Research paper

Exploring the conditions for academic teachers' informal collegial learning about teaching. A social network approach

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Contextualization

Competition for students, funding and reputation is putting pressure on higher education institutions to take action aimed at enhancing teaching quality. Much of the literature on teaching development focuses on voluntary or compulsory teacher training, on reflective practice (Schön, 1983) and on fostering communities of practice (Wenger, 1998b) as ways to raise teaching quality. While Schön is interested in individual professionals' informal learning through reflective practice, Wenger's concept of communities of practice emphasises collective informal learning.

My paper is concerned with the assessment and improvement of the conditions for academic teachers' collective informal learning. Learning with and from colleagues requires communication and is inhibited by social isolation. Based on this premise, I analyse teachers' communication networks at a higher education institution in order to identify structures that facilitate or impede collegial learning. Guided by social network theory, I also propose interventions to secure and enhance the teachers' capacity for informal collegial learning about teaching.

Abstract: *Teaching is widely regarded as a profession characterised by isolation. Teachers' isolation can be an obstacle to their informal social learning. This paper takes a look at the extent of higher education teachers' isolation and their conditions for teaching-related learning from colleagues. Based on a network interpretation of communities of practice, it applies social network analysis to the collegial relations of 40 professors at a Fachhochschule (German higher education institution). The study finds that while some professors are indeed isolated, a strong minority engage in various communities of teaching practice. However, these communities tend to be connected only by few individuals acting as informal hubs for teaching ideas. Informal collegial learning may thus be obstructed more by a shortage of highly connected professors than by isolated ones. Possible interventions should aim at increasing the density of weak ties across the organisation.*

Introduction

Expert knowledge is what higher education teachers get hired for, yet professional teaching knowledge is what they increasingly require (Beaty, 1998) to cope with the educational needs of a changing and growing student body; to meet the students' expectations of a positive study experience; and to satisfy the industry's and the government's demand for productive and performing graduates. But how do higher education teachers learn to teach?

In a recent survey of professors at German *Fachhochschulen* – non-university higher education institutions providing vocationally-oriented undergraduate and graduate degree programmes – I found that practically all 259 respondents saw themselves as reflective practitioners (Vogel, forthcoming). Almost half of them had never received even a basic introduction to teaching despite their weekly teaching load of 18 or 19 hours; only few were

making use of the literature on teaching and learning, and a majority saw collegial relations neither as important learning opportunities nor as a significant source of motivation. In fact, most survey participants preferred working alone and felt no particular responsibility towards their colleagues.

The two problem areas emerging from the survey, 'acquisition of teaching knowledge' and 'isolation in teaching', are of course not unique to *Fachhochschul* professors but rather common to higher education in general. Schön (1983), for instance, suggested that professionals develop their professional knowledge through reflective practice, and the participants in my survey seemed to agree. But the crisis of confidence in professional knowledge (Schön, 1992) has cast doubts on the ability and willingness of higher education teachers to learn enough through autonomous reflective teaching alone. Such doubts are expressed, inter alia, by some governments' decision to introduce compulsory teaching qualifications for higher education teachers (Gibbs and Coffey, 2004).

Teacher training, however, has been criticised for targeting the individual, even though poor teaching quality is often a systemic problem, rooted in "the context of a university […] which may have unexamined traditions" (USDU, 1994, p 5); and for taking a formal approach to solving a problem of informal culture. Trowler and Bamber (2005) note that "Relying on individual change to lead to systemic change commits the error of 'methodological individualism'; it exaggerates the power of agency over that of structure, seeing individual actors as the prime movers and shakers in social change" (p 84).

The other problem area emerging from my survey, isolation, seems to be almost characteristic for academic working life (eg, Baker, 1999; Baker and Zey-Ferrell, 1984; Bogler and Kremer-Hayon, 1999) and the teaching profession as a whole (De Lima, 2003; Drago-Severson and Pinto, 2006; García and Roblin, 2008; Massy and Wilger, 1994; Sears, 1991; Young, 2002). Reasons for the isolated nature of much academic work may be found at the individual (academics with inner-directed personalities striving for autonomy), functional (teaching as an individualistic, independent function), systemic (academics competing for resources, recognition and authority, often in a zero-sum game), and disciplinary level (disciplines, schools of thought, and areas of specialisation separating colleagues at the same institution).

For *Fachhochschulen*, my survey results concerning the risk of their professors' isolation are especially serious. Firstly, the primary mission of *Fachhochschulen* is teaching, not research, so their academic staff tend not to join research teams or networks. Without research acting as a community builder, the risk of social isolation may be greater than at universities. Secondly, professors at *Fachhochschulen* are required to have several years of professional experience *outside* higher education. Most of them come directly from the private sector and take up their teaching positions without ever having taught. Many *Fachhochschulen* do not manage this transition but leave it to chance, risking a bad start in isolation for their new teaching staff, possibly with lasting consequences because "If early socialization is deficient, then the longer-term prospect for higher education is a worrying one" (Knight, 2002, p 37). Thirdly, if it is true that most *Fachhochschul* professors avoid teacher training courses and ignore the literature on teaching and learning, and if on top of this their isolation prevents them from sharing and discussing their teaching with colleagues, what are the chances of modern teaching ideas, concepts, and practices ever reaching them?

Purpose and structure of this paper

Sensitised by my survey and the above considerations, the Vice-Chancellor of *Sonnberg*, a small *Fachhochschule* in Germany, agreed to support the initiation of a professional learning community (PLC) for professors as a collective staff development exercise. Stoll *et al* (2006) define a PLC as "a group of people sharing and critically interrogating their practice in an

ongoing, reflective, collaborative, inclusive, learning-oriented, growth-promoting way" (p 223). The PLC was intended not only as an experiment in collective reflection on teaching, but also in relationship-building. As Westheimer (1999) writes, "Teacher professional communities are seen as a promising solution to a profession wrought with isolation" (p 72). The plan was to invite between six and twelve professors to engage in a yearlong, self-directed programme about enhancing teaching and learning (eg, Cox, 2004; Walker, 2001).

For me, this endeavour was an opportunity to study the effects of a PLC on the organisation in which it is embedded, on its members, and on non-members. The fact that *Sonnberg* had no staff development programme rendered this opportunity particularly interesting, as it facilitated the study of a PLC in a 'pristine' academic environment where all teaching-related learning is and has been informal learning. According to Eraut (2004), informal learning includes implicit, unintended, opportunistic and unstructured learning taking place in absence of a teaching authority.

In this paper I present and discuss the results of a social network analysis which I conducted at *Sonnberg* in preparation of the PLC. My aim was to investigate certain initial conditions under which the PLC would form. Understanding these conditions would make it easier at later stages to identify the PLC's impacts, and it might help to identify professors who should ideally be invited to join. I had three research questions:

- How isolated in their teaching roles are *Sonnberg*'s professors from their colleagues (as opposed to: how isolated do they feel)?
- How does the structure of their interactions provide and prevent opportunities for informal collegial learning about teaching?
- How could the conditions for informal collegial learning be improved?

The focus on isolation and on the professors' learning from and with one another is directly related to the problem areas highlighted by my earlier survey, to the above discussion, and to *Sonnberg*'s conditions which the PLC was intended to improve.

The next section outlines the conceptual framework of this study which combines communities of practice and social network theory. Section 4 briefly introduces the concepts and methods of social network analysis which are necessary to understand the *Sonnberg* case study which is presented in section 5: from professors' self-reported collegial relations, social networks are constructed, analysed and interpreted from a social-learning perspective. Section 6 discusses the main results and offers answers to the above three questions. Section 7 concludes the paper with a few critical remarks. A glossary of network analysis terms can be found in the appendix.

Communities and networks of practice

Theories of social learning claim that ''the person and the environment do not function as independent units but instead determine each other in a reciprocal manner'' (Davis and Luthans, 1980, p 282). When studying the ways in which higher education teachers learn to teach, the view that learning has an important social component makes teachers' professional communities a natural object of study. Wenger's (1998b) concept of communities of practice has received particular attention in the literature as it emphasises the social context in which much informal workplace learning is situated. A community of practice can be understood as an informal group of people pursuing a joint enterprise, sharing a repertoire of communal resources (eg, expertise, discourses, meanings, symbols, routines, history), and engaging mutually.

Through peripheral participation, new community members learn with respect to all three dimensions by discovering how to align their own enterprise, how to develop their own repertoire, and how to engage with the community (Lave and Wenger, 1991). For the community as a whole, learning results from a tension between the competence this community has established, and its members' ongoing experience of the world. "Learning so defined is an interplay between social competence and personal experience" (Wenger, 2000, p 227).

Wenger (1998a) stresses that "Communities of practice develop around things that matter to people. As a result, their practices reflect the members' own understanding of what is important" (p 2). The shared and accepted practices within a community are not necessarily 'good' or even 'best' practices that could serve as models for all practitioners. Since community members jointly develop their own understandings of appropriate practices, it is quite conceivable that some communities' practices may actually be unacceptable for most other communities.

In spite of its widespread popularity with organisational developers and social scientists, the concept of communities of practice has not remained without criticism. Jewson (2007), for instance, points out that the notion of community is value-laden (see also Fox, 2002); that the definitions of community provided by Lave and Wenger lack clarity and rigour; and that the way they characterise communities of practice makes it "difficult to envisage how empirical research […] can proceed other than by means of qualitative ethnographic methodologies" (p 71).

To overcome the problems of terminology, insufficient rigour, and limited researchability, attempts have been made to interpret communities of practice in terms of social networks. Brown and Duguid (2000) regard communities of practice as special cases of networks of practice. While the latter are "networks that link people to others whom they may never get to know but who work on similar practices" (p 141), the former are "more tight-knit groups formed, again through practice, by people working together on the same or similar tasks. [...] They are usually face-to-face communities that continually negotiate with, communicate with, and coordinate with each other directly in the course of work" (pp 141-143). Interpreting frequent face-to-face contact between two people as a strong social tie, and a tight-knit group as a dense social network, Bogenrieder and Nooteboom (2004) summarise that "communities of practice are characterized by the high density and the strength of ties" (p 294).

High local density of strong ties is of course not the same as a community of practice. The network approach focuses on the structural and relational aspects of communities of practice, whilst being blind with respect to the identity, meaning, practice and learning which such communities produce. A high local density of strong ties is also no *sufficient* condition for a community of practice – families and groups of friends can produce similar patterns – but it is a *necessary* condition to identify communities of practice in larger social networks.

The advantage of the network interpretation of communities of practice consists in its combination of Wenger's (1998b) theory of social learning with the theory of social networks which, in turn, builds on mathematical graph theory. As a result, a mathematical toolbox has become available to detect empirically communities of practice, to describe and characterise them, and to explore their properties. Moreover, the insights gained during decades of sociological network research can now be used to enrich the understanding of situated learning.

A brief introduction to social network analysis

This section introduces the concepts and techniques of social network analysis, of which the subsequent sections of this paper will make use. A social network is a set of specific

relations between a given number of people. Social network analysis works with relational data such as membership, friendship and contacts, which cannot be reduced to characteristics of individuals themselves. “Relations are not the properties of agents, but systems of agents; these relations connect pairs of agents into larger relational systems” (Scott, 2000, p 3). Social network analysis is interested in the structural characteristics of networks and uses sociological concepts such as power, community and social cohesion strictly in this sense.

A social network can be represented by a matrix or by a graph. A data matrix typically describes relations of individuals (rows) with other individuals (columns). If the relations described are reciprocal (eg, being friends), the data matrix is symmetric. An asymmetric matrix, on the other hand, represents a network of directed relations (eg, one person may frequently seek another person’s advice, but not vice versa). A binary network only distinguishes between existing and non-existing relations (a person either knows her neighbour or not), whereas a valued network characterises the existing relations further (a person may know her neighbour very well). The characteristics are expressed numerically.

Assume, for example, that the individuals A, B and C have been asked as part of a survey to specify their social relations in terms of how often per month they normally have lunch with one another. The results are shown in Figure 1a: A claims to lunch three times per month with B and four times with C. B claims to lunch four times with B and twice with C. And C forgot to complete the survey questionnaire. Since ‘having lunch together’ is a reciprocal relation, the matrix in Figure 1a should be symmetric. This allows reconstructing the missing answers of C from their respective symmetric counterparts, ie, from the answers of A and B. This step is shown in Figure 1b. Moreover, symmetry requires that the cells (A; B) and (B; A) contain the same values. This can be achieved by replacing the stated lunch frequencies by their arithmetic mean (Figure 1c). Figure 1d finally visualises the symmetrised data matrix by a graph consisting of nodes (individuals) and ties (social relations). Stronger ties are represented by bold ties.

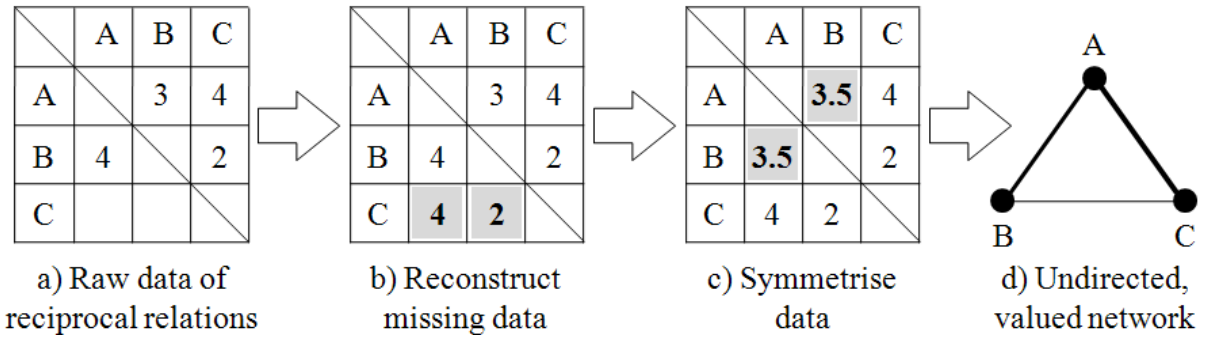

Figure 1. Constructing an undirected valued network

For certain types of analyses, valued networks cannot be used and need to be transformed into binary networks. To this end, the valued relations are dichotomised. This is done by setting all values exceeding a defined ‘cut-off point’ equal to one and eliminating all other values. Returning to the above example, assume that for a specific analysis only those relations between A, B and C are of interest which involve at least three lunches per month. Thus the cut-off point is set at 3. Figure 2 illustrates the process of dichotomisation. The network diagram in Figure 2c now only includes the bold ties of Figure 1d.

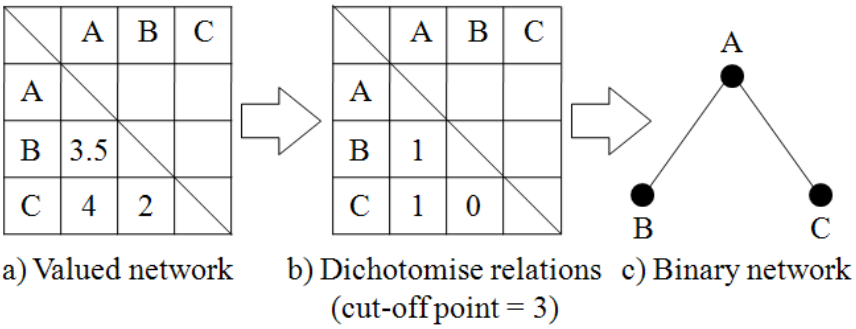

Figure 2. From valued to binary network

Different binary networks can be combined using Boolean operators. Figure 3c, for instance, results from the intersection (operator AND) of two data matrices. It comprises only those ties which are common to Figure 3a and 3b. To continue the example from above, if Figure 3a depicts the relations between A, B and C involving at least three lunches per month, and Figure 3b represents relations of friendship between the same people (A and B as well as B and C are friends, but not A and C), then Figure 3c shows only relations of friends who lunch together at least three times per month.

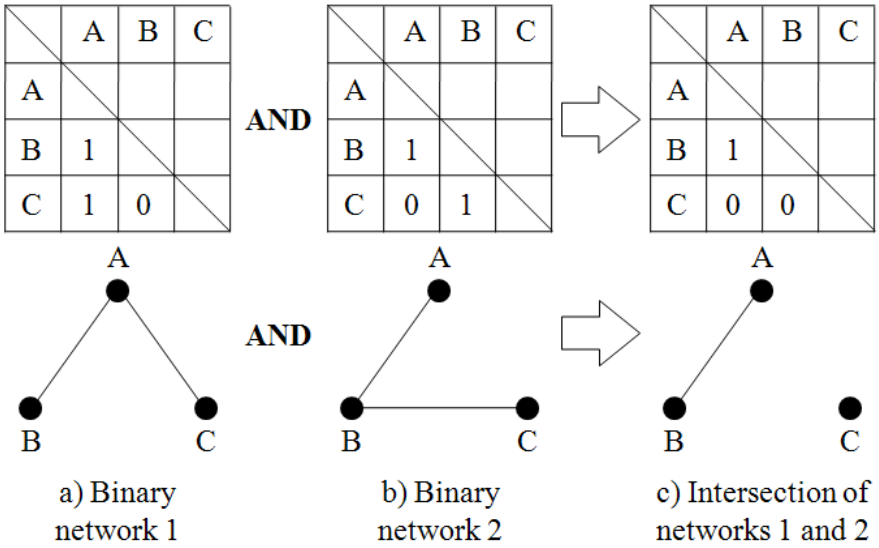

Figure 3. Intersection of binary networks

Figure 4c, by contrast, arises from the union (operator OR) of the same two data matrices and includes all ties of Figure 4a and 4b.

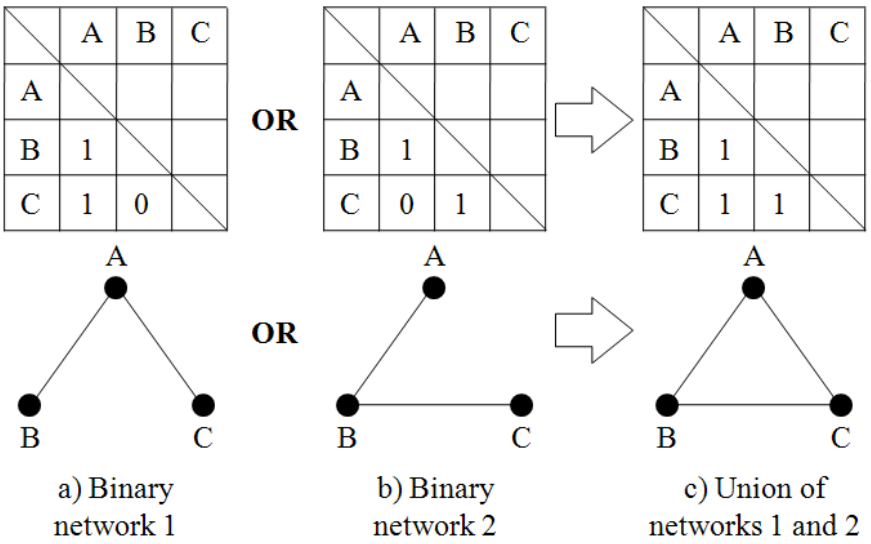

Figure 4. Union of binary networks

Various metrics and concepts are used to describe particular network or graph patterns. An important metric is the *degree* of a node, ie, the number of ties connecting it with other nodes. The higher the degree of a node compared to the average degree of a network, the more central is this node. *Centrality* may be interpreted as a form of power. Another metric is the network *density*, ie, the number of ties in a network in relation to the number of possible ties. Density is a measure of network cohesion. Density may vary across a network. A sub-graph with a significantly above-average density is called *cluster*. A cluster in which every node has a tie with every other node (ie, a cluster with a density of 1) is a *clique*. Different clusters may be connected by one or more ties called *bridges*. The absence of bridges leads to disconnected clusters and *structural holes* between them. Nodes on both ends of bridges and nodes directly connecting different clusters are referred to as *brokers*. Like centrality, brokerage is considered a form of power.

The Sonnberg case study

The methods and concepts just introduced will now be applied to the network of professorial relations at the *Fachhochschule Sonnberg* with the aim of inferring the conditions for informal collegial learning from the structure of the professors' interactions. The study is based on a survey which I carried out in summer 2008. *Sonnberg* was well suited for the purposes of this research because of its limited size, with only 69 professors, which made it possible to recruit a large share of them for the survey.

Sampling and data preparation

The survey was organised in two steps. First, all professors at *Sonnberg* were invited to participate. They were informed that participation would require permitting all other participants to reveal their communication and learning relations with them. The research and data handling procedures had been approved beforehand by the data protection commissioners in charge; I had resolved some ethical and strategic-behaviour issues

(Borgatti and Molina, 2003) with an internal 'critical friend', and the whole study adhered strictly to the ethical guidelines for educational research (BERA, 2004).

In all, 40 professors from the both faculties, engineering and economic sciences, volunteered and signed an informed consent form. *Sonnberg*'s engineering faculty which comprises 52 per cent of all professors was underrepresented in this group of volunteers with only 38 per cent. The 40 professors were then given a questionnaire listing the names of all participants as well as the items 'other internal colleagues' and 'external colleagues'. The questionnaire asked them to state how often they normally communicated with each person on the list:

a) in general

b) about the contents of their teaching

c) about the methods of their teaching, and

d) how strongly each colleague on the list had influenced their teaching.

The first three questions required answers on a five-point Likert scale (almost daily/weekly/ monthly/rarely/never), and the last question on a three-point Likert scale (strong/some/no influence). Only 39 participants completed their questionnaires. But due to the reciprocal nature of communication between people (if A communicates with B then B also communicates with A) it was possible to reconstruct the missing data for questions (a)-(c) from the other participants' responses (see Figure 1). For question (d), however, no symmetric counterparts were available since influence of one person on another need not be reciprocal.

Symmetric counterparts were also used to fill in some other missing data points and to substitute responses of one participant who seemed to have strongly and systematically overstated her/his communication relations with others. Finally, the communication data matrices were symmetrised on the basis of averages (see Figure 1). For data modelling, analysis and visualisation, I used UCINET 6 (Borgatti, Everett, and Freeman, 2002), SPSS 16, and Netdraw (Borgatti, 2002).

Constructing strong-tie and weak-tie networks

Each of the four networks resulting from the survey captures a different aspect of the conditions for the professors' informal collegial learning about teaching. For a more complete picture, however, the separate networks must be combined. To this end, Granovetter's (1973) distinction between strong and weak can be adopted. According to him, "the strength of a tie is a (probably linear) combination of the amount of time, the intensity, the intimacy (mutual confiding), and the reciprocal services which characterize the tie" (p 1361). Stronger ties make the professors' informal learning from one another more likely than weak ties.

In this paper, a relation between two professors shall be considered a *strong tie* with respect to teaching if it meets *each* of the following conditions:

- at least weekly communication in general
- at least monthly communication about teaching contents
- at least monthly communication about teaching methods
- at least some influence of one professor on the other's teaching in the past.

The strength of these ties lies in their integrity. Professors who regularly communicate about the contents and methods of their teaching may have or develop respect for each other as competent in both areas. Their frequent general communication is likely to strengthen their professional and personal relationships over time. And their history of positive influence of one colleague on the other's teaching might have built trust and can be seen as social capital.

By contrast, a relation between two professors will be considered a *weak tie* with respect to teaching if it involves at least monthly communication about the contents *or* methods of their teaching or both, and it is no strong tie.

In order to construct networks of strong and weak ties, the original networks have to be combined (see Figures 3 and 4) which, in turn, requires their dichotomisation (see Figure 2). The cut-off points are given by the above four criteria of strong ties and are visualised by Figure 5. The strong-tie network is obtained by *intersecting all four binary networks*. The weak-tie network results from the *union of the two networks* shown in the middle of Figure 5.

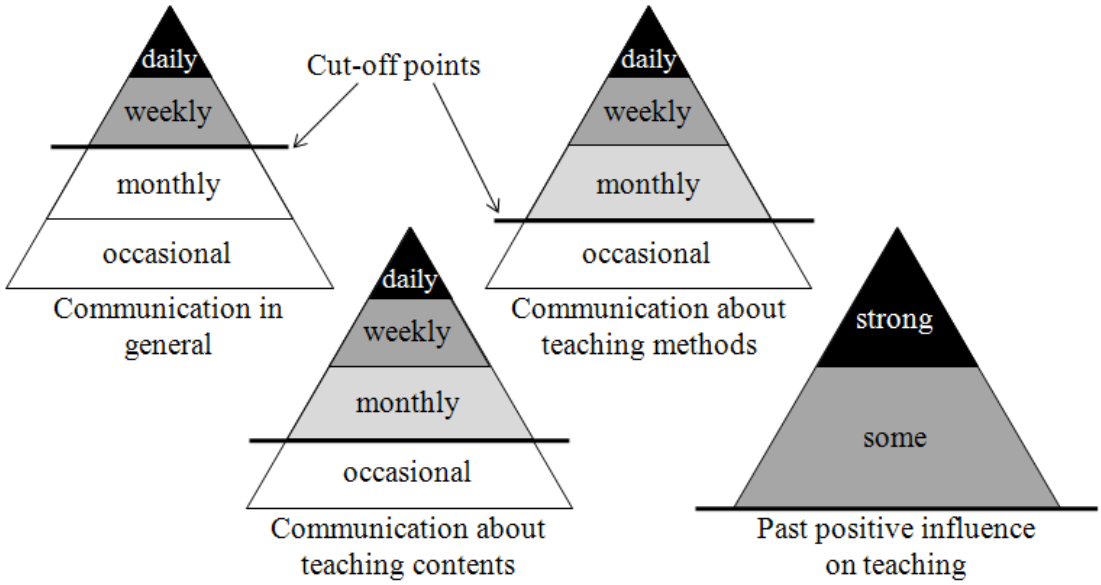

Figure 5. Cut-off points for network dichotomisation

Graphical network analysis

Figure 6 depicts the graph of the strong-tie network. Circles represent members of *Sonnberg*'s engineering faculty, triangles members of the economic faculty. The spatial distribution of nodes in the graph results from a multidimensional scaling algorithm. Proximity of two nodes reflects their similarity in the sense that they share similar shortest paths to all other nodes. As a result, most circles are located on one side and all triangles on the other side of the graph.

The network consists of three larger structures and two dyads. The large structure on the right-hand side of Figure 6 connects ten of the fifteen survey respondents from the engineering faculty. It consists of the clique ⟨A⟩ and two chains. The two other large structures include one cluster each. Figure 7 shows how the strong-tie structures, indicated by bold solid lines, are embedded in the network of weak ties. Thin solid lines represent relations between professors communicating about the contents *and* the methods of their

teaching. Dashed lines and dotted lines depict relations focusing *either* on teaching contents *or* on teaching methods but not both.

In Figure 7 the two isolated dyads of Figure 6 are integrated in cluster ⟨D⟩ which is held together only by its members' shared interest in a particular subject relevant to their teaching. This cluster would be disconnected from the rest of the weak-tie network if person ⟨a⟩ did not act as a *gatekeeper* to cluster ⟨C⟩. Also beyond this important brokerage role, person ⟨a⟩ is essential for the cohesion of *Sonnberg*'s teaching-related communication network, being the best-connected professor in Figure 7 with a degree of nine.

A similarly integrative position in Figure 7 is occupied by person ⟨e⟩, who is an isolate in Figure 6. The fact that ⟨e⟩ has more ties with members of the economic faculty than with members of her/his own enigneering faculty may be the result of the underrepresentation of the engineering faculty in the sample mentioned earlier. Not being a cluster member herself/himself, ⟨e⟩ is a *liaison* between the clusters ⟨B⟩, ⟨C⟩ and ⟨E⟩.

The persons ⟨b⟩, ⟨c⟩ and ⟨d⟩ have a degree of eight each. While ⟨b⟩ is particularly significant for the cohesion of cluster ⟨B⟩, the persons ⟨c⟩ and ⟨d⟩, like ⟨e⟩, seem to act as hubs for teaching ideas across cluster boundaries.

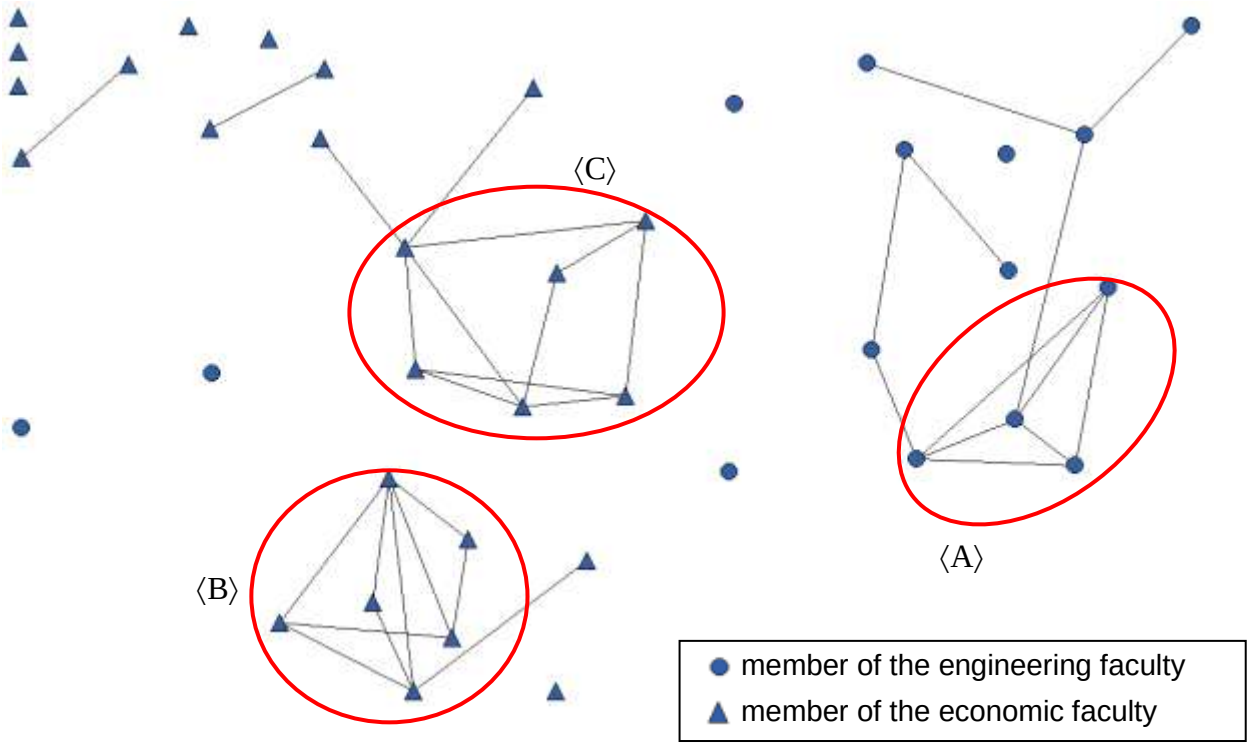

Figure 6. Graph of the strong-tie network

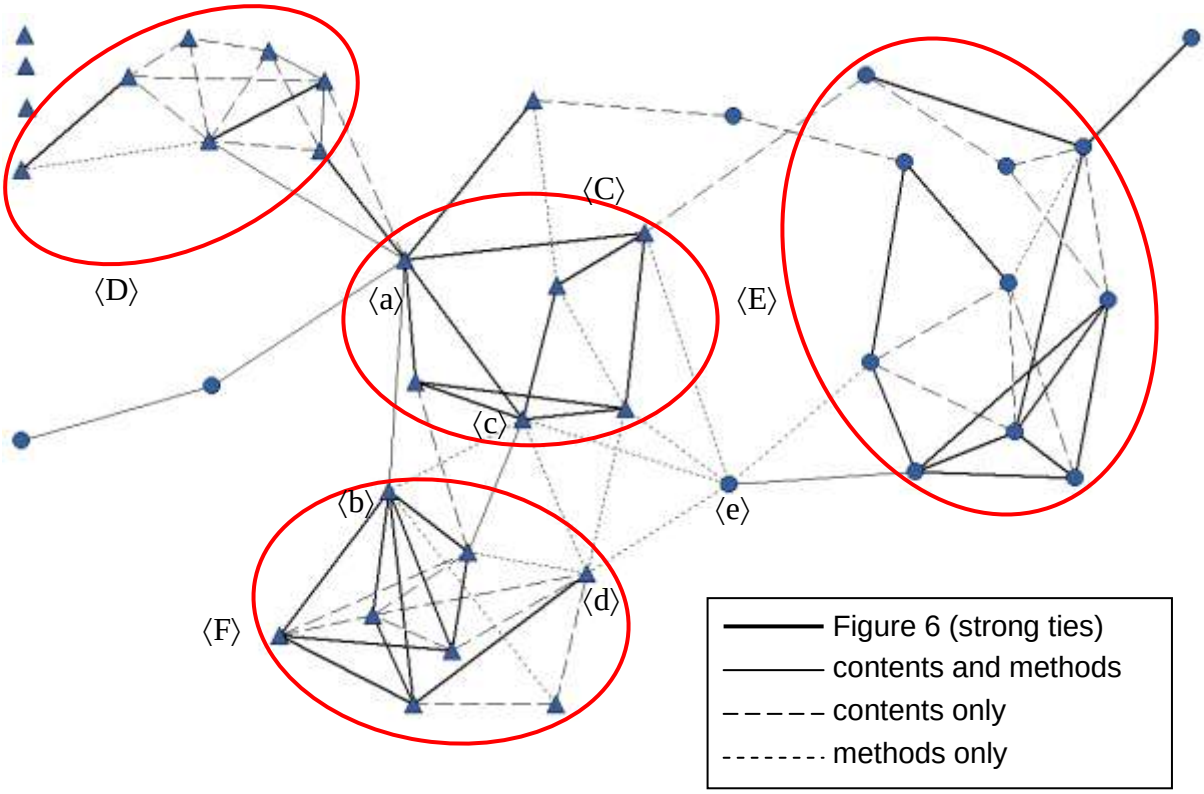

Figure 7. Graph of the combined strong-tie and weak-tie networks

⟨E⟩ is the largest cluster of the weak-tie network and includes not only clique ⟨A⟩, but almost all survey participants from the engineering faculty. Similar to the clusters ⟨D⟩ and ⟨F⟩, its coherence is largely based on a shared subject-related interest, suggesting that the engineering faculty's engineering professors have more common ground than the members of the economic faculty who tend to form several smaller clusters.

In higher education, different disciplines have developed strong and distinctive cultures, which Becher and Trowler (2001) refer to as academic tribes. "In its very nature, being a member of a disciplinary community involves a sense of identity" (p 47). It thus seems plausible to assume that the cluster boundaries in Figure 7 reflect disciplinary boundaries. The structural hole between the engineering and the economic faculty, and the predominance of teaching-content-specific ties within the clusters ⟨D⟩, ⟨E⟩ and ⟨F⟩ support this hypothesis.

Isolation and connectedness

Figure 8 shows that 80 per cent of the professors participating in the survey share at least three ties with other participants and 28 per cent have ties with six or more colleagues. Only 20 per cent of the survey respondents can be considered internally isolated with respect to teaching and are thus largely excluded from informal collegial learning. However, Figure 8 also points out that those professors who are least connected internally tend to interact more frequently with *Sonnberg*-external colleagues about teaching. This is in line with Jewson's (2007) observation that "Those on the periphery of a network may […] exercise great importance as a primary point of contact with outsiders and members of other networks" (p 73).

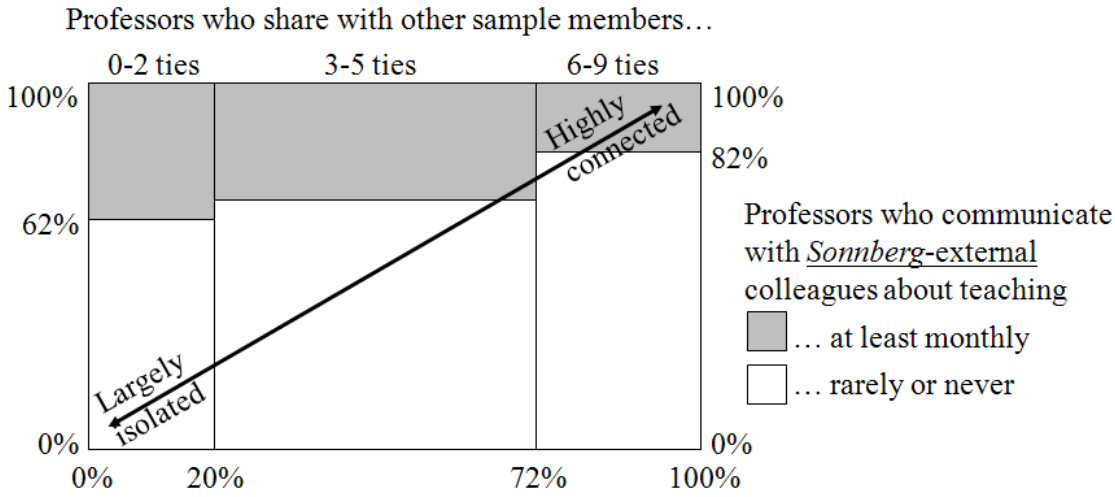

Figure 8. Isolation and connectedness of professors in the sample

Discussion

The network interpretation of communities of practice has made it possible to explore community structures by means of graph-theoretical concepts. According to this interpretation, clusters of individuals connected by strong ties represent communities of practice. Thus Figure 6 depicts three communities of teaching practice, ie, three groups of professors at *Sonnberg* who are informally bound together by the joint enterprise of teaching, by shared understanding and practices of teaching, and especially by mutual engagement with respect to teaching.

In this section I discuss the results of the social network analysis with respect to my three research questions: How isolated in their teaching roles are *Sonnberg*'s professors from their colleagues? How does the structure of their interactions provide and prevent opportunities for informal collegial learning about teaching? How could the conditions for informal collegial learning be improved?

Isolation from colleagues

Isolation did not emerge as a major *structural* characteristic of the professors' teaching-related collegial network at *Sonnberg* (yet the professors may still *feel* isolated). As shown by Figure 6, 40 per cent of the survey participants are integrated in a community of teaching practice. According to Figure 8, only 20 per cent have less than three strong or weak ties with colleagues *within the sample*. Had the sample been larger and included all professors at *Sonnberg*, the share of internally isolated individuals may have been lower still. One may of course debate whether this is a positive or negative feature, and every isolated colleague is one too many. But isolation as a general trait of the professors' collegial network is not what my research has found.

Informal learning from colleagues

The three communities of practice identified in the sample indicate that informal teaching-related collegial learning takes place, and reveal where. Many professors also appear to benefit from the exchange with colleagues outside of *Sonnberg*. However, 60 per cent of the respondents were only peripherally or not at all connected to a community of practice, and the majority of them were also not well connected externally. Chances are that these

individuals are somewhat decoupled from important social learning processes, which is likely not only to affect their teaching, but also their professional identity and motivation.

Generally, strong ties like those within communities of practice tend to be transitive and hence conducive to self-sealing groups (Degenne and Forsé, 1999, p 111) whose dense internal networks generate informational redundancy, and whose sparse external networks provide insufficient access to new ideas and knowledge. Over time, their members' shared experience and limited cognitive distance may lead to 'groupthink' and lack of innovation (Burt, 1992), especially if community membership is stable.

Therefore, the teaching knowledge developed within communities of practice "is intimately related to the specific social situations, interaction, and communities, which have generated, validated, maintained, and used it" (Park, Oliver, Johnson, Graham, and Oppong, 2007, p 370). It might neither be transferable to other contexts, nor stand the scrutiny of community-external peers or experts. The weak ties between certain communities of practice (see Figure 7), and the relations of *Sonnberg*'s professors with external colleagues (see Figure 8) may not be sufficient to ensure the circulation of teaching knowledge and ideas, and the cross-checking of local teaching practices with the outside world. Under such conditions, communities of practice can even become obstacles to learning.

For this reason, weak ties which bridge the gap between different communities of practice may actually be more important for learning than the community-internal strong ties. According to Granovetter (1983), "individuals with few weak ties will be deprived of information from distant parts of the social system and will be confined to the provincial news and views of their close friends" (p 202). Burt (1992) stresses that weakly connected people can access new knowledge, provide cognitive distance, and thus act as a source of learning.

At *Sonnberg*, closed communities probably only pose a minor risk for learning about teaching. The communities ⟨B⟩ and ⟨C⟩ are neither sealed nor cliquish, given their moderate cluster densities of 60 per cent and their many ties with community outsiders. Also cluster ⟨A⟩, despite being a clique, is well connected within the engineering faculty. In Figure 7, only cluster ⟨D⟩ is a candidate for self-sealing and exclusion from teaching-related knowledge flows.

Greater structural risk than from clusters emanates from individuals. In their respective roles as gatekeeper and liaison, the persons ⟨a⟩ and ⟨e⟩ control much of the teaching-related information circulating between the clusters ⟨C⟩-⟨F⟩ in Figure 7. Even though the control over teaching-related knowledge may not be a source of power over individual colleagues, it certainly is a source of power over teaching knowledge at *Sonnberg*. Given that teaching is the institution's main mission, ⟨a⟩ and ⟨e⟩ are in this sense mission-critical.

Improving the conditions for collegial learning

The structural risk can be reduced, and the flows of teaching knowledge enhanced, by limiting the network's dependence on ⟨a⟩ and ⟨e⟩. This could be achieved by encouraging the establishment of new ties between the barely connected clusters ⟨C⟩/⟨F⟩, ⟨D⟩, and ⟨E⟩, making the critical ties of ⟨a⟩ and ⟨e⟩ redundant. One way of increasing the connectedness of those clusters may indeed be the PLC planned at *Sonnberg*, provided that its membership is interdisciplinary.

Invitations for joining the PLC should be extended especially to professors who are active communicators with respect to teaching methods. A second selection criterion could be the number of direct ties a professor has with colleagues who do not have ties with other prospective members of the PLC. Both criteria together ensure a maximum multiplier effect in the sense that a fairly small number of professors involved in the endeavour could

spread their new insights, reflections and experience to a large number of colleagues across the *Fachhochschule*.

In Figure 9 which is based on Figure 7, nine professors are marked by circles. If these nine persons were to form the PLC, practically all other participants of this study would share a tie with at least one of them, thus being able to receive first-hand information about the community's activities.

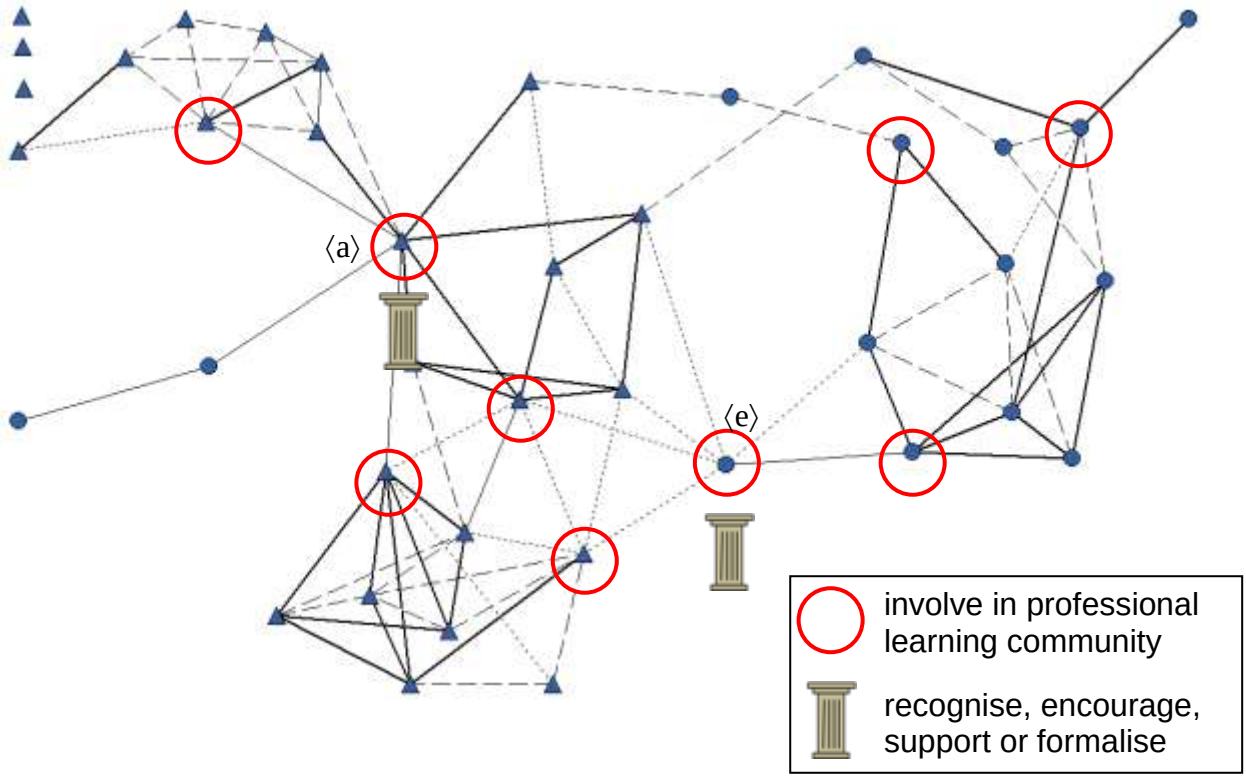

Figure 9. Possible intervention points

An alternative, smaller-scale intervention might do the exact opposite of making the critical ties of ⟨a⟩ and ⟨e⟩ redundant, namely strengthen these persons' roles as communication hubs by recognising, encouraging, supporting or even formalising them. In Figure 9, this option is visualised by columns 'supporting' ⟨a⟩ and ⟨e⟩. The idea underlying this intervention would be to use key individuals as change agents in order to leverage their existing networks, their networking skills, and their apparent interest in teaching-related communication.

Concluding remarks

Formal teacher training as a widespread approach to improving teaching effectiveness in higher education has been criticised for targeting the individual whilst ignoring the systemic causes of poor teaching quality. The influence of organisational context and culture on individuals may not only counteract the intended effects of interventions aimed at individual teachers; it can also create substantial tensions for these individuals who may feel pressured to conform to the teaching standards promoted in trainings, as well as to their respective departments' teaching conventions (Gibbs and Coffey, 2004). It thus seems important to design teaching development initiatives as systemic rather than isolated interventions, taking the social context of teachers' workplace explicitly into account.

The focus on formal teacher training also neglects the potential of informal learning from and with colleagues, which tends to be situated in communities of practice. Despite Wenger's explicit concern for the cultivation of communities of practice in organisations that thrive on knowledge (eg, Wenger, 2000; Wenger and Snyder, 2000), little attention has been given to informal learning about teaching by the academic development literature.

In this paper I addressed this aspect by concentrating on the assessment and improvement of the conditions for academic teachers' informal collegial learning. Learning from and with colleagues requires communication and is inhibited by social isolation. Based on this premise, and guided by social network theory, I mapped and analysed teachers' communication and influence networks at an exemplary higher education institution in order to identify network structures that facilitate or impede collegial learning. The social network analysis emphasises the significance of academic teachers' positions in a social network for their access to relevant information; the possible direct and indirect influences which the teachers exert on each other's teaching; and the importance of targeting an intervention at suitably connected groups and individuals to maximise its impact.

For academic developers, my study offers three main messages. Firstly, mapping the social networks of departments and faculties, whether based on a formal survey or on casual observations, can be a valuable exercise when planning interventions. By providing a systemic or holistic view of social relations, network diagrams shift developers' attention from the individual to the collective. Secondly, teaching development measures may be targeted at individuals but should be planned bearing in mind the interaction between these individuals and their peers. New teaching practices, for instance, may require a critical mass of adopters to overcome resistance and inertia; and investments in the development of individuals occupying key positions in a social network (eg, gatekeepers, liaisons, stars) might benefit the network as a whole. Thirdly, academic developers should consider activities enhancing their institutions' capacity for informal knowledge exchange and learning, eg, facilitating the establishment of new relations between different communities of practice. Interventions which increase social network cohesion may complement formal teacher training very effectively.

Appendix: Glossary of network analysis terms

Binary network	Non-valued network. All ties have the same value and represent the existence of relations but not their strength.
Centralisation	A measure of how tightly a graph is organised around its most central point.
Chain	Node(s) with degree 2.
Clique	A complete sub-graph in which every node has a tie with every other node.
Cluster	A sub-graph of significantly higher density than its environment.
Degree	The degree of a node is the number of ties connecting it with other nodes. In directed networks, in-degree and out-degree are the numbers of ties pointing towards and away from a node.
Density	The number of ties in relation to the number of possible ties.
Directed network	Ties have a direction, pointing from one node to another. The underlying data matrix is asymmetric.
Dyad	A pair of nodes.
Gatekeeper	A member of a cluster who controls access of outsiders to this cluster.
Isolate	Node with degree 0.
Liaison	Connects two or more clusters without being a member of them.
Pendant	Node with degree 1.
Star	"The star network is the most centralized or most unequal possible network for any number of actors. In the star network, all the actors but one have degree of one, and the 'star' has degree of the number of actors, less one" (Hanneman and Riddle, 2005, p 150).
Structural hole	One node is connected to two others, who are not connected to each other.
Transitivity	Nodes A, B and C form a transitive triad if A directs a tie to B, B directs a tie to C, and A also directs a tie to C.
Valued network	Ties may have different values representing different strengths of relations rather than their mere presence.

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