the number of seminars or workshops that you have attended since you became a trainer.

6. Of the seminars and workshops that you have attended, are there any that you think were most useful to you professionally? If so, please explain in what way they were useful

7. Besides teaching in your own institution, have you done any teaching elsewhere? If so, please write down in the table below any external teaching assignments that you have had?

Name of Training Institution	Name of Training Program	Subject(s) Taught	Describe Frequency e.g. twice a year

8. Of your total commitment to professional activities, what is the approximate proportion between teaching internally within your own unit and outside your unit or training institution?

In-house activities	Away activities	Total
%	%	100%

B. Information Access

This section is about your access to information resources through various means. Please tick appropriate boxes or write down your answers in the spaces provided.

1. Do you use any of the telecommunication technologies below on regular basis? If so, please tick (✔) the ones that you use.

   ☐ Telephone

   ☐ Cellular phone

   ☐ Internet

   ☐ Other, please specify: ____________________

2. Do you have access to the Internet?

   If YES, please indicate the type of access that you have. You may tick more than one box.

   ☐ Subscription from home

   ☐ Communal access at office

   ☐ Individual access at office

   ☐ Internet cafes

   ☐ Other(s), please specify: ____________________

if NOT, please indicate why not? You may tick (✔) more than one box.

☐ Too costly

☐ Have not had a chance to learn how to use it

☐ Do not know how to use a computer

☐ Not needed at present

☐ Other(s), please specify: ______________________________

3. Have you ever subscribed to any printed or electronic journals? If so, please provide details of the publications you have subscribed to in the table below.

Journal Name	Tick (✔) medium		From (year)	To (year)
	Paper	Electronic		

4. If you have not subscribed to any journal, do you have access to journals through other means? If so, tick (✔) one or more options as they apply to you?

☐ Home institution library

☐ Public libraries

☐ Government institutions

☐ Other(s), please specify: ____________________

5. If there are other matters that you feel strongly about and would like to add, please write them down in the box below.

C. Personal Information

The information you supply will be used strictly for research purposes only and will not be revealed to third parties without your prior consent.

1. What is your current address?

   Street name :

   Suburb :

   City :

2. When did you enter the training career?

   ☐☐/☐☐/☐☐☐☐ (dd/mm/yyyy)

3. Prior to entering the training profession in your current organisation, did you work somewhere else (in another organisation or in another unit within your current organisation)?

   ☐ No, I started my career as a trainer in this organisation

   ☐ Yes, I have worked somewhere else prior to entering my current training career in this organisation

   Organisation : ____________________

   Title of Job/function : ____________________

   Brief description of activities involved: ____________________

4. What was your first entry rank as a trainer?

   ____

5. What is your current rank as a trainer?

____

6. If you have not already reached the top rank in the training career, what highest rank you hope to achieve before retiring?

____

7. What is your highest level of formal education?

Degree : ______________________________

Year obtained : ______________________________

Educational institution : ______________________________

8. What is your date of birth?

☐☐/☐☐/☐☐☐☐ (dd/mm/yyyy)

9. What is your religious denomination?

____

10. What ethnic group do you identify yourself with?

____

11. Apart from the Indonesian, do you speak any other languages? If so, which?

Local dialect(s) : ______________________________

Foreign language(s) : ______________________________

Thank You

INTERVIEW SCHEDULE

This interview schedule is divided into two parts. The first part is semi-structured, containing questions about learning needs and name generator questions as a basis for establishing structure of social relationships pertaining to informal learning.

The second part is largely open-ended. Questions in this part cover areas such as trainer's perception about social networks and informal learning, their profession, policies as well as socio-cultural and organisational contexts that may influence how social networks are structured and how they may leverage informal learning among trainers.

Interview No. ________

Venue: ____________ **Date:** ___/___/___ **Time started:** ___:___

I. Semi-structured Interview

A. Learning needs

1. As a trainer, what knowledge and skills do you think are most essential for facilitating your professional activities?

2. In general, how do you develop such knowledge and skills?

3. Are there any aspects of the training profession that require or compel you to learn continuously, and how do you normally fulfil such learning needs?

4. What kind of work-related problems do you normally encounter in your daily activities as a trainer? Can you give some examples and how do you normally attempt to solve such problems?

5. Are there work-related situations that require you to talk to your colleagues or other people? Please, give examples.

Interview No. _______

B. Social Relationships

14. Who do you interact with in any way in your daily activities, that you find contributing to your work-related knowledge and skills as a trainer?	15. Do you interact with [this person] on		16. How long have you known [this person]?
	professional level?	personal level?	

17. Do you live in the same neighbourhood with [this person]? (e.g. within about 5 minutes walk from each other's house)	18. Do you interact with [this person] outside work hours]? e.g.		
	visit each others' house?	Play sport	Go to the movie, etc.

19. How often do you interact with [this person]?	20. In what capacities do you interact with [this person]? e.g. workmate, relative, friend lecturer, etc.

21. Can you think of anything in particular that you have leaned from [this person]?
If so, can you give some examples? e.g. Something related to teaching, research, or other professional activities.

22. [Show Card 1] Is there anyone with whom you normally exchange ideas, stories or information, or discuss work-related matters? If so, who are they?	23. [Show card 2] Is there anyone whom you normally go to for advice when you have work-related problems, or when you want to consult someone whose professional opinions are in general of great value to you? If so, who are they?

24. [Show Card 3] Is there anyone who usually comes to you for advice on work-related matters? If so, who are they?	25. [Show card 4] Is there anyone with whom you often collaborate in carrying out your professional activities? If so, who are they?

Note: If the respondent name new associates in response to questions 22-25, add their names to the first column, then repeat question 15- 21 before proceeding to question 26

26. Are there any other forms of relationships with these people, or with others you have not named, that you think affect your professional development in positive or negative ways? Can you give examples?

[Identification of internal and external actors] 27. What is the occupation or profession of [this person] and what organisation [this person] works for?	
Profession or Occupation	Organisational Affiliation

Quickly, copy names of external actors to the Form "Interconnection among External Actors"

Interconnection among External Actors (Note: The actual instrument uses larger paper and the grid contains more cells)

28. To your knowledge, does [name of an external actor] know [name of another external actor]? If so, how well?

	2	3	4	5	6
1	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well ....
2		☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well ....
3			☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well ....
4				☐ Don't know ☐ Not at all ☐ A little ☐ Quite well	☐ Don't know ☐ Not at all ☐ A little ☐ Quite well ....
5					☐ Don't know ☐ Not at all ☐ A little ☐ Quite well ....

For each pair of external associates, if the respondent indicates that the pair know each other quite well, verify further, e.g. by asking whether they work in the same organisation, live in the same neighbourhood, meet each other at least once a week, do activities together outside work hours such as play sport, go to the movies, and so on

These cards were shown to the research participant in conjunction with questions 22 – 25 in part B (Social Relationships) of the semi-structured interview.

For question 22

Card 1. Communication

Is there anyone with whom you normally exchange ideas, stories or information, or discuss work-related matters? If so, who are they?

You may nominate people other than you have mentioned before.

For question 23

Card 2. Advice-seeking

Is there anyone whom you normally go to for advice when you have work-related problems, or when you want to consult someone whose professional opinions are in general of great value to you? If so, who are they?

You may nominate people other than you have mentioned before.

For question 24

Card 3. Advice-giving

Is there anyone who usually comes to you for advice on work-related matters? If so, who are they?

You may nominate people other than you have mentioned before.

For question 25

Card 4. Collaboration

Is there anyone who you often collaborate with in carrying out your professional activities? If so, who are they?

Collaborating in this context means working together on a particular activity, work, assignment, project such as co-authoring articles, developing a training material together, conducting a research together, and the like.

You may nominate people other than you have mentioned before

Interview No.: ____________

Venue: ____________________________ **Date:** ___/___/___ **Time Started:** ___:___

II. Open-ended Interview

The following questions serve as a rough guide only. It is anticipated that respondents' answers may raise further relevant questions.

A. Social Relationships and Informal Learning

1. Do you think the relationships that we have discussed help or contribute to you as a trainer and to the training profession as a collective? If so, how?

2. Can you give some specific examples of benefits that you obtain from your relationships with others; both related to learning or to other aspects of your professional life?

3. Could you describe one or more events where you felt you learn something from other people? (Respondent should be allowed to tell his or her story as openly as possible, although the following probes may be useful).

- What did you learn from the event?

- In what situation or context did the learning event take place?

- Was it a contribution of one, or more than one persons?

4. In general, how do you compare formal training and informal learning?

B. Trainer's Perception of their Profession

1. Why did you decide to enter the training profession?

2. Compared to other types of career, e.g. managerial position, what are the advantages and disadvantages of being a trainer?

3. What are some of the major challenges faced by the training profession in your organisation?

4. How much do you think the training profession is appreciated? Why?

5. Are you prepared to move to another career (e.g, a managerial position) if opportunity arises? Why, and on what condition would you leave the training profession?

6. How easy or difficult is it to develop career in the training profession? What are the problems if any ?

7. Does the current system recognise and reward talent and work fairly?

C. Organisational Environment

1. What are some of the most popular professional activities that most trainers would want to involve in? Are there enough of such activities for every trainer? Are they fairly distributed among trainers?

2. Are you aware of any indication of people demonstrating opportunistic behaviour when it comes to resource exchange? Can you give some examples? You do not have to mention their names.

3. Have you discovered any indication of favoritism in terms of work distribution?

4. What policy is in place regarding external (teaching) activities? For example, are trainers (formally) allowed to teach in other training institutions?

5. Are there any factors (physical environment, policies, politic, organisational practices, routines or procedures, etc) that you think drive or restrain trainers' opportunity to be in contact with one another internally or with people from outside this training centre?

6. What kind of access to information and knowledge are available to trainers? e.g. Internet, seminars, magazines, newsletters, etc.?

7. Has your organisation organised retreats for trainers? Or have trainers themselves organised such retreats?

8. Are there any initiatives such as team-teaching, mentoring programs, apprenticeship, class observation, and the like that have been, are being, or will be implemented?

9. To what extent current professional development programs have helped improve trainers' capability?

10. Is there anything else that you would like to add?

Time ended: ___:___

OBSERVATION GUIDE

1. Daily activities and interactions among trainers, and between the trainers and others who are not trainers in their workplace. This may show the type of people with whom they are in contact and the type of information or resources they exchange.
2. The trainers' teaching activities
3. Training programs attended by the trainers
4. Formal meetings or informal, incidental gatherings
5. Conferences or seminars and other such events where the trainers are involved
6. If possible, sporting or leisure activities involving trainers outside their workplace
7. Physical environmental structures such as provisions and arrangements of facilities that may encourage or discourage social relationships and interactions
8. Additional items of observation may be included during fieldwork

DOCUMENT ANALYSIS GUIDE

1. Personnel records to see the socio-demographic features and other basic data about the trainers (Subject to an agreement of each respondent).
2. Annual reports which may show:
   a. General information such as the total number of training programs and other relevant development activities that have been organised for the trainers
   b. Informal learning activities that have been used or at least acknowledged as part of developing the quality and performance of the public service trainers.
   c. Turnover of trainers
3. Trainers' performance evaluation reports (Subject to respondents' agreement, availability of data and approval to access the data)
4. Policy papers which govern the trainers and their activities
5. Internal periodicals or newsletters
6. Organisational chart
7. Additional documents found to be relevant during data collection may be considered

Appendix 3. Consent Form

CONSENT FORM

Researcher : Muhammad Firdaus
Adress : School of Social Sciences, Faculty of Arts
the Australian National University, Canberra ACT 0200
Telephone : +61 2 61254420 Fax +61 2 61252222
Email : Muhammad.Firdaus@anu.edu.au

Background Information

I intend to carry out a study on social networks and informal learning involving trainers in [name of organisation]. The study is part of my Ph.D. program at the Australian National University. The purpose of the study is to investigate the role that social networks play in informal learning. It is expected to provide recommendations on how to maximise the benefits of social networks in developing trainers. It is also hoped that this study can contribute to the literature, especially in the areas of social network analysis and informal learning.

As part of this study, you are invited to take part as a research respondent. Your participation will be in the form of answering a questionnaire indicating with whom you normally collaborate, exchange advice and information as well as expressing your opinions and experiences on matters related to informal learning through the social relations above; participating in an interview and allowing the relevant official to authorise access to your personnel records.

All data obtained will be used for research purposes only, and the researcher will endeavour to keep your identity protected according to the requirements of Australian law by not disclosing your data to third parties, these data will not be published in any form that contains identifying or linking information. In conformity with the National Statement on Ethical Conduct in Research Involving Humans, a set of confidentiality protection procedures have been put in place to ensure your privacy and your data security as follows: (1) Participants' information will be de-identified as soon as data collection is completed by keeping identifiers separate from other information. (2) Researcher have been made familiar with relevant ethical considerations required by this research. (3) The number of project personnel who have access to identifying/linking information will be restricted to an absolute minimum and no identifying information will be shared outside this study, (4) The computer used for storing and processing raw data will not be connected to any network, (5) Files containing raw data (even encrypted) will not be transferred over the Internet, and (6) No data containing identifying information will be retained beyond the conclusion of this study.

You have the right to decide whether or not to participate in this study or to withdraw your participation at any stage without having to give reasons to justify your decision. In order to protect your privacy and the confidentiality of your information, I am required by the Human Research Ethics Committee of the Australian National University to obtain consent from those who are willing to participate. If you have any ethical concerns or queries regarding your participation in this research please contact the committee c/o Sylvia Deutsch (Human Ethic Officer) on +61 2 6125 2900, Fax +61 2 61254807, or Email Sylvia.Deutsch@anu.edu.au

Declaration

I have understood the purpose, methods, procedures, benefits and demands of the study and I agree to participate.

Signed:... Date: ....

Appendix 4. Adjacency Matrices

Communication relations between trainers in the GTC

GTC Trainer																																												
1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
8	1	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	1	1	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	1	1	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	1	0	0	1	0	0	0	1	1	1	0	0	1	1	0	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
28	0	0	1	0	0	1	0	0	0	1	1	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0
31	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Collaboration relations between trainers in the GTC

GTC Trainer																																												
1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	1	1	0	0	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
8	1	0	1	0	1	0	0	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
9	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
15	1	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	1	0	0	0	0	1	0	1	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
27	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
28	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0
31	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	1	0	1	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0
33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0
91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Advice-seeking relations between trainers in the GTC

GTC Trainer	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	8	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	15	1	1	0	0	1	0	0	1	0	1	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	16	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	31	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
	91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Advice-giving relations between trainers in the GTC

GTC Trainer	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	2	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	3	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	8	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	9	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
	15	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	16	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	17	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	18	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	25	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	26	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
	31	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	1	0	0	1	0	1	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
	32	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	1	0	0	0	0	0	1	0	0	0	0	0	0	0
	33	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	34	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	35	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	36	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	37	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	39	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	40	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	74	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
	88	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	89	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	90	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	91	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
	191	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	194	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Communication relations between trainers in the CTU

CTU Trainer 1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
2	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
3	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
4	1	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1	1	0	1	0	0	1	1	1	0	0	0
5	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
12	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	1	0	0	0	0	0	1	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	1	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	1	0	1	0	0	1	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	0	0	1	1	0	1	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	1	1
28	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0

Collaboration relations between trainers in the CTU

CTU Trainer 1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
2	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
3	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
4	1	1	1	0	1	1	0	0	0	0	0	1	0	0	0	0	1	1	0	1	1	0	1	0	0	1	1	1	0	0	0
5	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
6	0	0	1	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
9	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
11	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
12	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	1	1	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	1	1	1	0	0	0	0	0	1	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	1	1	1	0	1	1	1	1	0	0	0	0	0	1
22	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	1	0	1	0	0	1	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	1	1	1	0	0	0	0	0	0	1	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
27	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	1	1	1
28	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0
29	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	1	1	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0

Advice-seeking relations between trainers in the CTU

CTU Trainer 1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
2	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
3	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
4	1	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	0	1	0	0	1	1	1	0	0	0
5	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
12	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	1	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	1	1
28	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
29	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0

Advice-giving relations between trainers in the CTU

CTU Trainer 1	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
2	1	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
3	1	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
9	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0
12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1
14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1	0	0	1	1	1	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1	0	1	0	0	0	1	0	1	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0
27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0
28	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0
29	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	1	1	1	1	0	1	1	1	0	0	0
31	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix 5. Activities of public service trainers and their credit point values

Category	Areas of activities	Sub activities	Detail activities	Credit Points	Note
Primary activities	Formal education and training	Formal education relevant to trainers' areas of expertise	Doctoral degree	150	All disciplines
			Masters degree	100	
			Undergraduate degree	75	
		Formal training with certificate	> 960 hours	15	All levels
			641 - 960 hours	9	All levels
			401 - 640 hours	6	All levels
			161 - 400 hours	3	All levels
			81 - 160 hours	2	All levels
			30 - 80 hours	1	All levels
	Development and management of training programs in trainer's own organisation	Training needs assessment	Top level training programs	0.75	Senior
			Middle level training programs	0.75	Upper middle
			Extended level training programs	0.5	Lower middle
			Basic level training programs	0.5	Junior
		Designing training curriculum	Top level training	0.5	Senior
			Middle level training	0.5	Upper middle
			Extended level training	0.25	Lower middle
			Basic level training	0.25	Junior
		Designing training materials	Top level training programs	0.75	Senior
			Middle level training programs	0.75	Upper middle
			Extended level training programs	0.5	Lower middle
			Basic level training programs	0.5	Junior
		Designing guidelines of training sessions	Top level training programs	0.5	Senior
			Middle level training programs	0.5	Upper middle
			Extended level training programs	0.4	Lower middle
			Basic level training programs	0.4	Junior
		Designing training modules	Top level training programs	10	Senior
			Middle level training programs	7.5	Upper middle
			Extended level training programs	5	Lower middle
			Basic level training programs	2.5	Junior
		Designing end of course evaluation	Top level training programs	0.1	Senior
			Middle level training programs	0.1	Upper middle
			Extended level training programs	0.05	Lower middle
			Basic level training programs	0.05	Junior
		Teaching, tutoring and making observation in training activities in trainer's own organisation	Teaching in top level training programs	0.08	Senior
			Teaching in middle level training programs	0.06	Upper middle
			Teaching in extended level training programs	0.05	Lower middle
			Teaching in basic level training programs	0.03	Junior
			Tutoring for top level long distance training programs	0.08	Senior
			Tutoring for middle level long distance training programs	0.06	Upper middle
			Tutoring for extended level long distance training programs	0.05	Lower middle
			Tutoring for basic level long distance training programs	0.03	Junior
			Observation in Top level training programs	0.02	Senior
			Observation in Middle level training programs	0.02	Upper middle
			Observation in Extended level training programs	0.01	Lower middle
			Observation in Basic level training programs	0.01	Junior

Category	Areas of activities	Sub activities	Detail activities	Credit Points	Note
		Managing training programs in trainer's own organisations	Program coordinator for training with > 401 hours	4	All ranks
			Program coordinator for training with 301 - 400 hours	3	
			Program coordinator for training with 201 - 300 hours	2.5	
			Program coordinator for training with 101 - 200 hours	2	
			Program coordinator for training with 81 - 100 hours	1.5	
			Program coordinator for training with 30 - 80 hours	1	
			Member of team managing training with > 401 hours	2	All ranks
			Member of team managing training with 301 - 400 hours	1.5	
			Member of team managing training with 201 - 300 hours	1.25	
			Member of team managing training with 101 - 200 hours	1	
			Member of team managing training with 81 - 100 hours	0.75	
			Member of team managing training with 30 - 80 hours	0.5	
		Providing advice and/or being a consultant	Advising in project report for top level training	0.25	Senior
			Advising in project report for middle level training	0.25	Upper middle
			Advising in project report for extended level training	0.1	Lower middle
			Advising in project report for basic level training	0.1	Junior
			Advising in the field trip for top level training programs	0.3	Senior
			Advising in the field trip for middle level training programs	0.3	Upper middle
			Advising in the field trip for extended level training programs	0.2	Lower middle
			Advising in the field trip for basic level training programs	0.2	Junior
			Being a facilitator/moderator/resource person in seminar or discussion of top level training	0.2	Senior
			Being a facilitator/moderator/resource person in seminar or discussion of middle level training	0.25	Upper middle
			Being a facilitator/moderator/resource person in seminar or discussion of extended level training	0.15	Lower middle
			Being a facilitator/moderator/resource person in seminar or discussion of basic level training	0.15	Junior
			A consultant for top level training programs	0.5	Senior
			A consultant for middle level training programs	0.5	Upper middle
			A consultant for extended level training programs	0.3	Lower middle
			A consultant for basic level training programs	0.3	Junior
		Training program evaluation	Evaluating top level training programs	0.25	Senior
			Evaluating middle level training programs	0.25	Upper middle
			Evaluating extended level training programs	0.15	Lower middle
			Evaluating basic level training programs	0.15	Junior
		End of training module examination	Invigilators for top level training programs	0.1	Senior
			Invigilators for middle level training programs	0.1	Upper middle
			Invigilators for extended level training programs	0.05	Lower middle
			Invigilators for basic level training programs	0.05	Junior
			Marking exam for top level training programs	1	Senior
			Marking exam for middle level training programs	1	Upper middle
			Marking exam for extended level training programs	0.5	Lower middle
			Marking exam for basic level training programs	0.5	Junior

Category	Areas of activities	Sub activities	Detail activities	Credit Points	Note
	Development of trainer profession	Publications	Published research report in the form of book and distributed nation wide	12.5	All ranks
			Unpublished but acknowledged by trainers' own organisation	6	
			Unpublished book based on research held in trainers' own institution's library	8	
			Unpublished work based on research held in trainers' own institution's library	4	
			Published book based on trainers' own opinion, distributed nationally	8	
			Published work based on trainers own opinion, acknowledged by trainers' own institution	4	
			Unpublished book based on trainers own opinion, held in own institution's library	7	
			Unpublished document based on trainers' own opinion, held by institution's own library	3.5	
			Popular writing published in mass media	2	
			Papers presented in seminars or workshops	2.5	
		Book translation or review	Nationally distributed published book translation/review	7	All ranks
			Published paper translation/review acknowledge by own institutions	3.5	
			Unpublished book translation/review relevant to training	3	
			Unpublished paper translation/review relevant to training	1.5	
		Academic speech/lecture	Delivering academic speech or public lecture relevant to the subject taught	5	All ranks
Supporting activities	supporting for training	Attending seminar/workshop relevant to the subject taught	As a presenter	2	All ranks
			As a moderator/resource person	2	
			As a participant	1	
		Being a member of trainers evaluator team	Active member	0.5	All ranks
		Teaching in public service training programs in other institutions	Teaching subjects relevant to one's discipline outside trainers' own institution	0.04	Senior
				0.03	Upper middle
				0.02	Lower middle
				0.01	Junior
		Teaching in non-public service training	Teaching in non-public service training programs	0.04	Senior
				0.03	Upper middle
				0.02	Lower middle
				0.01	Junior
		Participating in international academic meetings	As a delegate coordinator	3	All ranks
			As a delegate member	2	
		Being a member of professional organisations	As a board member	6	All ranks
			As an ordinary member	1	
		Awarded with accredited additional academic degrees	Doctoral degree outside of one's primary discipline	15	All ranks
			Masters degree outside of one's primary discipline	10	
		other awards	Achieving international award for personal achievements	3	All ranks
			Achieving national award for personal achievements	2.5	
			Achieving local award for personal achievements	2	
			Academic award by Indonesian government (the Department of Education)	1.5	

Appendix 6. Similarity matrices based on structural equivalence and regular equivalence

Structural equivalence

Computed using Pierson correlation product moment on communication, collaboration, advice-seeking and advice-giving relations in the GTC

	1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	18	19	20	23	24	25	26	27	28
1	1.000																								
2	0.257	1.000																							
3	0.198	0.062	1.000																						
4	0.051	-0.038	-0.046	1.000																					
5	0.577	0.245	0.128	-0.037	1.000																				
6	-0.055	-0.006	0.151	-0.051	-0.002	1.000																			
7	-0.035	-0.038	-0.046	-0.032	-0.037	0.261	1.000																		
8	0.203	0.179	0.155	-0.017	0.102	0.027	0.033	1.000																	
9	0.627	0.270	0.275	-0.034	0.362	-0.053	-0.034	0.169	1.000																
10	0.348	0.156	0.241	0.074	0.387	0.086	-0.051	0.226	0.246	1.000															
11	-0.035	-0.038	0.358	-0.032	-0.037	0.199	-0.032	-0.067	-0.034	0.199	1.000														
12	-0.030	-0.032	0.118	-0.027	-0.031	0.248	-0.027	0.001	0.076	0.103	0.301	1.000													
13	-0.021	-0.023	-0.028	-0.019	-0.022	0.175	0.443	0.124	-0.020	-0.030	-0.019	-0.016	1.000												
15	0.191	0.245	-0.053	-0.037	0.107	-0.057	-0.037	0.235	0.122	0.109	-0.037	-0.031	-0.022	1.000											
16	-0.061	-0.066	0.334	-0.056	-0.012	0.257	0.175	0.037	-0.003	0.104	0.290	0.222	-0.033	-0.063	1.000										
17	0.074	0.004	0.224	0.089	0.068	0.286	0.089	0.119	-0.049	0.286	0.291	0.276	-0.028	-0.053	0.417	1.000									
18	0.314	0.229	0.312	0.019	0.240	0.321	-0.047	0.112	0.330	0.145	0.217	0.191	-0.028	0.123	0.080	0.217	1.000								
19	0.153	0.074	0.146	0.102	0.080	0.173	-0.043	0.064	0.024	0.077	0.246	0.048	-0.026	0.016	0.148	0.198	0.293	1.000							
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000						
23	-0.030	-0.032	-0.039	0.301	-0.031	-0.043	-0.027	-0.057	-0.029	0.030	-0.027	-0.023	-0.016	-0.031	-0.047	-0.039	-0.040	0.048	0.000	1.000					
24	-0.021	0.110	-0.028	-0.019	-0.022	-0.030	-0.019	-0.040	-0.020	-0.030	-0.019	-0.016	-0.011	-0.022	-0.033	-0.028	-0.028	-0.026	0.000	-0.016	1.000				
25	0.000	-0.008	0.234	0.010	0.051	0.286	0.071	-0.010	-0.054	-0.041	0.255	0.099	-0.031	-0.059	0.287	0.278	0.313	0.215	0.000	-0.044	-0.031	1.000			
26	0.263	0.375	0.083	0.135	0.252	-0.030	-0.019	-0.040	0.423	0.175	-0.019	-0.016	-0.011	0.115	-0.033	-0.028	0.297	0.093	0.000	-0.016	-0.011	-0.031	1.000		
27	0.057	-0.061	-0.030	0.194	-0.004	0.000	0.194	-0.042	-0.054	-0.041	0.010	-0.044	-0.031	-0.004	0.174	0.058	0.097	0.073	0.000	0.314	-0.031	0.077	0.070	1.000	
28	0.078	0.066	0.282	0.024	0.071	0.066	-0.045	0.162	-0.047	0.112	0.231	0.042	-0.027	0.010	0.430	0.331	0.176	0.205	0.000	-0.038	0.086	0.378	-0.027	0.063	1.000
29	-0.044	0.018	0.051	-0.040	0.022	0.342	-0.040	-0.003	-0.042	0.240	0.264	0.232	-0.024	-0.046	0.070	0.270	0.155	0.063	0.000	-0.034	0.226	0.084	-0.024	-0.065	0.167
30	-0.002	-0.062	-0.076	0.249	-0.060	0.078	0.249	-0.046	-0.055	0.037	-0.053	-0.045	0.167	-0.060	0.131	0.141	-0.035	0.069	0.000	0.167	-0.032	0.034	0.068	0.546	-0.030
31	-0.073	-0.079	0.047	0.083	-0.076	0.193	0.132	-0.086	-0.070	-0.105	-0.067	-0.057	0.206	-0.076	-0.055	-0.096	0.042	-0.012	0.000	0.060	-0.040	0.088	-0.040	0.186	-0.057
32	-0.053	-0.057	0.023	-0.049	-0.055	0.225	0.664	-0.032	-0.051	-0.076	-0.049	-0.041	0.290	-0.055	0.075	0.023	0.020	-0.065	0.000	-0.041	-0.029	0.134	-0.029	0.261	-0.068
33	0.046	-0.040	0.146	-0.034	-0.038	0.007	-0.034	-0.022	0.051	0.007	0.146	0.076	-0.020	-0.038	0.052	0.146	0.077	0.024	0.000	-0.029	-0.020	0.005	-0.020	-0.054	0.151
34	-0.048	-0.052	-0.063	0.238	-0.050	0.025	0.379	-0.092	-0.046	-0.022	-0.044	-0.037	-0.026	-0.050	0.227	0.038	-0.065	-0.059	0.000	0.127	-0.026	0.068	-0.026	0.344	-0.010
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000
39	-0.028	-0.030	-0.037	-0.026	0.075	-0.040	-0.026	-0.053	-0.027	-0.040	-0.026	-0.022	-0.015	0.075	-0.044	-0.037	-0.038	-0.034	0.000	-0.022	-0.015	0.035	-0.015	-0.041	-0.036
40	-0.044	-0.048	-0.058	0.416	0.022	-0.013	-0.040	-0.044	-0.042	0.139	-0.040	-0.034	-0.024	-0.046	-0.023	0.051	-0.060	-0.054	0.000	0.232	-0.024	0.035	0.101	0.284	-0.001
41	0.078	-0.053	0.084	0.024	0.071	0.021	0.231	-0.094	0.085	0.066	-0.045	-0.038	-0.027	-0.051	0.345	0.034	0.030	-0.060	0.000	-0.038	-0.027	0.108	-0.027	0.198	0.038
74	-0.024	-0.025	-0.031	-0.022	-0.024	-0.034	-0.022	-0.045	-0.023	-0.034	-0.022	-0.018	-0.013	-0.024	-0.037	-0.031	-0.032	0.078	0.000	-0.018	-0.013	-0.035	-0.013	-0.035	-0.030
88	-0.018	-0.020	-0.024	-0.017	-0.019	-0.026	-0.017	-0.035	-0.017	-0.026	-0.017	-0.014	-0.010	-0.019	-0.029	-0.024	-0.025	-0.022	0.000	-0.014	-0.010	-0.027	-0.010	-0.027	-0.023
89	-0.015	-0.016	-0.020	-0.014	-0.015	-0.021	-0.014	-0.028	-0.014	-0.021	-0.014	-0.012	-0.008	-0.015	-0.023	-0.020	-0.020	-0.018	0.000	-0.012	-0.008	-0.022	-0.008	-0.022	-0.019
90	-0.024	-0.025	-0.031	-0.022	-0.024	-0.034	-0.022	-0.045	-0.023	-0.034	-0.022	-0.018	-0.013	-0.024	-0.037	-0.031	-0.032	-0.029	0.000	-0.018	-0.013	-0.035	-0.013	-0.035	-0.030
91	-0.015	-0.016	-0.020	-0.014	-0.015	-0.021	-0.014	-0.028	-0.014	-0.021	-0.014	-0.012	-0.008	-0.015	-0.023	-0.020	-0.020	-0.018	0.000	-0.012	-0.008	-0.022	-0.008	-0.022	-0.019
191	-0.015	-0.016	-0.020	-0.014	-0.015	-0.021	-0.014	-0.028	-0.014	-0.021	-0.014	-0.012	-0.008	-0.015	-0.023	-0.020	-0.020	-0.018	0.000	-0.012	-0.008	-0.022	-0.008	-0.022	-0.019
194	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000

(Continued)

	29	30	31	32	33	34	35	36	37	39	40	41	74	88	89	90	91	191	194
29	1.000																		
30	-0.066	1.000																	
31	-0.084	0.211	1.000																
32	-0.061	0.337	0.450	1.000															
33	-0.042	-0.055	-0.070	-0.051	1.000														
34	-0.055	0.291	0.283	0.323	-0.046	1.000													
35	0.000	0.000	0.000	0.000	0.000	0.000	1.000												
36	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000											
37	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000										
39	-0.032	-0.042	-0.053	-0.039	-0.027	-0.035	0.000	0.000	0.000	1.000									
40	0.011	0.179	0.199	0.097	-0.042	0.345	0.000	0.000	0.000	-0.032	1.000								
41	-0.057	0.192	0.126	0.122	-0.047	0.353	0.000	0.000	0.000	-0.036	-0.001	1.000							
74	-0.027	-0.035	-0.045	-0.032	-0.023	-0.029	0.000	0.000	0.000	-0.017	-0.027	-0.030	1.000						
88	-0.021	-0.027	-0.035	-0.025	-0.017	-0.023	0.000	0.000	0.000	-0.013	-0.021	-0.023	-0.011	1.000					
89	-0.017	-0.022	-0.028	-0.020	-0.014	-0.019	0.000	0.000	0.000	-0.011	-0.017	-0.019	-0.009	0.815	1.000				
90	-0.027	-0.035	-0.045	-0.032	-0.023	-0.029	0.000	0.000	0.000	-0.017	-0.027	-0.030	-0.014	-0.011	-0.009	1.000			
91	-0.017	-0.022	-0.028	-0.020	-0.014	-0.019	0.000	0.000	0.000	-0.011	-0.017	-0.019	-0.009	-0.007	-0.006	-0.009	1.000		
191	-0.017	-0.022	-0.028	-0.020	-0.014	-0.019	0.000	0.000	0.000	-0.011	-0.017	-0.019	-0.009	-0.007	-0.006	-0.009	-0.006	1.000	
194	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Structural equivalence

Computed using Pierson correlation product moment on communication, collaboration, advice-seeking and advice-giving relations in the CTU

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
1	1.000																	
2	0.597	1.000																
3	0.441	0.544	1.000															
4	0.456	0.393	0.320	1.000														
5	0.742	0.467	0.426	0.441	1.000													
6	0.378	0.088	0.188	0.116	0.316	1.000												
7	-0.092	-0.123	-0.132	-0.109	-0.094	0.145	1.000											
8	-0.062	-0.083	-0.089	-0.099	-0.064	-0.056	0.430	1.000										
9	-0.020	-0.027	-0.029	-0.032	-0.021	-0.018	-0.018	-0.012	1.000									
10	-0.075	-0.100	-0.108	-0.075	-0.077	0.136	0.204	0.341	-0.015	1.000								
11	-0.105	-0.026	0.030	0.103	-0.107	-0.094	0.111	0.374	-0.021	0.045	1.000							
12	-0.007	0.113	-0.004	-0.022	-0.010	0.006	0.076	0.157	-0.014	-0.053	0.435	1.000						
13	-0.058	-0.101	-0.114	-0.133	-0.061	-0.094	0.008	0.082	-0.021	-0.016	-0.061	-0.074	1.000					
14	-0.092	-0.123	-0.132	-0.109	-0.094	-0.083	0.088	-0.056	-0.018	-0.068	-0.094	-0.065	-0.043	1.000				
15	-0.097	-0.129	-0.139	-0.047	-0.100	-0.088	-0.088	-0.059	-0.019	-0.072	-0.100	-0.069	-0.002	0.402	1.000			
16	-0.127	-0.170	-0.183	-0.145	-0.130	-0.115	-0.115	-0.077	-0.025	-0.094	-0.130	-0.090	0.068	0.238	0.258	1.000		
17	0.152	0.098	0.086	-0.073	0.147	0.174	-0.041	-0.028	-0.009	-0.034	-0.047	0.101	-0.047	0.067	-0.044	0.026	1.000	
18	0.197	0.130	0.115	-0.087	0.191	0.134	0.134	-0.033	-0.011	-0.040	-0.056	0.075	-0.056	0.226	-0.052	-0.068	0.322	1.000
19	-0.105	-0.139	-0.150	-0.065	-0.107	-0.094	0.008	-0.064	-0.021	-0.077	-0.107	-0.074	-0.107	0.316	0.292	0.107	-0.047	0.191
20	0.221	0.152	0.136	-0.080	0.215	0.152	0.152	-0.031	-0.010	-0.037	-0.052	0.087	-0.052	0.152	-0.048	-0.063	0.351	0.924
21	-0.048	-0.120	-0.140	-0.119	-0.054	-0.062	-0.139	0.071	-0.031	-0.021	-0.089	-0.061	0.120	0.170	0.259	0.286	0.150	0.104
22	-0.142	-0.189	-0.204	-0.119	-0.146	-0.128	-0.006	-0.086	-0.028	-0.105	-0.072	-0.100	0.111	0.402	0.294	0.264	0.013	0.121
23	0.065	0.004	-0.012	-0.147	0.060	0.031	-0.026	-0.056	-0.018	-0.068	-0.094	0.006	0.162	0.031	0.130	0.282	0.174	0.409
24	-0.123	-0.164	-0.176	-0.136	-0.126	-0.111	-0.020	-0.075	-0.024	-0.091	-0.126	-0.087	0.199	0.206	0.229	0.406	-0.055	0.080
25	-0.041	-0.054	-0.059	-0.065	-0.042	-0.037	0.204	-0.025	-0.008	-0.030	-0.042	-0.029	-0.042	0.445	0.191	0.042	-0.018	0.365
26	0.311	0.367	0.445	0.348	0.458	0.088	-0.019	0.094	-0.036	-0.046	0.169	0.006	0.009	-0.161	-0.170	-0.085	0.055	0.076
27	0.282	0.154	0.270	0.109	0.121	0.167	0.001	-0.025	-0.027	-0.052	0.083	-0.046	0.121	0.042	0.068	0.085	0.096	0.127
28	0.416	0.270	0.078	0.191	0.362	0.206	0.160	0.118	-0.024	0.071	-0.004	-0.031	0.077	-0.111	-0.117	-0.083	0.116	0.152
29	0.078	0.006	0.059	-0.005	0.026	0.055	0.306	0.150	-0.021	-0.019	0.162	0.174	-0.064	-0.096	-0.054	-0.056	-0.048	-0.057
30	-0.006	-0.084	-0.050	-0.007	-0.083	-0.096	-0.136	-0.091	-0.030	-0.111	-0.013	-0.106	0.306	0.061	0.120	0.360	0.007	-0.080
31	-0.087	-0.115	-0.124	-0.059	-0.089	-0.078	-0.018	-0.053	-0.017	-0.064	-0.089	-0.061	0.127	0.042	0.089	0.217	-0.039	0.050

(Continued)

	19	20	21	22	23	24	25	26	27	28	29	30	31
19	1.000												
20	0.126	1.000											
21	0.155	0.125	1.000										
22	0.295	0.071	0.283	1.000									
23	0.111	0.349	0.209	0.321	1.000								
24	0.281	0.018	0.090	0.250	0.477	1.000							
25	0.391	0.396	0.101	0.115	0.083	0.142	1.000						
26	-0.183	0.097	-0.101	-0.070	0.088	-0.074	-0.072	1.000					
27	0.121	0.148	0.102	-0.073	0.167	0.098	0.121	0.097	1.000				
28	-0.126	0.174	0.029	0.023	0.115	-0.076	-0.049	0.350	0.329	1.000			
29	-0.110	-0.053	-0.094	-0.113	-0.096	-0.049	-0.043	-0.061	0.150	0.191	1.000		
30	0.058	-0.074	0.093	0.297	0.100	0.287	-0.060	-0.066	0.055	0.037	0.016	1.000	
31	0.073	0.061	-0.050	0.137	0.102	0.229	0.092	0.073	0.146	0.038	0.068	0.162	1.000

Computed using REGE on communication, collaboration, advice-seeking and advice-giving relations in the GTC

	1	2	3	4	5	6	7	8	9	10	11	12	13	15	16	17	18	19	20	23	24	25
1	1.000																					
2	0.608	1.000																				
3	0.599	0.457	1.000																			
4	0.529	0.409	0.473	1.000																		
5	0.740	0.538	0.596	0.510	1.000																	
6	0.591	0.454	0.660	0.495	0.602	1.000																
7	0.553	0.577	0.629	0.426	0.517	0.770	1.000															
8	0.643	0.432	0.629	0.392	0.650	0.708	0.674	1.000														
9	0.840	0.619	0.686	0.527	0.654	0.620	0.595	0.679	1.000													
10	0.731	0.373	0.645	0.526	0.714	0.690	0.584	0.686	0.707	1.000												
11	0.397	0.280	0.498	0.519	0.370	0.517	0.435	0.379	0.369	0.522	1.000											
12	0.337	0.071	0.334	0.369	0.429	0.395	0.310	0.330	0.386	0.519	0.389	1.000										
13	0.330	0.478	0.368	0.312	0.284	0.365	0.535	0.297	0.375	0.258	0.286	0.165	1.000									
15	0.581	0.602	0.487	0.405	0.632	0.401	0.445	0.478	0.529	0.450	0.197	0.174	0.275	1.000								
16	0.565	0.317	0.581	0.479	0.603	0.719	0.680	0.644	0.597	0.635	0.482	0.452	0.271	0.404	1.000							
17	0.498	0.388	0.555	0.481	0.509	0.609	0.564	0.536	0.606	0.632	0.527	0.529	0.360	0.279	0.707	1.000						
18	0.666	0.623	0.723	0.517	0.652	0.767	0.602	0.621	0.725	0.652	0.471	0.283	0.466	0.438	0.522	0.523	1.000					
19	0.641	0.594	0.577	0.604	0.598	0.624	0.576	0.518	0.567	0.560	0.573	0.283	0.395	0.452	0.522	0.561	0.659	1.000				
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000			
23	0.408	0.418	0.455	0.520	0.452	0.491	0.394	0.431	0.361	0.393	0.521	0.303	0.328	0.329	0.420	0.474	0.500	0.632	0.000	1.000		
24	0.406	0.828	0.423	0.391	0.400	0.387	0.524	0.314	0.386	0.177	0.280	0.000	0.518	0.606	0.227	0.234	0.555	0.514	0.000	0.459	1.000	
25	0.569	0.550	0.658	0.549	0.606	0.755	0.655	0.637	0.615	0.658	0.527	0.327	0.420	0.474	0.680	0.587	0.713	0.592	0.000	0.471	0.459	1.000
26	0.388	0.626	0.443	0.400	0.376	0.418	0.435	0.334	0.466	0.360	0.416	0.245	0.482	0.278	0.242	0.447	0.563	0.519	0.000	0.446	0.578	0.419
27	0.570	0.349	0.496	0.423	0.578	0.685	0.698	0.661	0.559	0.638	0.509	0.394	0.303	0.384	0.707	0.549	0.516	0.523	0.000	0.519	0.267	0.638
28	0.663	0.464	0.714	0.604	0.615	0.605	0.551	0.575	0.622	0.653	0.566	0.380	0.388	0.464	0.666	0.658	0.659	0.665	0.000	0.532	0.409	0.673
29	0.589	0.339	0.636	0.498	0.627	0.732	0.617	0.759	0.588	0.761	0.647	0.568	0.213	0.261	0.681	0.618	0.637	0.591	0.000	0.558	0.261	0.655
30	0.613	0.485	0.598	0.509	0.625	0.775	0.760	0.722	0.672	0.696	0.463	0.353	0.372	0.483	0.745	0.599	0.646	0.550	0.000	0.454	0.360	0.763
31	0.541	0.643	0.516	0.386	0.529	0.712	0.764	0.580	0.664	0.582	0.347	0.164	0.488	0.409	0.512	0.436	0.650	0.486	0.000	0.321	0.576	0.803
32	0.489	0.564	0.577	0.315	0.494	0.771	0.909	0.667	0.587	0.542	0.374	0.276	0.492	0.449	0.601	0.491	0.589	0.500	0.000	0.353	0.509	0.697
33	0.779	0.557	0.709	0.585	0.609	0.655	0.572	0.672	0.854	0.668	0.462	0.456	0.360	0.478	0.632	0.672	0.713	0.601	0.000	0.438	0.326	0.654
34	0.529	0.493	0.555	0.502	0.520	0.658	0.782	0.580	0.650	0.611	0.394	0.315	0.305	0.395	0.742	0.587	0.537	0.486	0.000	0.349	0.423	0.713
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000
39	0.441	0.406	0.531	0.481	0.432	0.536	0.404	0.535	0.457	0.547	0.518	0.303	0.245	0.397	0.476	0.414	0.540	0.553	0.000	0.448	0.375	0.517
40	0.619	0.548	0.634	0.622	0.662	0.747	0.716	0.687	0.671	0.729	0.478	0.441	0.358	0.515	0.725	0.606	0.682	0.584	0.000	0.465	0.409	0.777
41	0.506	0.070	0.417	0.305	0.501	0.558	0.657	0.536	0.633	0.622	0.366	0.479	0.217	0.215	0.705	0.557	0.334	0.246	0.000	0.217	0.000	0.458
74	0.423	0.434	0.558	0.439	0.468	0.498	0.407	0.449	0.513	0.478	0.385	0.389	0.439	0.242	0.394	0.498	0.601	0.484	0.000	0.449	0.411	0.492
88	0.202	0.048	0.172	0.137	0.179	0.147	0.145	0.193	0.272	0.269	0.103	0.327	0.066	0.069	0.230	0.259	0.095	0.107	0.000	0.121	0.000	0.117
89	0.126	0.000	0.180	0.148	0.125	0.128	0.104	0.142	0.225	0.235	0.111	0.304	0.077	0.037	0.160	0.198	0.099	0.061	0.000	0.067	0.000	0.100
90	0.246	0.317	0.195	0.190	0.183	0.202	0.236	0.146	0.149	0.092	0.238	0.000	0.293	0.262	0.114	0.076	0.270	0.248	0.000	0.223	0.423	0.195
91	0.026	0.067	0.039	0.000	0.026	0.036	0.094	0.027	0.039	0.012	0.013	0.000	0.178	0.034	0.002	0.014	0.046	0.013	0.000	0.006	0.135	0.026
191	0.035	0.000	0.026	0.005	0.020	0.031	0.050	0.046	0.061	0.040	0.010	0.025	0.035	0.010	0.047	0.035	0.011	0.000	0.000	0.000	0.000	0.033
194	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	0.000	0.000	0.000

(Continued)

	26	27	28	29	30	31	32	33	34	35	36	37	39	40	41	74	88	89	90	91	191	194
26	1.000																					
27	0.332	1.000																				
28	0.447	0.546	1.000																			
29	0.440	0.711	0.652	1.000																		
30	0.374	0.790	0.590	0.664	1.000																	
31	0.486	0.580	0.475	0.484	0.806	1.000																
32	0.449	0.661	0.475	0.571	0.784	0.807	1.000															
33	0.469	0.545	0.668	0.548	0.678	0.664	0.578	1.000														
34	0.374	0.650	0.556	0.556	0.787	0.710	0.708	0.617	1.000													
35	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000												
36	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000											
37	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000										
39	0.323	0.452	0.551	0.615	0.486	0.358	0.339	0.497	0.407	0.000	0.000	0.000	1.000									
40	0.487	0.757	0.614	0.650	0.854	0.802	0.768	0.664	0.815	0.000	0.000	0.000	0.466	1.000								
41	0.158	0.679	0.435	0.633	0.637	0.355	0.539	0.607	0.639	0.000	0.000	0.000	0.407	0.628	1.000							
74	0.503	0.345	0.557	0.514	0.433	0.426	0.404	0.560	0.404	0.000	0.000	0.000	0.435	0.491	0.315	1.000						
88	0.101	0.155	0.169	0.232	0.142	0.057	0.097	0.314	0.139	0.000	0.000	0.000	0.103	0.168	0.304	0.163	1.000					
89	0.118	0.104	0.158	0.210	0.116	0.055	0.058	0.255	0.115	0.000	0.000	0.000	0.115	0.163	0.246	0.187	0.800	1.000				
90	0.207	0.147	0.222	0.154	0.144	0.195	0.184	0.165	0.089	0.000	0.000	0.000	0.218	0.127	0.000	0.155	0.000	0.000	1.000			
91	0.092	0.017	0.013	0.024	0.028	0.073	0.091	0.022	0.026	0.000	0.000	0.000	0.014	0.042	0.000	0.145	0.000	0.000	0.086	1.000		
191	0.000	0.049	0.017	0.025	0.048	0.027	0.027	0.071	0.053	0.000	0.000	0.000	0.113	0.018	0.115	0.018	0.080	0.100	0.000	0.000	1.000	
194	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000	1.000	1.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	1.000

Regular equivalence

Computed using REGE on communication, collaboration, advice-seeking and advice-giving relations in the CTU

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	1.000																					
2	0.964	1.000																				
3	0.958	0.972	1.000																			
4	0.874	0.868	0.856	1.000																		
5	0.984	0.964	0.959	0.876	1.000																	
6	0.750	0.653	0.674	0.594	0.713	1.000																
7	0.630	0.579	0.553	0.573	0.589	0.680	1.000															
8	0.431	0.483	0.397	0.530	0.415	0.367	0.680	1.000														
9	0.057	0.089	0.082	0.108	0.127	0.074	0.095	0.113	1.000													
10	0.363	0.435	0.364	0.573	0.407	0.303	0.406	0.660	0.232	1.000												
11	0.671	0.721	0.689	0.696	0.685	0.544	0.600	0.636	0.099	0.493	1.000											
12	0.629	0.612	0.590	0.704	0.613	0.542	0.538	0.564	0.051	0.424	0.759	1.000										
13	0.955	0.955	0.957	0.832	0.956	0.739	0.720	0.627	0.127	0.515	0.820	0.624	1.000									
14	0.780	0.625	0.687	0.542	0.763	0.777	0.552	0.321	0.058	0.281	0.516	0.647	0.663	1.000								
15	0.758	0.668	0.654	0.676	0.697	0.657	0.479	0.389	0.000	0.353	0.584	0.721	0.680	0.758	1.000							
16	0.936	0.936	0.939	0.877	0.936	0.734	0.589	0.412	0.091	0.399	0.713	0.690	0.943	0.730	0.729	1.000						
17	0.392	0.274	0.303	0.155	0.317	0.493	0.431	0.241	0.000	0.016	0.254	0.373	0.363	0.411	0.369	0.353	1.000					
18	0.586	0.368	0.454	0.262	0.507	0.623	0.481	0.197	0.000	0.020	0.342	0.625	0.335	0.582	0.556	0.485	0.538	1.000				
19	0.790	0.759	0.732	0.833	0.787	0.607	0.462	0.423	0.086	0.493	0.664	0.777	0.772	0.670	0.779	0.805	0.290	0.518	1.000			
20	0.559	0.349	0.437	0.241	0.480	0.573	0.500	0.210	0.000	0.021	0.275	0.529	0.318	0.513	0.455	0.441	0.587	0.923	0.389	1.000		
21	0.862	0.890	0.872	0.830	0.859	0.735	0.640	0.526	0.082	0.416	0.695	0.644	0.874	0.667	0.685	0.880	0.345	0.434	0.722	0.398	1.000	
22	0.884	0.895	0.892	0.819	0.879	0.759	0.571	0.418	0.078	0.388	0.684	0.624	0.896	0.721	0.737	0.898	0.343	0.462	0.748	0.403	0.870	1.000
23	0.845	0.778	0.807	0.648	0.824	0.715	0.669	0.410	0.065	0.295	0.659	0.677	0.878	0.643	0.718	0.786	0.518	0.697	0.714	0.610	0.758	0.731
24	0.951	0.948	0.949	0.857	0.949	0.732	0.600	0.421	0.092	0.367	0.695	0.630	0.951	0.749	0.698	0.945	0.326	0.476	0.771	0.447	0.873	0.903
25	0.415	0.244	0.313	0.190	0.368	0.494	0.352	0.074	0.000	0.013	0.269	0.475	0.262	0.447	0.437	0.358	0.568	0.723	0.433	0.703	0.303	0.321
26	0.944	0.964	0.958	0.864	0.949	0.643	0.558	0.475	0.071	0.406	0.711	0.633	0.961	0.617	0.675	0.939	0.272	0.390	0.765	0.358	0.893	0.891
27	0.949	0.943	0.937	0.890	0.943	0.680	0.600	0.525	0.104	0.486	0.764	0.708	0.944	0.683	0.724	0.927	0.284	0.428	0.836	0.369	0.868	0.890
28	0.864	0.784	0.784	0.757	0.861	0.767	0.620	0.371	0.055	0.325	0.585	0.616	0.847	0.734	0.723	0.852	0.392	0.574	0.707	0.529	0.761	0.786
29	0.710	0.558	0.601	0.511	0.659	0.674	0.674	0.344	0.000	0.180	0.477	0.644	0.608	0.707	0.639	0.664	0.408	0.628	0.565	0.574	0.582	0.582
30	0.950	0.948	0.950	0.834	0.949	0.754	0.634	0.436	0.090	0.338	0.703	0.581	0.954	0.707	0.679	0.955	0.346	0.454	0.706	0.437	0.889	0.899
31	0.976	0.954	0.955	0.888	0.968	0.735	0.662	0.527	0.087	0.528	0.764	0.715	0.954	0.756	0.811	0.944	0.352	0.518	0.836	0.492	0.851	0.885

(Continued)

	23	24	25	26	27	28	29	30	31
23	1.000								
24	0.825	1.000							
25	0.518	0.336	1.000						
26	0.768	0.942	0.278	1.000					
27	0.788	0.937	0.317	0.950	1.000				
28	0.733	0.844	0.399	0.793	0.848	1.000			
29	0.657	0.656	0.450	0.570	0.603	0.731	1.000		
30	0.799	0.954	0.312	0.948	0.938	0.814	0.627	1.000	
31	0.837	0.952	0.404	0.945	0.952	0.878	0.728	0.959	1.000

BIBLIOGRAPHY

Alba, R. D. (1973). "A graph-theoretic definition of a sociometric clique." Journal of Mathematical Sociology **3**(1): 113-126.

Alba, R. D. & Moore, G. (1978). "Elite social circles." Sociological Methods and Research **7**(2): 167-188.

Arabie, P. (1984). "Validation of sociometric structure by data on individuals' attributes." Social Networks **6**: 373-403.

Araujo, L. (1998). "Knowing and learning as networking." Management Learning **29**(3): 317-336.

ARDA (n.d.). Tacit knowledge and abstract data visualization [Online]. Available: http://www.ic-arda.org/InfoExploit/gi2vis/tkaadv.html [24 Nov 2001].

Argote, L., Ingram, P., Levine, J. M. & Moreland, R. L. (2000). "Knowledge transfer in organizations: Learning from the experience of others." Organizational Behavior & Human Decision Processes **82**(1): 1-8.

Argyris, C. & Schon, D. A. (1996). Organizational Learning II: Theory, method and practice. Reading, Mass.: Addison-Wesley.

Athanassiou, N. & Nigh, D. (1999). "The impact of US company internationalization on top management team advice networks: A tacit knowledge perspective." Strategic Management Journal **20**: 83-92.

Baldwin, T. T., Bedell, M. D. & Johnson, J. L. (1997). "Special Research Forum on Teaching Effectiveness in the Organizational Sciences The Social Fabric of a Team-Based M.B.A. Program: Network effects on student satisfaction and performance." The Academy of Management Journal **40**(6): 1369-1397.

Barlas, C. (2001). Learning-within-relationship as context and process in adult education: Impact on transformative learning and social change agency. Adult Education Research Conference, Michigan State University in East Lansing, AERC.

Batagelj, V. (1997). "Notes on blockmodeling." Social Networks **19**: 143-155.

Bell, D. C., Atkinson, J. S. & Carlson, J. W. (1999). "Centrality measures for disease transmission networks." Social Networks **21**: 1–21.

Bernard, H. R., Killworth, P. D. & Sailer, L. (1980). "Informant accuracy in social network data IV: A comparison of clique-level structure in behavioral and cognitive network data." Social Networks **2**: 191-218.

Blau, P. M. (1963). The dynamics of bureaucracy: A study of interpersonal relations in two government agencies (Revised edition). Chicago: The University of Chicago.

Blau, P. M. (1982). Structural sociology and network analysis: An overview. In P. V. Marsden and N. Lin (Eds.), Social structure and network analysis. (273-279). California: Sage Publications.

Boekaerts, M. & Minnaert, A. (1999). "Self-regulation with respect to informal learning." International Journal of Educational Research **31**: 533-544.

Bondonio, D. (1998). "Predictors of accuracy in perceiving informal social networks." Social Networks **20**: 301-330.

Borgatti, S. P. (1995). "Centrality and AIDS." CONNECTIONS **18**(1): 112-115.

Borgatti, S. P. (1997). Communication structure and its effects on task performance [Online]. Available: http://www.analytictech.com/networks/commstruc.htm [18 September 2001].

Borgatti, S. P. (1998). Data collection for complete Networks (in Social Network Analysis Instructional Web Site) [Online]. Available: http://www.analytictech.com/networks/data.htm [3 September 2004].

Borgatti, S. P. (2000). Informal organizational structure: The Hawthorne Studies [Online]. Available: http://www.analytictech.com/mb119/Hawthorne.html [2 February 2004].

Borgatti, S. P. (2002). NetDraw: Graph Visualization Software. Harvard, Analytic Technologies.

Borgatti, S. P. (2005a). "Centrality and network flow." Social Networks **27**: 55–71.

Borgatti, S. P. (2005b). Creating knowledge: Network structure and innovation [Online]. Available: http://www.socialnetworkanalysis.com/knowledge_creation.htm [15 April 2005].

Borgatti, S. P. (2005c). Facilitating knowledge flows [Online]. Available: http://www.socialnetworkanalysis.com/knowledge_sharing.htm [15 April 2005].

Borgatti, S. P. & Cross, R. (2003). " A relational view of information seeking and learning in social networks." Management Science **49**(4): 432.

Borgatti, S. P. & Everett, M. G. (1989). "The class of all regular equivalences: Algebraic structure and computation." Social Networks **11**: 65-88.

Borgatti, S. P. & Everett, M. G. (1992). "Notions of position in social network analysis." Sociological Methodology **22**: 1-35.

Borgatti, S. P. & Everett, M. G. (1993). "Two algorithms for computing regular equivalence." Social Networks **15**(4): 361-376.

Borgatti, S. P. & Everett, M. G. (1999). "Models of Core/Periphery Structures." Social Networks **21**: 375–395.

Borgatti, S. P., Everett, M. G. & Freeman, L. C. (2002). UCINET for Windows: Software for Social Network Analysis. Harvard, Analytic Technologies.

Borgatti, S. P., Everett, M. G. & Shirey, P. R. (1990). "LS Sets, Lambda Sets and other cohesive subsets." Social Networks **12**: 337-357.

Borgatti, S. P. & Foster, P. C. (2003). "The Network Paradigm in Organizational Research: A Review and Typology." Journal of Management Information Systems **29**(6): 991–1013.

Bothner, M. S. (2003). "Competition and Social Influence: The diffusion of the Sixth-Generation Processor in the global computer industry." American Journal of Sociology **108**(6): 1175–1210.

Bott, E. (1957). Family and social network: Roles, norms and external relationships in ordinary urban families. London: Tavistock.

Boud, D. & Walker, D. (1991). Experience and learning: Reflection at work. Geelong, Vic.: Deakin University Press.

Brieger, R. L. (1976). "Career attributes and network structure: A blockmodel study of a biomedical research specialty." American Sociological Review **41**(1): 117-135.

Brown, J. S. & Duguid, P. (2000). Organizational learning and communities of practice: Toward a unified view of working, learning, and innovation. In E. L. Lesser , M. A. Fontaine, *et al.* (Eds.), Knowledge and communities. (99-122). Boston, [Mass.]; Oxford: Butterworth-Heinemann.

Burt, R. S. (1976). "Positions in Networks." Social Forces **55**(1): 93-122.

Burt, R. S. (1980). "Innovation as a structural interest: Rethinking the impact of network position on innovation adoption." Social Networks **2**: 327-355.

Burt, R. S. (1982). Towards a structural theory of action. New York: Academic Press.

Burt, R. S. (1992). Structural holes: The social structure of competition. Cambridge: Harvard University Press.

Burt, R. S. (1997). "The contingent value of Social Capital." Administrative Science Quarterly **42**: 339-365.

Burt, R. S. (2000). Structural holes versus network closure as social capital (Pre-print for a chapter). In N. Lin , K. S. Cook, *et al.* (Eds.), Social Capital: Theory and Research. Aldine de Gruyter.

Burt, R. S. (2004). "Structural Holes and Good Ideas." American Journal of Sociology **110**(2): 349-399.

Butts, C. T. (2003). "Network inference, error, and informant (in)accuracy: A Bayesian approach." Social Networks **25**: 103-140.

Calloway, M., Morissey, J. P. & Paulson, R. I. (1993). "Accuracy and reliability of self-reported data in interorganizational networks." Social Networks **15**: 377-398.

Campos, J. E. & Root, H. L. (1996). The key to the Asian miracle: Making shared growth credible. Washington D.C.: The Brookings Institution.

Carley, K. M. & Hill, V. (n.d.). Structural change and learning within organizations (forthcoming). In A. Lomi (Ed.), Dynamics of organizational societies : Models, theories and methods. MIT Press/AAAI, Press/Live Oak.

Carter, C. & Mueller, F. (n.d.). The dialectics of organizational knowledge: The duality of creation and appropriation, University of Leicester Management Centre.

Casciaro, T. (1998). "Seeing things clearly: Social structure, personality, and accuracy in social network perception." Social Networks **20**: 331-351.

Clardy, A. (2000). "Learning on their own: Vocationally Oriented Self-Directed Learning Projects." Human Resource Development Quarterly **11**(2).

Cross, K. P. (1981). Adults as learners: Increasing participation and facilitating learning. California: Jossey-Bass.

Cross, R., Borgatti, S. P. & Parker, A. (2001a). "Beyond answers: Dimensions of the advice network." Social Networks **23**: 215–235.

Cross, R., Parker, A. & Borgatti, S. P. (2002). A bird's-eye view: Using social network analysis to improve knowledge creation and sharing, IBM Institute for Knowledge-Based Organizations.

Cross, R., Parker, A., Prusak, L. & Borgatti, S. P. (2001b). "Knowing what we know: Supporting knowledge creation and sharing in social networks." Organizational Dynamics **30**(2): 100-120.

Cross, R., Rice, R. E. & Parker, A. (2001c). "Information seeking in social context: Structural influences and receipt of information benefits." IEEE **31**(4): 438-448.

Curtis, R., Friedman, S. R., Neaigus, A., Jose, B., Goldstein, M. & Ildefonso, G. (1995). "Street-level drug markets: Network structure and HIV risks." Social Networks **17**(3-4): 229-249.

Daley, B. J. (2001). "Learning and professional practice: A study of four professions." Adult Education Quarterly **52**(1): 39-54.

Davenport, T. H., Eccles, R. G. & Prusak, L. (1992). “Information politics.” Sloan Management Review **34**(1): 53-65.

Davenport, T. H. & Prusak, L. (1998). Working knowledge: How organizations manage what they know. Massachusetts: Harvard Business School Press.

Day, N. (1998). “Informal learning gets results.” Workforce **June**: 31-36.

de Nooy, W., Mrvar, A. & Batagelj, V. (2005). Exploratory social network analysis with Pajek: Cambridge University Press.

Djiwandono, J. S. (1999). Effectiveness of policy measures adopted in pursuit of recovery: Indonesian perspectives [Online]. Available: http://www.pacific.net.id/pakar/sj/kkn_1.html [3 May 2002].

Doreian, P. (1988). “Equivalence in a social network.” Journal of Mathematical Sociology **13**(3): 243-282.

Emirbayer, M. & Goodwin, J. (1994). “Network analysis, culture, and the problem of agency.” American Journal of Sociology **99**(6): 1411-1454.

Everett, M. (n.d.). Cohesive subgroups (A course note).

Everett, M. G. & Borgatti, S. P. (1998). “Analyzing Clique Overlap.” CONNECTIONS **21**(1): 49-61.

Everett, M. G. & Borgatti, S. P. (1999). “Peripheries of cohesive subsets.” Social Networks **21**: 397–407.

Falk, J. H. & Dierking, L. D. (1998). “Free-choice learning: An alternative term to informal learning?” Informal Learning Environment Research Newsletter **2**(1): 2.

Faust, K. (1988). “Comparison of methods for positional analysis: Structural and general equivalences.” Social Networks **10**: 313-341.

Ferligoj, A., Doreian, P. & Batagelj, V. (n.d.). Optimizational approach to blockmodeling.

Fershtman, M. (1997). “Cohesive group detection in a social network by the segregation martrix index.” Social Networks **19**: 193-207.

Festinger, L., Schacter, S. & Back, K. (1950). Social pressures in informal groups. California: Stanford university.

Fiske, S. T. (1993). “Social cognition and social perception.” Annual Review of Psychology **44**: 155-194.

Frank, K. A. (1995). “Identifying cohesive subgroups.” Social Networks **17**(1): 27-56.

Freeman, L. C. (1977). “A set of measures of Centrality based on Betweenness.” Sociometry **40**(1): 35-41.

Freeman, L. C. (1979). "Centrality in social networks: Conceptual clarification." Social Networks **1**: 215-239.

Freeman, L. C. (1992). "The sociological concept of group: An empirical test of two models." American Journal of Sociology **98**(1): 152-166.

Freeman, L. C., Roeder, D. & Mulholland, R. R. (1980). "Centrality in social networks: II. Experimental results." Social Networks **2**: 119-141.

Friedman, S. R. (1996). "Editorial: Network methodologies, contact tracing, gonorrhea and Human Immunodeficiency Virus." Sexually Transmitted Diseases **23**(6): 523-525.

Fuhrer, U. (1993). Behavior setting analysis of situated learning: The case of new comers. In S. Chaiklin and J. Lave (Eds.), Understanding practice: Perspective on activity and context. (179-211). Cambridge: Cambridge University Press.

Gersten, R. & Baker, S. K. (1998). "Real world use of scientific concepts: Integrating situated cognition with explicit instruction." Exceptional Children **65**(1): 23-35.

Gherardi, S. (2001). "From organizational learning to practice-based knowing." Human Relations **54**(1): 131 - 139.

Gherardi, S., Nicolini, D. & Odella, F. (1998). "Toward a social understanding of how people learn in organizations: The notion of situated curriculum." Management Learning **29**(3): 273 - 297.

GOI (1985). Angka kredit bagi Jabatan Widyaiswara (Credit point administration for Public Service Trainers). Keputusan Menteri Negara Pendayagunaan Aparatur Negara (Decree of the Minister for Administrative Reform). **No. 68/MENPAN/1985**.

GOI (1986). Batas usia pensiun pegawai negeri sipil yang menjabat jabatan fungsional widyaiswara dan penyuluh pertanian (Mandatory retirement for Public Service Trainers and Agricultural Consultants). Keputusan Presiden (Presidential Decree). **No. 63/1986**.

GOI (2001a). Jabatan fungsional Widyaiswara dan angka kreditnya (The functional position of civil service trainer and its credit points). Keputusan Menteri Negara Pendayagunaan Aparatur Negara (Decree of the Minister for Administrative Reform). **No. 01/KEP/M.PAN/1/2001**.

GOI (2001b). Operational Guidelines for the Functional Position of Public Service Trainer. Surat Keputusan Bersama Kepala Lembaga Administrasi Negara dan Kepala Badan Kepegawaian Negara (Joint Decision between the Head of the National Institute for Public Administration and the Head of the National Public Service Agency). **No. 598.A/10/6/2001 and No. 39.A Tahun 2001**.

GOI (2001c). Petunjuk teknis jabatan fungsional widyaiswara (Technical Guidelines for Public Service Training Career Position). Keputusan

Kepala Lembaga Administrasi Negara (Decree of the Head of the National Institute for Public Administration). **No. 810.A/I/10/6/2001**.

Gorard, S. (1999). "The apparent decline of informal learning." Oxford Review of Education **25**(4): 437-454.

Granovetter, M. (1982). The strength of weak ties: A network theory revisited. In P. V. Marsden and N. Lin (Eds.), Social structure and network analysis. (105-130). California: SAGE Publications.

Granovetter, M. S. (1973). "The strength of weak ties." American Journal of Sociology **78**(6): 1360-1380.

Grootaert, C. (1999). Social capital, household welfare and poverty in Indonesia. Policy Research Working. Washington D.C., The World Bank.

Hagen, G., Killinger, D. K. & Streeter, R. B. (1997). "An Analysis of Communication Networks Among Tampa Bay Economic Development Organizations." Connections **20**(2): 13-22.

Hager, P. (1998). "Recognition of informal learning: Challenges and issues." Journal of Vocational Education and Training **50**(4).

Hamel, G. (1991). "Competition for competence and inter-partner learning within international strategic alliances." Strategic Management Journal **12**(Special Issue: Global Strategy): 83-103.

Hansen, M. T. (1999). "The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits." Administrative Science Quarterly **44**(1): 82-111.

Hara, N. (2001). Formal and informal learning: Incorporating Communities of Practice into professional development. American Educational Research Association Annual Meeting, Seattle, WA.

Harary, F., Norman, R. Z. & Cartwright, D. (1965). Structural Models: An introduction to the theory of directed graphs. New York, Wiley.

Harzem, P. (2004). "Behaviorism for new psychology: What was wrong with behavorism and what is wrong with it now." Behavior and Philosophy **32**(1): 5-12.

Haythornthwaite, C. (2001). "Exploring Multiplexity: Social Network Structures in a Computer-Supported Distance Learning Class." The Information Society **17**: 211–226.

Horvath, J. A. (2001). Working with tacit knowledge [Online]. Available: http://knowledgemanagement.ittoolbox.com/documents/document.asp?i=1127&r=default.asp [4 November 2001].

ID21 (2000). It's not what you know - it's who you know!: Economic analysis of social capital [Online]. Available: http://www.id21.org/insights/insights34/index.html [2 December 2003].

Jarvis, P. (1987). Adult learning in the social context. London ; New York: Croom Helm.

Kamoche, K. (1998). "Human resource management and the Appropriation-Learning perspective." Human Relations **51**(8): 1033-1060.

Kapferer, B. (1969). Norms and the manipulation of relationships in a work context. In J. C. Mitchel (Ed.), Social Networks in urban situations: Analysis of personal relationships in Central African Towns. (181-244). Manchester: Manchester University Press.

Katoppo, A. (1999). Indonesia's tortuous road to reform. 1999 Pacific Symposium, Honolulu, Hawaii.

Killworth, P. D. & Bernard, H. R. (1980). "Informant accuracy in social network data III: A comparison of triadic structure in behavioral and cognitive data." Social Networks **2**: 10-46.

Klovdahl, A. S. (1989). Urban social networks: Some methodological problems and possibilities. In M. Kochen (Ed.), The small world. (176-210). New Jersey: Alex Publishing.

Klovdahl, A. S. (1997). Social Network Analysis. In J. P. Keeves (Ed.), Educational research, methodology, and measurement: An International Handbook (2Ed). (684-690). Oxford: Pergamon.

Klovdahl, A. S. (2001). "Human subject protection and research on social networks (With particular reference to infectious disease networks)." Unpublished.

Klovdahl, A. S., Potterat, J. J., Woodhouse, D. E., Muth, J. B., Muth, S. Q. & Darrow, W. W. (1994). "Social networks and infectious disease: The Colorado Spring study." Social Science and Medicine **38**(1): 79-88.

Knoke, D. & Kuklinski, J. H. (1982). Network analysis. Beverly Hills, Calif: Sage Publications.

Krackhardt, D. (1987). "Cognitive social structures." Social Networks **9**: 109-134.

Krackhardt, D. & Hanson, J. R. (1993). "Informal networks: The company behind the chart." Harvard Businesss Review: 104-111.

Krackhardt, D. & Porter, L. W. (1986). "The snowball effect: Turnover embedded in communication networks." Journal of Applied Psychology **71**(1): 50-55.

Krebs, V. (1998). Knowledge networks: Mapping and measuring knowledge creation and re-use [Online]. Available: http://www.orgnet.com/IHRIM.html [29 August 2001].

Krebs, V. (1999). Working in the connected world [Online]. Available: http:/www.orgnet.com/MCA3.html [30 August 2001].

Kulkarni, R. G., Stough, R. R. & Hayness, K. E. (2000). "Towards modeling of Communities of Practice (CoPs): A Hebbian learning approach to organizational learning." Technological Forecasting and Social Change **64**: 71–83.

Kusterer, K. C. (1978). Know-How on the job: The important working knowledge of "unskilled" workers. Colorado: Westview Press.

Laumann, E. O., Marsden, P. V. & Prenksy, D. (1989). The boundary specification problem in network analysis. In L. C. Freeman , D. R. White, *et al.* (Eds.), Reserach Methods in Social Network Analysis. (61-87). Fairfax: George Mason University.

Lave, J. & Wenger, E. (1991). Situated learning: Legitimate Peripheral Participation. Cambridge: Cambridge University Press.

Leonard, D. (1998). "The role of tacit knowledge in group innovation." California Management Review **40**(3): 112-132.

Leonard-Barton, D. (1992). "The factory as a learning laboratory." Sloan Management Review **Fall**: 23-38.

Leslie, B., Aring, M. K. & Brand, B. (1997). "Informal learning: The new frontier of employee and organizational development." Economic Development Review **15**(4): 12-18.

Lesser, E. L., Fontaine, M. A. & Slusher, J. A., (Eds.). (2000). Knowledge and communities. Boston, [Mass.]; Oxford: Butterworth-Heinemann.

Liebeskind, J. P., Oliver, A. L., Zucker, L. & Brewer, M. (1996). "Social networks, learning, and flexibility - sourcing scientific knowledge in new biotechnology firms." Organization Science **7**(4): 428-443.

Liebow, E., McGrady, G., Branch, K., Vera, M., Klovdahl, A., Lovely, R., Mueller, C. & Mann, E. (1995). "Eliciting social network data and ecological model-building: Focus on choice of name generators and administration of random-walk study procedures." Social Networks **17**: 257 - 272.

Livingstone, D. W. (2000). Exploring the icebergs of adult learning: Findings of the first Canadian survey of informal learning practices (NALL Working Paper #10-2000), The Research Network for New Approaches to Lifelong Learning.

Livingstone, D. W. (2001). Adult's informal learning: Definitions, findings, gaps and future research (NALL Working Paper # 21-2001), The Research Network for New Approaches to Lifelong Learning.

Lorrain, F. & White, H. C. (1971). "Structural Equivalence of individuals in social networks." Journal of Mathematical Sociology **1**(1): 49-80.

Low, A., Tjongarero, A., Low, A. & Nambundunga, B. (2001). "Donor support to human resource capacity building in Namibia: Experience of resident technical assisnatce support for workplace learning and assessment of alternative options." Journal of International Development **13**: 269-285.

Luce, R. D. (1950). "Connectivity and generalized cliques in a sociometric group structure." Psychometrika **15**(2): 169–190.

Luce, R. D. & Perry, A. D. (1949). "A method of matrix analysis of group structure." Psychometrika **14**(1): 95-116.

MacAndrews, C., (Ed.). (1986). Central government and local development in Indonesia. New York: Oxford University Press.

MacIntyre, A. (1996). Investment, property rights, and corruption in Indonesia. In J. E. Campos and H. Root (Eds.), The key to the Asian miracle : Making shared growth credible. The Brookings Institution.

Mansoor, D. & Dabbagh, N. (2002). Etienne Wenger and Communities of Practice [Online]. Available: http://immersion.gmu.edu/portfolios/dmansoor/immersion/classwork/704/leader_wenger.doc [17 April 2003].

Marsden, P. V. (1989). Methods for characterization of role structures in network analysis. In L. C. Freeman , D. R. White, *et al.* (Eds.), Reserach Methods in Social Network Analysis. (489-530). Fairfax: George Mason University.

Marsick, V. J. (1987). New paradigms for learning in the workplace. In V. J. Marsick (Ed.), Learning in the workplace. (11-30). New York: Croom Helm.

Marsick, V. J. & Watkins, K. E. (1997). Management learning: Integrating perspectives in in theory and practice. In J. Burgoyne and M. Reynolds (Eds.), Lessons from informal and incidental learning. (295-311). London, UK: Sage.

McElroy, M. W. (2000). Sustainable innovation and the 'Learning Drive' (A White Paper By President, Macroinnovation Associates, LLC), Systems Thinking Press.

McGrady, G. A., Marrow, C., Meyers, G., Daniels, M., Vera, M., Mueller, C., Liebow, E., Klovdahl, A. & Lovely, R. (1995). "A note on implementation of random-walk design to study adolescent social networks." Social Networks **17**: 251-255.

McVey, R. T. (1982). The Beamtenstaat in Indonesia (1977). In B. Anderson and A. Kahin (Eds.), Interpreting Indonesian politics: Thirteen contributions to the debate. (84-91). New York: Cornell University.

Mergel, B. (1998). Instructional Design & Learning Theory [Online]. Available: http://www.usask.ca/education/coursework/802papers/mergel/mergel.PDF [25 March 2003].

Miles, M. B. & Hubberman, A. M. (1984). Qualitative data analysis: A sourcebook of new methods. Beverly Hills, Calif.: SAGE Publications.

Miner, A. S. & Mezias, S. J. (1996). "Ugly duckling no more: Pasts and futures of organizational learning research." Organization Science **7**(1): 88-99.

Mizruchi, M. S. & Stearns, L. B. (2001). "Getting deals done: The use of social network in bank decision-making." American Sociological Review **66**(5): 647-671.

Mokken, R. J. (1979). "Cliques, clubs and clans." Quality and Quantity **13**(2): 161-173.

Molina, J. L. (2001). "The informal organizational chart in organizations: An approach from the social network analysis." CONNECTIONS **24**(1): 78-91.

Monge, P. R. & Contractor, N. S. (2003). Theories of comunication networks. New York: Oxford Univerity Press.

Moore, B. J. (1998). "Situated cognition versus traditional cognitive theories of learning." Education **119**(1): 161.

Mullins, N. C., Hargens, L. L., Hecht, P. K. & Kick, E. L. (1977). "The group structure of cocitation clusters: A comparative study." American Sociological Review **42**(4): 552-562.

Murphy, E. (1997). Constructivism: From Philosophy to Practice [Online]. Available: http://www.cdli.ca/~elmurphy/emurphy/cle.html

Newman, M. E. J. & Girvan, M. (2003). Finding and evaluating community structure in networks.

Nidumolu, S. R., Subramani, M. & Aldrich, A. (2001). "Situated learning and the situated knowledge web: Exploring the ground beneath knowledge management." Journal of Management Information Systems **18**(1): 115-150.

Nonaka, I. & Takeuchi, H. (1995). The knowledge-creating company: How Japanese companies create the dynamics of innovation. New York: Oxford University Press.

PACT (n.d.). Organizational learning systems [Online]. Available: http://www.pactworld.org/Services/Ols.html [4 September 2001].

Podolny, J. M. & Baron, J. N. (1997). "Resources and relationships: Social networks and mobility in the workplace." American Sociological Review **62**(5): 673-693.

Podolny, J. M. & Page, K. L. (1998). "Network forms of organization." Annual Review of Sociology **24**: 57-76.

Poell, R. F., Chivers, G. E., Van der Krogt, F. J. & Wildermeersch, D. A. (2000). "Learning-network theory: Organizing the dynamic relationships between learning and work." Management Learning **31**(1): 25-49.

Polanyi, M. (1958). Personal knowledge: Towards a post-critical philosophy. London: Routledge and Kegan Paul.

Polanyi, M. (1967). The tacit dimension. London: Routledge & Kegan Paul.

Powell, W. W. (1998). "Learning from collaboration: Knowledge and networks in the biotechnology and pharmaceutical industries." California Management Review **40**(3): 228-240.

Prestera, G. (2002). Three learning theories [Online]. Available: http://www.personal.psu.edu/users/g/e/gep111/ [2 August 2003].

Puliyel, M. M., Puliyel, J. M. & Puliyel, U. (1999). "Drawing on adult learning theory to teach personal and professional values." Medical Teacher **21**(5): 513-515.

Reio, T. G. J. & Wiswell, A. (2000). "Field investigation of the relationship among adult curiosity, workplace learning, and job performance." Human Resource Development Quarterly **11**(1): 5-30.

Rhee, M. (2000). "The effects of network structure and content on learning environments in the workplace. Proceedings of the Annual Meeting-Industrial Relations Research Association." IRRA **52**: 280-296.

Richman-Hirsch, W. L. (2001). "Posttraining interventions to enhance transfer: The moderating effects of work environments." Human Resource Development Quarterly **12**(2): 105-120.

Richter, I. (1998). "Individual and organisational learning at the executive level: Towards a research agenda." Management Learning **29**(3): 299-316.

Ritzer, G. (1996). The McDonaldization of society : An investigation into the changing character of contemporary social life, Revised Edition. California: Pine Forge Press.

Rohdewohld, R. (1995). Public Administration in Indonesia. Merbourne: Montech.

Rusaw, A. C. (1995). "Learning by association: Professional associations as learning agents." Human Resource Development Quarterly **6**(2): 215-226.

Saha, L. J. (1997). Sociometric Method. In J. P. Keeves (Ed.), Educational Research, Methodology, and Measurement: An International Handbook (2Ed). (691-695.

Sailer, L. D. (1978). "Structural equivalence: Meaning and definition, computation and application." Social Networks **1**(1): 73-90.

Schugurensky, D. (2000). The forms of informal learning: Towards a conceptualization of the field (NALL Working Paper #19 -2000), The Research Network for New Approaches to Lifelong Learning.

Schweizer, T. (1988). "Detecting positions in networks: A formal analysis of loose social structure in rural Java." American Anthropologist **90**: 944-951.

Schweizer, T. (1997). "Embeddedness of ethnographic cases: A social networks perspective." Current Anthropology **38**(5): 739.

Schweizer, T., Klemm, E. & Schweizer, M. (1993). "Ritual as action in a Javanese community - A network perspective on ritual and social-srtucture." Social Networks **15**(1): 19-48.

Scott, J. (1991a). "Networks of corporate power: A comparative assessment." Annual Review of Sociology **17**: 181-203.

Scott, J. (1991b). Social network analysis: A handbook. London: Sage Publications.

Seidman, S. B. (1983). "Internal cohesion of LS sets in graphs." Social Networks **5**(2): 97-107.

SiDA (2004). Daftar alamat lembaga Diklat (Inventory of government training centres) [Online]. Available: http://sida.lan.go.id [31 October 2005 2005].

Singleton, J. (1998). Situated learning in Japan: Our educational analysis. In J. Singleton (Ed.), Learning in likely places: Varieties of apprenticeship in Japan. (3-19). Cambridge: Cambridge University Press.

Skinner, B. F. (1954). "The science of learning and the art of teaching." Harvard Educational Review **24**: 86-97.

Skinner, B. F. (1957). Verbal behavior. New York: Appleton-Century-Crofts.

Skruber, R. (1987). Organizations as clarifying learning environments. In V. J. Marsick (Ed.), Learning in the workplace. (55-78). London: Croom Helm.

Smith, D. A. & White, D. R. (1992). "Structure and dynamics of the global economy: Network analysis of international trade 1965-1980." Social Forces **70**(4): 857-893.

Snyder, D. & Kick, E. L. (1979). "Sructural position in the world system and economic growth, 1955-1970: A multiple network analysis of transnational interactions." American Journal of Sociology **84**(5): 1096-1126.

Soo-Hoon, L. & Keng-Howe, C. I. (2000). "The impacts of social networks on pay increase, promotions and layoffs in Singapore." Labour and Management in Development Journal **1**(9): 1-15.

Sparrowe, R. T., Liden, R. C., Wayne, S. J. & Kraimer, M. L. (2001). "Social networks and the performance of individuals and groups." Academy of Management Journal **44**(2): 316-325.

Spilerman, S. (1966). "Structural analysis and the generation of sociograms." Behavioral Science **11**: 312-318.

Stamps, D. (2000). Communities of practice: Learning is social, training is irrelevant? In E. L. Lesser , M. A. Fontaine, *et al.* (Eds.), Knowledge and communities. (53-64). Boston, [Mass.]; Oxford: Butterworth-Heinemann.

Stein, D. (1998). Situated learning in adult education. [Online]. Available: http://www.ericdigests.org/1998-3/adult-education.html [2 November 2004].

Stenmark, D. (2000). Turning tacit knowledge tangible. 33rd Hawaii International Conference on System Sciences (HICSS33), Maui, Hawaii, The Institute of Electrical and Electronics Engineers,Inc. (IEEE).

Stephenson, K. & Zelen, M. (1989). "Rethinking centrality: Methods and examples." Social Networks **11**: 1-37.

Stewart, T. A. (1996). "Managing: Ideas & solutions/The leading edge." Fortune **134**(3): 173+.

Stinchcombe, A. L. (1968). Constructing social theories: Harcourt, Brace & World.

Stork, D. & Richards, W. D. (1992). "Nonrespondents in Communication Network Studies: Problems and Possibilities." Group & Organization Management **17**(2): 193-209.

Taylor, R. (1997). Innovation as knowledge and learning. Adult Education Research Conference, Oklahoma State University in Stillwater, AERC.

Tindall, D. B. & Wellman, B. (2001). "Canada as social structure: Social Network Analysis and Canadian sociology." Canadian Journal of Sociology **26**(3).

Torraco, R. J. (1999). "Integrating learning with working: A reconception of the role of workplace learning." Human Resource Development Quarterly **10**(3): 249-270.

Uzzi, B. & Lancaster, R. (2003). "Relational embeddedness and learning: The case of bank loan managers and their clients." Management Science **49**(4): 383–399.

Valente, T. W. (1995). Network models of the diffusion of innovation. New Jersey: Hampton Press.

Valente, T. W. & Davis, R. L. (1999). "Accelerating the diffusion of innovation using opinion leaders." Annals, AAPSS **566**: 55-67.

Valente, T. W., Hoffman, B. R., Ritt-Olson, A., Lichtman, K. & Johnson, A. (2003). "Effects of social-network method for group assignment strategies on peer-led tobacco prevention programs in schools." American Journal of Public Health **93**(11): 1837-1843.

Valente, T. W. & Saba, W. P. (1998). "Mass media and interpersonal influence in a reproductive health communication campaign in Bolivia." Communication Research **25**(1): 96-124.

Van der Krogt, F. J. (1998). "Learning network theory: The tension between learning systems and work systems in organisations." Human Resource Development Quarterly **9**(2): 157-177.

Van Krieken, R., Smith, P., Habibis, D., McDonald, K., Haralambos, M. & Halborn, M. (2000). Sociology: Themes and perspectives. NSW: Pearson Education Australia.

Wasserman, S. & Faust, K. (1994). Social network analysis: Methods and applications. Cambridge: Cambridge University Press.

Wasserman, S. & Galaskiewicz, J., (Eds.). (1994). Advances in social network analysis : Research in the social and behavioral sciences. California: Sage Publications.

Watson, J. B. (1970). Behaviorism. New York: W.W. Norton.

Wenger, E. (1998). Communities of practice : Learning, meaning, and identity. New York: Cambridge University Press.

Wenger, E., McDermott, R. & Snyder, W. M. (2002). Cultivating communities of practice : A guide to managing knowledge. Boston, Mass.: Harvard Business School Press.

Wenger, E. & Snyder, W. (2000a). "Learning in communities." Line Zine **Summer**(1).

Wenger, E. C. & Snyder, W. M. (2000b). "Communities of practice: The organizational frontier." Harvard Business Review **78**(1): 139-145.

White, D. R. & Reitz, K. P. (1983). "Graph and semigroup homomorphism on networks of relations." Social Networks **5**: 193-234.

White, H. C., Boorman, S. A. & Breiger, R. L. (1976). "Social structure from multiple networks. I. Blockmodels of roles and positions." American Journal of Sociology **81**(4): 730-780.

White, K. & Watkins, S. C. (2000). "Accuracy, stability and reciprocity in informal conversational networks in rural Kenya." Social Networks **22**: 337-355.

Yamnill, S. & McLean, G. N. (2001). "Theories supporting transfer of training." Human Research Development Quarterly **12**(2): 195-208.

Zemke, R. (2001). Learning as conversation. Training. **June 2001:** 14.