Chapter 15
Social Network Analyses of Learning at Workplaces

Tuire Palonen and Kai Hakkarainen

Abstract The purpose of this paper is to examine social network analysis from the perspective of expertise studies and workplace learning. While research on expertise has traditionally been individually oriented, the present paper explores its socially distributed dimensions. Expertise relies on transactive processes involving pursuit of a network of mutually supporting projects where earlier achievements are used to manage more demanding intellectual environments. The paper includes theoretical introduction, methodological considerations, and a minor review of SNA studies that are related to workplaces. The research of social networks stresses the importance of cross-boundary analyses of workplaces' networks and even experts' past relations in their former networks. Previous studies have indicated some relevance to study the significance of the worker's network positions. SNA studies have indicated evidence especially as regards the importance of cohesive network positions, mediator and boundary crossing roles, and the relationship between informal and formal power positions. Particularly, previous research has demonstrated a relationship between network structure and instrumental outcomes. As regards for network profits, individual-level results appear to be easier to evaluate than group- or organizational-level gains.

T. Palonen (✉)
Centre for Learning Research and Department of Teacher Education, University of Turku, Finland
e-mail: tuire.palonen@utu.fi; tuire.palonen@spindel.fi

K. Hakkarainen
Department of Education, University of Turku, Turku, Finland
e-mail: kai.hakkarainen@utu.fi

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15.1 Introduction

15.1.1 Superior Performance and Relational Expertise

The purpose of the present paper is to examine workplace learning from the perspective of sociocultural research on expertise in general and networked expertise of professional communities in particular (Hytönen, Hakkarainen & Palonen, 2011; Palonen, Hakkarainen, Talvitie, & Lehtinen, 2004; Rissanen, Palonen, & Hakkarainen, 2010; Rissanen, Palonen, Pitkänen, Kuhn, & Hakkarainen, 2013; Tuomainen, Palonen, & Hakkarainen, 2010). An advanced knowledge society requires mastery of ever more sophisticated knowledge and expertise. Professionals have to constantly update their knowledge and develop their skills and competencies so as to cope with unforeseen obstacles and challenges emerging at turbulent and rapidly transforming environment. A significant proportion of professionals, also beyond those knowledge workers taking traditionally part in research and development, are working with complex knowledge-creating tasks and projects. Productive participation in rapidly developing global knowledge society requires that they repeatedly appropriate intellectual skills and competencies. Therefore, expertise development wears an important social facet. Outstanding skills and knowledge do only emerge after there is a social mechanism through which certain individuals are more or less collectively recognized to be experts in the field. Expertise is constituted as a socially initiated nomination by the experts' constituency (Agnew, Ford, & Hayes, 1994). The ascription of expert status is based on perceived differences in knowledge and skills so that the expert can only be defined relationally to the knowledge and skills of other members inside a shared context. Expertise in that sense implies not only particular cognitive components but also an acknowledged role as expert within the constituency (Edwards, 2005; Mieg, 2006). To conclude, expertise might be reasonable to understand both from the approach of excellent performance and high skills but also as regards how it fits to its environment, i.e., from the point of relational expertise.

15.1.2 The Volume and Structure of the Ties in Workplaces

Connections or ties between actors indicate the access to critical resources of a community (Gruber, Lehtinen, Palonen, & Degner, 2008). Ties facilitate an intensive flow of information across the wider network of actors in the same field, helping to gather richer information than would be possible for an individual working alone. According to Larson (1992) and Hansen (1999), social dimensions like reputation, trust, reciprocity, or interdependence of the transaction are pivotal in the exchange structures of organizations in general. The quality of information resources, however, does not only depend on the volume of information flow but on the patterns of connections as well. The same amount of ties can be much more or less fruitful for

professionals depending on who is involved in his or her network. Larger patters of connections form a kind of potential network, which can be activated if needed (Gruber et al., 2008).

The development of expertise involves cultivating collective capacities for pursuing purposeful and coordinated societal actions that involve applying cultural knowledge in particular settings of professional activity. Expertise may be defined as mastery of a well-organized body of usable knowledge that a participant can (and does) utilize to selectively focus on the critical aspects of a complex problem and, thereby, reach an exceptionally high level of performance (Chi, 2006; Ericsson, 2003, 2006; Glaser & Chi, 1988). The knowledge is embodied in instruments and practices of expert communities and networks.

15.1.2.1 Socially Distributed Expertise

Rather than representing mere individual capabilities, higher-level professional competencies may be seen as appropriations, within individuals, of capabilities of professional communities and networks in which they participate in. Participation in distributed networks of professional knowing augments the participants' cognitive capacities to the extent that enables solving significantly more complex problems that would otherwise be possible. The participants' professional competencies are materially, socially, and temporally distributed (Pea, 1993). The materially distributed aspect of human mind can be explicated with the following analogy. Originally one thought of the power of an individual computer, located in one box, or those nearby (for mind-as-a-computer metaphor, see Boden, 2004; Gardner, 2003). But the networking of computers has opened new heights of collective capabilities; the network functions as a supercomputer. Human minds, with their limited cognitive characteristics, attain vastly greater power when they are integrated with heterogeneous networks of tools and artifacts and with the other minds of humans in their communities (Donald, 2001). Expertise is socially distributed in terms of people sharing their efforts in various communities and networks and creating collective cognitive systems together. Further, it is temporarily distributed; human cognitive efforts always capitalize on intergenerational emergence of knowledge practices as well as personal and collective transactive processes (Hakkarainen, Hytönen, Makkonen, Seitamaa-Hakkarainen, & White, 2013).

Social neuroscience implies that there prevail certain kinds of internal-external correspondence in terms of human brains being shaped by and adapted to the surrounding cultural environment (Wexler, 2006). Human activity is embedded in cognitive-cultural macrostructures consisting of individuals, communities, and networks as well as evolving tools, external symbol systems, and cultural environments. In order to cope with increasing complexity of professional challenges, it has often been necessary to create whole epistemic systems for enabling expert communities to complete successfully world transforming projects (Hughes, 1998, 2004). Due to revolutionary development of socio-digital tools and networks, the instruments and tools of professional activity have been constantly changing

together with changing social structures and practices of activity, in many cases collectivizing traditionally individual professional activity. Adopting novel instruments and their systems as instruments of professional expert's activity is a challenging, long-standing developmental process on its own (Béguin & Rabardel, 2000; Ritella & Hakkarainen, 2012).

15.1.2.2 Merging People and Artifacts

Beyond merging people and artifacts to hybrid systems of brains, bodies, and environmental elements (Clark, 2008), there is another aspect of distributed cognition, i.e., the fusing of minds in social communities and networks (Hutchins, 1995; John-Steiner, 2000; Pea, 1993). In nature, humans appear to be unique hypercollaborative (Tomasello, 2009) and ultrasocial (Rogoff, 2003) beings whose cognition is thoroughly collaborative based on pro-social motivation and shared intentionality (Tomasello & Carpenter, 2007; Tomasello, 2009). Even if individual experts' cognitive resources remain limited, collective activity allows specialization, cognitive division of labor, and sharing of intellectual efforts that provide qualitatively stronger creative resources than would otherwise be humanly possible. Significant human achievements appear across domains to be correspondingly based on social distribution of cognitive efforts and collective merging and fusing of cognitions into higher-level systems. In the background of each creative achievement, there is always a smaller or a larger network people and their knowledge, intelligence, and creativity which is accumulated across time and embodied in artifacts, tools, practices, and epistemic systems. The relational perspective nicely highlights the socially distributed nature of human creativity that was acknowledged by Herbert Simon: "To make interesting scientific discoveries, you should acquire as many good friends as possible, who are as energetic, intelligent, and knowledgeable as they can. Then sit back and relax. You will find that all the programs you need are stored in your friends, and will execute productively and creatively as long as you don't interfere too much. The work I have done with more than eighty collaborators will testify to the power of that heuristic" (quoted by John-Steiner, 2000).

15.1.2.3 Social-Emotional Dimension

Professional collaboration does not, however, always function as smoothly that indicated by Herbert Simon. In many cases, tremendous efforts are needed for making collaboration to function well, and there occur various tensions and conflicts. In spite of tensions, ruptures, and disagreements that characterize all professional activities (Kramer, 1999), partners of collaboration are likely, all the time, scaffolding each other. They create supporting structures that allow them to do something that they would not be able to do on their own (John-Steiner, 2000). Through sustained collaborative activity, the participants' activities and creative efforts may become coupled so tightly that they "live in each other's minds," as John-Steiner

has observed. Further, it is important to acknowledge that scaffolding is not only an epistemic activity but that involves a *socio-emotional* dimension as well. Highly regarded creative experts need other people that help to soften their sharp corners, provide a supporting shoulder in a difficult moment, and help to sustain a sufficient level of internal stability so that they can completely focus on their work. Networking efforts going often beyond boundaries of an immediate workplace community often allow professionals to change the ecology of their learning and development. In order to keep up and develop professional competence, it is necessary to deliberately build a *social network*. Senior professionals may facilitate learning and activity of their junior colleagues by "lending" their personal social network (and, thereby, also their reputation) to younger ones (Gruber et al., 2008; Palonen et al., 2004).

15.1.2.4 Expert Roles

The mainstream psychological approach examined expertise *entirely* as an objectively measurable superior individual problem-solving capacity (Ericsson, 2009); in many cases, it was deliberately focused on analyzing merely individual aspects of expertise and disregarded the abovementioned critical aspects of professional expertise (sacrificing relevance for methodological rigor). From a sociological perspective, in contrast, expertise may be seen relationally as a *role in a workplace community* (Hakkarainen, Palonen, Paavola, & Lehtinen, 2004; Mieg, 2001, 2006) needed for solving emerging and partially unforeseen complex problems. In professional organizations, expertise is examined relationally by assessing whether professionals complement one another's expertise (i.e., have sufficient heterogeneously distributed expertise, Johnson, Heinmann, & O'Neill, 2000) so that they are able to capitalize on productive division of labor and master collectively strategic competence. In rapidly changing environment, what a professional knows and masters in relation to workmates than any specific pieces of knowledge and competence matters more (although those could sometimes be important).

15.1.2.5 Communities of Networked Expertise

In order to examine the relational aspect of expertise, investigators have to rely on specific methodological tools and instruments, such as social network analysis (SNA); addressing such methodological issues of studying networked expertise is an important aim of this paper. Such methods enable investigators tracing relations between personal and collective aspects of expertise in a way that ethnographic case studies of professional communities do not tend to reach. Some sociocultural investigations of collective expertise give an impression that knowledge and competence belong entirely to a community; methodological individualism of traditional expert studies replaces with methodological collectivism. Nevertheless, a striking result of many studies of workplace expertise has been the extent to which knowledge and

competence tend to concentrate to one and few central actors who have an extremely large amount of knowledge and competence (Palonen, et al., 2004). In many cases, such experts are not only centrally located within their own professional community (or close to other central actors), but they also keep up rich and multifaceted personal social networks extending to various external communities and organizations (Hakkarainen et al., 2004; Nardi, Whittaker, & Schwarz, 2000; Palonen et al., 2004; Tuomainen et al., 2010). Building such extended networks represents such professionals' agentic efforts of creating personal learning networks in interaction with which their professional development takes place.

On the basis of above considerations, Hakkarainen and his colleagues (2004) have developed a framework of "networked expertise" a term that means "higher-level cognitive competencies that arise, in appropriate environments, from sustained collaborative efforts to solve problems and build knowledge together. Networked expertise is relational in nature; it emerges from the tailoring and fine-tuning of individual competencies to specific conditions of the environment of the activity, and it is represented as a joint or shared competence of communities and organized groups of experts *and professionals.* … heterogeneous networks involve – in addition to human actors – collectively developed knowledge artifacts and knowledge embedded in tools and practices. Networked expertise coevolves with the transformation of social communities, a process …that may be facilitated by encouraging the participants to reflect on their current social *and cognitive practices.*" (p. 9). Cultivation of such expertise, which makes knowledge sharing as an integrated aspect of an expert's cognitive-cultural operating system, appears to play a crucial role in the cultivation of human collective creativity. We have ourselves investigated networked aspects of expertise regarding knowledge workers of telecommunication companies (Palonen et al, 2004), special-education teachers (Tuomainen et al., 2010; Tuomainen, Palonen, & Hakkarainen, 2012), primary school teachers (Ryymin, Palonen, & Hakkarainen, 2008), Finnish magicians (Rissanen et al., 2013), academic researchers (Hakkarainen et al., 2009, 2013; Pyhältö, Stubb, & Lonka, 2009; Rehrl, Palonen, Lehtinen, & Gruber, 2014), professors (Palonen & Lehtinen, 2001), and diplomats (Hytönen et al., 2011).

15.1.2.6 Experts' Personal Networks

The network study approach connects the social context to individual capacity by describing how people create, maintain, cultivate, and activate their personal social networks (e.g., Brown & Duguid, 1999, 2001; Hakkarainen et al., 2004). Instead of relying on the shelter of the workplaces and institutes, the expertise is cultivated and covered in experts' own personal social networks. Experts nurture and profile their own expertise by reactivating and strengthening some relevant links depending on what kind of work they are doing (McCarty, 2002; Nardi et al., 2000). In order to engage in networking efforts for stretching their abilities and developing their expertise, professionals have to believe that their efforts matter and that they are

able to initiate, implement, and attain their purposeful actions and desired objectives within their professional community. In other words, they need to have minimum level of personal and collective self-efficacy (Bandura, 2006). Especially important is that the professionals experience that their contributions are valued, socially recognized, and reciprocated with efforts of their professional communities and networks.

15.1.2.7 Knowledge Communities and Their Boundaries

Knowledge-creating processes involve deliberate efforts in spanning boundaries of prevailing knowledge by creating novel and often far-reaching networking linkages to experts, communities, and networks representing heterogeneous knowledge and competence. Productive "sparks" of collective creativity are likely to emerge when an unexpected "boundary encounter" between different knowledge communities takes place (Miettinen, 2006) and/or there happens actual crossing of boundaries between communities (Engeström, Engeström, & Kärkkäinen, 1995) that result in cross-fertilizing heterogeneous knowledge practices or hybridizing expertise of two or more domains of knowledge (Howells, 1999). While new information flows through weak (or occasional) networking linkages, actual sharing of knowledge practices requires gradual building of reciprocal interactive relations of working with a joint epistemic object; in this regard, mutual appropriation of concepts, instrument, and practices may be essential. Rather than the traditional pursuit of stable practices of teamwork, it is typical for concurrent knowledge-intensive work to rely on "negotiated knotworking" (Engeström, Engeström, & Vähäaho, 1999), i.e., "rapidly pulsating, distributed and partially improvised orchestration of collaborative performance between otherwise loosely connected actors and activity systems" (Engeström, 2004, p. 153). Such processes of creating new collaborative partnership with participants representing heterogeneous expertise constitute an important aspect of collaborative emergence. Collective activity appears to rely on an invisible network in creative intelligence that breaks organizational, institutional, disciplinary, and cultural boundaries.

Above, we examined some basic features of human expertise and its material and social dimensions. Yet, in present-day society, the highest levels of expertise are continuously evolving. In rapidly changing environment, professionals need to function as adaptive experts constantly stretching their abilities so as to keep up with emerging requirement. While individual experts have often a critical role in pursuit of novelty and innovation, it takes place on a fertile ground provided by collaborative activity (Paavola, Lipponen, & Hakkarainen, 2004). Knowing takes place more and more often in specific kinds of social communities and more and more complex expanded networks to support knowledge-creation efforts. Well-functioning innovative professional communities have cultivated methods and practices of facilitating professional development and networked expertise of all employees. Networked professional development is not just an individual but also collective concern. It may be argued that truly innovative professional communities

have cultivated shared practices (routines, standard operating procedures, collective habits) that channel and direct the participants' activity in a way that facilitates the development of expertise. As Herbert Simon (1977, 2002) has argued, excellence may be pursued in institutions by making pursuit of novelty and innovation as an everyday social practices; this process is driven by a central characteristic of experts' collective activity. It is important to consider the nature of communities which nurture such activity.

15.1.2.8 Methods to Study Experts' Networks and Communities

A few studies have pointed to the important role of particular social contacts for the long-term development of individuals in expertise research (Mieg, 2006) and in high ability research (Sosniak, 2006). While results of such studies are very encouraging and indicate the fundamental adaptability of the human cognitive system, a common limitation is the relatively narrow nature of the experimental tasks used to measure expertise. In parallel of providing objectively measurable criteria of assessing level of expertise (Ericsson, 2009; Ericsson & Smith, 1991), focus on a narrowly defined specific skills has meant abstracting from many relevant collective and socially distributed aspects of expertise crucial in professional context (Engeström, 2004; Hakkarainen et al., 2004). As mentioned above, professional organizations are not predominantly interested in individual expertise, but evaluate expertise relationally, capitalizing on heterogeneously distributed knowledge and competence (Hakkarainen et al., 2004). Because investigators have mostly focused on analyzing personal aspects of expertise, research on collective expertise is still in its infancy. In this chapter, we will survey methodological tools of social network analysis (SNA, Wasserman & Faust, 1994) that allow investigators to address many distributed and relational aspects of expertise; at the same, it partially supersedes older approaches to investigation of such phenomena. In addition to presenting the potential behind SNA, we aim to study whether there is real empirical evidence produced by earlier studies around SNA. Can it contribute to research on workplace learning in general and examining its socially shared and distributed aspects in particular?

15.2 Methodological Considerations

In psychological sciences, research methods, so to speak, appear to define the phenomenon (research object) investigated. To a significant degree, research instruments determine and shape psychological theories generated by researchers (Gigerenzer, 1994). The predominating experimental methods have focused on analyzing the individual aspects of expertise by relying on protocol analysis (Ericsson & Simon, 1993), cognitive task analysis (Grandall, Klein, & Hoffman, 2006), and other research techniques. Such investigations have provided interesting and

valuable results regarding task-specific cognitive adaptations that participation in sustained deliberate practice bring about (Ericsson & Lehmann, 1996); such findings appear to encourage and empower professionals and other learners seeking to cultivate their expertise to surpass themselves. Real-world expertise has previously been examined by participation observation and other ethnographic methods (Clancey, 2006). Some of the most interesting investigations are longitudinally oriented and involve examination for expert performance gradually changes as a function of systematic practice and training (Ericsson, 2006). It is challenging, however, that the timescale of the development of expertise is very long; it may take a decade or more.

We have earlier been developing frameworks and methods for analyzing networked and collaboratively emergent aspects of expertise. Social network analysis addresses relational rather than individual phenomena (Hakkarainen et al., 2004; Palonen, 2003). Such investigations may be carried out at multiple levels. Participants' personal social networks may be examined by interviews in which they are asked to visualize their egocentric networks and explain networking linkages. Social networks of coherent communities can be analyzed by networking questionnaires that allow examination of prevailing weak and strong networking linkages as well as identification of key actors of the community to whom the others go for advice and from whom the participants get new knowledge and novel insights (Palonen et al, 2004). From the methodological perspective, it is relevant that such methods allow assessing an individual participant's expertise and creative contribution through reliance on ties incoming from a whole community so as to avoid potentially biases of self-reports (Ericsson & Simon, 1993). Corresponding methods can also be used to trace networking linkages among artifacts (e.g., coauthorship or citation networks) that expert activity produces. It is common to use SNA to identify either central or peripheral actors from whom more detailed information is acquired through interviews or observations.

In this paper, our framework focuses on social networks including cohesion approach, structural equivalence techniques, and personal (egocentric) networks. Some empirical evidence based on earlier studies is sought for analyzing organizational-, community-, and individual-level results regarding expertise and workplace learning.

15.2.1 Social Network Analysis

SNA is an increasingly used approach to investigate both the social structure of interaction within subgroups and the attributes that are related to the actors inside a community. Although SNA allows us to study practically all kinds of connections, the method has especially been used to uncover the patterning of people's interaction that leads to various types of applications, such as interorganizational relations, the spread of contagious diseases, social support, the diffusion of information, and animal social organization, i.e., SNA facilitates the analysis of structural data.

Social relations may be considered to represent relational dyadic attributes, whereas the methods of mainstream social science, such as regular self-report questionnaires, are concerned with monadic attributes. The relations, i.e., dyadic attributes, may represent, for instance, kinship, social roles, affective or cognitive properties, actions, flows, distance, or co-occurrence. Relational structure models can be used to describe social and other phenomena where interactions between units are observed. These models allow researchers to represent pairwise relational structures of social actors (individuals, teams, organizations, etc.), where the relationships are defined by social interactions, e.g., collaborating, seeking advice, mediating information, and providing friendship.

15.2.2 The Whole Network Approach and Egocentric Networks

A social network is defined as a set of actors and the relations that hold them together. In *the whole network approach*, the actors are tied together via resource, e.g., information and exchange. The essential aim is to reveal the importance of repeated exchange relations that form the basis of both dyadic (between individuals) and structural (in the network) embeddedness. The continuous flow of communication creates a structure, which is then studied. In *the egocentric approach*, the network is examined from the perspective of one person (ego), and the focus is on his or her links to other people (alters). According to the latter approach, the network is "owned" by an ego. The network members (alters) consist of the people who have reported that ego is part of their network or who are nominated by the ego himself or herself. Although the analysis of relational structures focused on the pattern of relationships between the actors involved, the relations often are strongly affected by the monadic attributes possessed by the actors, e.g., age, gender, or educational status, length of work expertise, or level of expertise in the domain. The complexity of the situation is increased by the fact that it is often, a priori, unclear which attributes influence the relationship patterns, and whether these attributes have been measured.

In cohesion approach, density is a basic concept. It is a simple way to measure a network: the more actors have relationship with one another, the denser will be the network. When studying centralization, it is possible to focus either on centrality of an individual actor or centralization of a network structure (e.g., team, workplace, or geographical location). The centrality of an individual shows the most popular actors, those who stand at the center of attention and are highly chosen individuals in contrast to the isolates, who are rarely or not at all chosen. For example, Freeman's betweenness (Borgatti, Everett, & Freeman, 1996) has been used as an indicator of the information gatekeepers' positions. The measure is based on the concept of path distance, which can be understood better if we think communication as an information flow consisting of the individual connections. In SNA interactions between two nonadjacent actors, i.e., actors who are not directly interacting, depend on the other actors, who lie on the paths between these two. An actor has a high betweenness

value if he or she often lies between other actors, who are not directly connected to each other, given that the shortest distance between two actors in the network (the geodesic) is used to calculate the betweenness (Wasserman & Faust, 1994, pp. 188–192). The term centralization refers to the extent to which a whole graph has a centralized structure. Centralization measures are always related to individual centrality measures. The concepts of density and centralization focus on differing aspects of overall compactness of a graph. Density describes the general level of cohesion in a graph, while centralization describes the extent to which this cohesion is organized around particular focal points. Centralization and density, therefore, are important complementary measures (Scott, 1991; Wasserman & Faust, 1994, pp. 169–219).

In searching for the most active and visible key workers, we can, for example, calculate the centrality values to look at the amount of addressed and received information and knowledge. We have ourselves often set up an advice size variable, measured by flows of advice (to whom workers go for work-related advice) as a performance measure for the study. It can be treated as a rough estimate of workers' relative importance or cognitive centrality in the organization (Burt, 2000; Krackhardt, 1990). The relationships of various network dimensions tend to be were different even among the same actors when looking at how cohesion is distributed. Further, knowledge exchange dimensions are positively correlated with each other. The values are often reported to be highest between various instrumental, i.e., work-related network dimensions, and lowest between expressive ties (friendship) and instrumental dimensions (Ibarra, 1992; Ibarra & Andrews, 1993; Ibarra, Kilduff & Tsai, 2005). The notion of important and central network actors is obvious. As indicated above, the social networks are not random, but they are concentrated on some important and influential persons, "stars" (Scott, 1991), or "hubs" (Barabasi, 2002). These central actors have key roles in their communities. Figure 15.1 indicates some features that are related to cohesion view.

Structurally equivalent people, in turn, occupy the same position in the social structure and are so proximate to the extent that they have the same pattern of relations with occupants of other positions. So, two people are structurally equivalent if they have identical relations with all other individuals in the study population, e.g., at the workplace. Actors who are structurally equivalent do not need to be in direct contact with each other. Many methods that are concerned with this kind of notion of *social position* or *social role* translate into procedures for analyzing actors' structural similarities and patterns of relations in multi-relational networks. Although the methods are mathematically and formally diverse, they share a common goal of representing patterns in complex social network data in a simplified form to reveal a subset of actors who are similarly embedded in networks of relations and to describe the associations among relations in multi-relational networks (Wasserman & Faust, 1994, pp. 345–393).

In real life, it is rare that two actors would have exactly equivalent position. Therefore, a stochastic criterion might be a more accurately referred method to find structurally similar actors (Frank, 1996). Since it often is a priori unclear, which attributes@ influence the relationship patterns, stochastic modeling can also be used

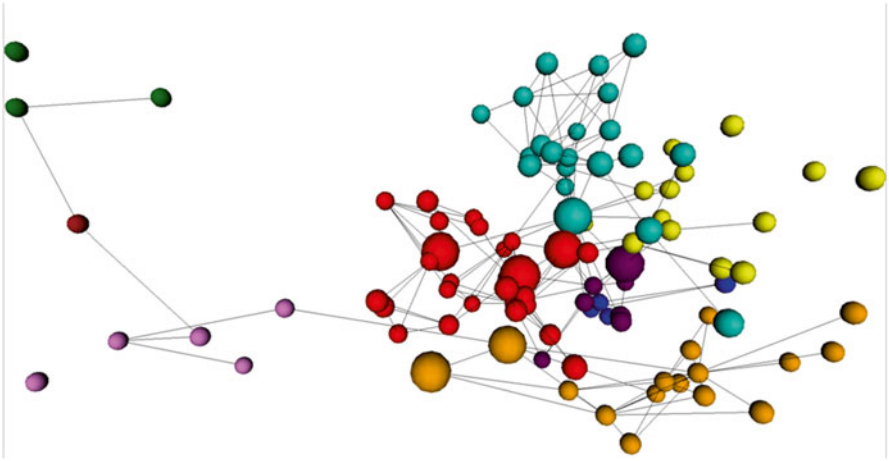

Fig. 15.1 The visualization is a snap-shot of a 3D multidimensional scaling map where *spheres* represent individuals and *lines* are reciprocal ties between them. The group that is located highest up has plenty of internal cohesion. In turn, some other subgroups are only loosely connected and have low internal cohesion. Further, there are some isolates in the picture, some particular spheres bridging these to the rest of the network. The most central members of the network are indicated in the figure with *bigger spheres*

to find latent classes, that is to say, some kinds of clusters or "colors" in which the workers belonging to the same class have the same probability distribution as that of their relations to other workers. The stochastic block model has two parts: the division of the set of actors into latent classes (the coloration) and the probability distribution of the relations within and between these classes (Nowicki & Snijders, 2001; Snijders & Nowicki, 2001).

Structural similarity can be understood as "radio channels" inside of a professional community. Those having similar network positions may be seen, so to speak, listening to the same radio channel. They may or may not be tied to other listeners of the same channel, but overall cohesive groups are not evidently needed. Evidence exists concerning that similar network positions are tied to some kind of hierarchy among network members (Wasserman & Faust, 1994). The structural position has been shown to be an important indicator of power, because a good network position provides access to information, people, and other resources (Burt, 1987; Lomi, Snijders, Steglich, & Torló, 2011). Although the stochastic methods appear to be superior, those have only seldom used in empirical studies.

15.2.3 Data Gathering

The SNA data can be gathered in many ways, e.g., through a social networking questionnaire in which interpersonal collaboration and informal discussion can be addressed (see Fig. 15.2). The questionnaire consists of a list of names in which rows

Fig. 15.2 An example of a SNA questionnaire

represent names whereas columns represent different types of networking relations, e.g., concerning advice seeking, information exchange, collaboration, or social support. By questionnaire, the information can be collected, e.g., about the networking practices, with a focus on tracing how the knowledge sharing takes places in some communities or organizations. Each of the network dimensions can be studied separately, but the features can also be combined if correlation between them is observed.

Beyond networking questionnaires, it is possible to use, for example, citation counts, interviews, and electronic log files (Nurmela, Lehtinen, & Palonen, 1999; Nurmela, Palonen, Lehtinen, & Hakkarainen 2003). It would also be possible to have a sample of informants, who report the information needed. They could, for instance, be asked to keep a record or diary of their networking encounters and systematically documents different aspects of networking events. Such an approach is close to event-contingent sampling of experiences (Bolger, Davis, & Rafaeli, 2003; Reis & Gable, 2000): repeated sampling of such events would allow overcoming retrospective biases that decrease reliability of questionnaire studies. If not carefully planned, the gathering and working with network data can be very time-consuming as network techniques are usually analyzed in the form of case-by-case matrices. The samplings, used mainly in the form of snowball sampling, are sensitive to research design and, as well, become large without showing the saturation expected.

In egocentric network analysis, data can be gathered, e.g., via interviews, in which network members are free listed. For interviewees, this appears to be a natural way to report their personal network members. People tend to classify their collaborators into groups, and often members of one group do not know members of another. In attribute-based analyses, the data are often summaries of attributes of network members that are then compared to the same or other attributes of respondents. One typical question asked concerns the type or content of the relation with each network member. Structural analyses can be gathered, e.g., as lists of the names in which respondents mark with whom they are having a relationship (such as advice seeking, collaboration, social support). It is to be noticed that gathering whole network data is a time-consuming task if the network is large.

We shall next take a look at empirical findings around SNA on the field of workplace learning and expertise development. The text is organized in two parts: (1) individual-level view, i.e., relational expertise approach, and (2) group- or team-level view. The short review is based on Internet search by using keywords of SNA and workplace. Further references have been followed that have been cited in the literature found by these keywords. In the following, we refer to results that are frequently reported, newly found, or crucial for the field.

15.3 SNA's Empirical Contribution for Relational Expertise and Workplace Learning

The research of social networks stresses the importance of cross-boundary analyses of workplaces' networks and even experts' past relations in their former networks. Previous studies have indicated some relevance to study the significance of the worker's network positions. SNA studies have indicated especially the importance of cohesive network positions, mediator and boundary crossing roles, the relationship between informal and formal power positions, personal characteristics and how they are related to persons' network position, and the different roles of strong and weak network ties in knowledge mediation. Particularly, previous research has demonstrated a relationship between network structure and instrumental outcomes.

15.3.1 Individual-Level Results

First, the central position in knowledge exchange network has been indicated as a patterned set of cohesive advice and information flows. In organizational settings, the structure of knowledge exchange is often a nested one. Information circulates within a work group more than between groups, within a division more than between divisions, and so on. At the individual level, knowledge diffusion occurs among

tightly linked workers (Burt, 1999, 2000; Friedman & Podolny, 1992; Palonen et al., 2004). Consequently, informal communities of practice have an essential role in knowledge exchange. Secondly, not only dense network flows but also the importance of nonredundant sources of information has been highlighted. Burt's (1992) argument about "structural holes" reveals how gaps between nonredundant contacts can generate control and information benefits. The information benefits are various, when there are people bridging diverse groups that have little or no interaction. Boundary crossing workers have access to more and varying information, and they are likely to hear about more valuable information sooner than other workers. They are also more likely to be exposed to a range of interpretations and, thus, be more accurate in their judgments about the trustworthiness and validity of the information available (Burt, 1999).

In the report of Friedman and Podolny (1992), a moderately high correlation between a central position within the team and boundary spanning has been found. Those who are most influential within the teams appear to be the most likely to occupy boundary-spanning roles. Plenty of empirical investigations has supported Burt's theoretical position demonstrating the diverse benefits which stem from bridging unconnected others at the individual level of analysis (Burt, 1997, 2004, 2007; Fleming, Mingo, & Chen, 2007; Mizruchi & Stearns, 2001; Rodan & Galunic, 2004; Seibert, Kraimer, & Liden, 2001; Soda & Bizzi, 2012).

In the same way, the structural position has shown to be an important resource of power (Burkhardt & Brass, 1990). There is evidence that individual characteristics, such as high self-monitoring (Mehra, Kilduff, & Brass, 2001), or entrepreneurial personality (Burt, 1998) correlate with network agency. There has been shown that correlation exists between individual cognitive and social structures (Janicik, 1997; Krackhardt, 1990). There is also empirical evidence according to which personal network characteristics are closely related with individual experiences and with differences in learning (Janicik, 1997). The nature of the knowledge exchanged and the strength of ties among members of the network are shown to be very important considerations (Hansen, 1999; Uzzi, 1997). Strong ties represent the reciprocal, redundant, and specialized information flow, whereas weak ties guarantee an adequate number of ties with the result that new information can also be captured in the network. The strong ties provide the best net effect in the case of complex knowledge, whereas weak ties may be more effective in transmitting well-coded knowledge.

The majority of SNA studies have focused on positive or neutral relations, whereas negative relations have been studied very seldom. There are, however, some studies that report how persons who hinder another person's work performance are related to social networks (Brass & Labianca, 1999; Labianca, Brass, & Gray, 1998). Negative relations are important factors in understanding attitudes and behaviors because they are more salient than positive relations. Individual job performance is positively related to centrality in advice networks and negatively related to centrality in hindrance networks composed of relationships tending to thwart task behaviors (Sparrowe, Liden, Waynemaria, & Kraimer, 2001).

15.3.2 Group-Level Results

Networking studies also examine group network structure and performance in work settings. Baldwin, Bedell, and Johnson's (1997) MBA team study found that team interaction patterns consistent with cohesive work groups were positively related to the team's final grade. However, an individual MBA team member's centrality in an "adversarial" network was negatively related to his or her satisfaction. At the group level, the number of adversarial relations within the team was negatively related to perceptions of team effectiveness, but positively related to the team grade. Labianca et al. (1998) found that the number of negative (avoidance) relationships with outgroup members was positively related to perceptions of intergroup conflict. Hindrance network density has found to be significantly and negatively related to group performance (Sparrowe et al., 2001).

Moliterno and Mahony (2011) acknowledged that network theoretic constructs tend to be isomorphic. As it is beneficial for an individual to bridge unconnected individuals, we would expect that it is likewise beneficial for a group to bridge unconnected groups. However, the latter perspective has not so often been highlighted. According to Burt's (1992) theory, brokers are capable of filtering and maneuvering information so that they can have access to superior information. Brokers gain advantage as long as they keep information to themselves or charge a "brokerage fee" that unconnected others must pay for the information (Burt, 1997; Buskens & van de Rijt, 2008; Fernandez & Gould, 1994). On the contrary to this view, work groups function effectively when members equally share knowledge with one another, do not engage in self-oriented behaviors, and collaborate instead of competing (Bizzi, 2013; Stasser & Titus, 1985).

There are some studies that report opposite results as regards profits for individual- and group-level indicators. Balkundi and Harrison (2006) performed a meta-analytical study and supported that density in both instrumental and affective networks relates to aggregate performance, whereas Sparrowe et al. (2001) and Cummings and Cross (2003) found evidence that centralization relates to group performance in negative way. Moliterno and Mahony (2011) showed that although previous studies addressed the nested nature of individual networks in groups, they were not empirical works employing multilevel methodology and examining the cross-level bridges between variables and different levels of analysis. Therefore, although individual-level structural holes are supposed to exercise positive effects, we may expect that at group level, the results are negatively associated with individual outcomes (Bizzi, 2013).

The individualistic, competitive, manipulative, and power-oriented behaviors of employees occupying structural hole positions may be beneficial when considering independent individuals, but not necessarily when it comes to group functioning and group climate. Group composition variables exercise a constraining effect on individuals, making them perceive less autonomy, and negatively affect satisfaction and performance (Bizzi, 2013).

15.4 Visions and Limitations Regarding SNA Approach to Workplace Learning

In organizational sciences, networks are considered a potential source of learning, facilitating learning by promoting skill transfer or by producing novel synthesis of existing information. It appears that heterogeneous networks and multiplex relationships facilitate such learning, but very close, long-term relationships are likely to result in network homogeneity, reducing the diversity of experiences and turnover in networks (Beckman & Haunschild, 2002). Similar results have been found in small group research (Jehn, Northcraft, & Neale, 1999). This would provide a clear contribution to the methods and tools such as SNA. However, though the SNA studies have provided interesting cases of fieldwork, they have not become part of the larger interpretations of communication studies or learning research. One reason for this is the level at which the data have been gathered. To be able to follow complex communication processes, more detailed and richer datasets combined with qualitative methods should be collected. In spite of these limitations, the contribution that SNA methods have provided for fieldwork in organizations is promising. The concrete tools to describe patterns of interaction have been helpful. In particular, the visualizations have shown their strength in laying out abstract networks in a readable way (for visualizations, see Freeman, 2000).

It appears that SNA studies could contribute academic world by adding our understanding of the complex phenomena, such as connections among experts in the professional communities. SNA methods have potential to facilitate interaction and knowledge exchange in working organizations. In recent years, resolution of social media has become better, and obviously this has had influence on informal work communities, adding transparency. Social media has, however, a distinct role inside and outside of the working organizations. Making invisible issues visible can be helpful, but at the same time it may be a risk (Kaplan & Haenlein, 2010). The "glass house generation" seems to be willing to show everything what they do or who they like or what they think (Brzozowski, Sandholm & Hogg, 2009). By using SNA, it is, e.g., possible to create an album for working organizations that indicates how the knowledge is exchanged in the workplace by using visualizations or organigraphs (Mintzberg & Van der Heyden, 1999) that are the organizations' x-ray pictures (Slaughter, Yu, & Koehly, 2009). Yet, it is important to distinguish that SNA has strong tools in making invisible things visible but only limited knowledge to provide advice of optimal network structures and especially how to create these.

Further, it seems obvious that there are some biases in SNA related to its use, e.g., as concerning the routine coordinators (it might show too high effect), experts with special competencies on the not widely known expert field (it might show too low effects), and social overemphasizing in general. A need to get independent indicator for expertise and skilful communication is obvious. There should have to be possibilities to evaluate SNA results with tools, which are not themselves leaning to same principles. Complex and rapidly changing networks entail challenges to research methodology. Until now collaboration among members of an organization

has often been studied through examining the routine exchanges of various kinds of resources, such as information, pieces of advice, emotional support, and so on. Local practices and regularities of these transfers and exchanges are assumed to shape the structure of collaboration, e.g., in multifunctional or multidisciplinary workgroups. Recently, specific statistical tools and models have been developed to identify these exchanges in order to analyze structures of collaborative activities that go beyond individual resources. These approaches allow an examination of participation in collective action at the level of subcultures rather than mere dyads. In networks, this kind of approach allows an examination of indirect or generalized structural relation of exchange.

The new methods, therefore, provide an important contribution toward the theory of collective action since they extend our understanding of how collegial action creates local social structures. Simultaneously, network analysis also provides rigorous methods for tracing how social structures mediated activities of individuals, groups, and communities. Resulting information might help individuals and communities to find indirect ways to manage their resources, including information, advice seeking, emotional support, and many others.

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