Around and around: The concentric circles method as powerful tool to collect mixed method network data

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Abstract

This chapter focuses on the potential of using the 'concentric circles' (CC) method. The CC method is an interview-based data collection procedure that allows researchers to co-construct personal networks with respondents. In specific, respondents map their network in a dynamic and visual way on concentric circles, and allow researchers to easily capture data on the ego-, alter-, alter-by-alter, and tie-level. The CC method also facilitates the simultaneous collection of quantitative and qualitative network data. Drawing on concrete examples, we present a practical lay-out for both researchers and practitioners on how the concentric circles method can be adopted. We also demonstrate how the CC method can be used in various mixed method designs and for various research purposes: to gather insight into the quality of ties, to deepen understanding of network dynamics, to build network visualizations from, to gain insight into network agency, and to design network interventions.

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Intro

Visualizations are an essential element of the social network paradigm (Freeman, 2004). Beyond the aesthetic value of visualizations, their power lies in allowing the conversion of quantitative data to qualitative and vice versa (Molina, Maya-Jariego, & McCarty, 2014). Network visualizations make it possible to translate the structural features of social networks to laymen (Palonen, in this volume), and to communicate between researchers with different quantitative and/or qualitative backgrounds. As such, the explanatory power of network visualizations has been discussed extensively (Brandes, Kenis, & Raab, 2006; Freeman, 2005). Until now, the use of network visualizations has often remained confined to the research lab as visualizations are mostly used by researchers in the analysis phase. Yet, recent work has extended its use to field by integrating visualizations in the data collection phase and co-constructing networks with respondents (Hogan, Carrasco, & Wellman, 2007). In specific, a method using concentric circles has been set forward to co-construct personal networks with respondents in a dynamic and visual way (based on work by Antonucci, 1986; Hogan et al., 2007). This so-called 'concentric circles method' (CC method) concerns a powerful tool to simultaneously generate both quantitative and qualitative network data. This chapter demonstrate how the CC method can be used in various mixed method designs and for various research purposes. Moreover, this chapter offers a practical lay-out for both researchers and practitioners on how the concentric circles method can be adopted.

The concentric circles (CC) method

The concentric circles method is an interview-based data collection procedure that allows to visualize and co-construct network information with respondents. It specifically helps to visualize personal networks or ego-networks. A personal network entails the systematic mapping of a focal actor (*ego*) and the specific connections (ties) s/he has with people (*alters*) (Crossley et al., 2015). For example, mapping the personal network of a teacher (*ego*) and the relationships (*ties*) s/he has with people influencing his/her teaching practice (*alters*). Most traditional network research starts the data collection with matrices of name-generating questions and follow-up questions about the specific connections with and between these people. The network visualizations resulting from this information mostly appears only later on in the research report. In contrast, the CC method already uses network visualization in real-time during the data collection, as a means to accelerate aspects of the collection process and to provide reliability checks (Hogan et al., 2007).

The CC method finds its origin in the work of Fitzgerald (1978) who had her respondents write the names of alters on plastic chips that were arranged in rows on a table. Respondents then ranked the alters on the chips based on their closeness to each other. Later on, Kahn and Antonucci (1980) developed a method based on three concentric circles to arrange network members; where the outer circles represented decreasing levels of closeness (see Figure 16.1). Respondents described this level of nesting using circles as intuitive and intelligible (Antonucci, 1986). More recent, Hogan, Carrasco and Wellman (2007) further developed the technique, using a name tag system on movable post-its. Their approach used four circles instead of three, and worked with five-layer name-templates bundled in binders. Their CC method also allows to easily collect data on the relationships between alters (alter-by-alter ties) and on subgroups (by drawing lines around groups of alters). Based on this work, we used an adapted version of the CC method in our own work (using three concentric circles combined with the post-it approach) to generate both quantitative and qualitative network data.

<INSERT FIGURE 16.1 ABOUT HERE>

The use of the CC method

The CC method facilitates the collection of network data as it supports respondents in mapping their network in an insightful way (Molina et al., 2014), and has high face-validity. We illustrate the use of the method by describing its application in our own research where we mapped teaching networks of university instructors (Van Waes et al., 2016; Van Waes, Van den Bossche, Moolenaar, De Maeyer, & Van Petegem, 2015; Van Waes, Van den Bossche, Moolenaar, Stes, & Van Petegem, 2015). We were interested in with whom instructors interacted around their teaching practice, in the quality of their ties, in the composition and structure of the networks, and the change in their networks over time. To this end, we used the CC method to collect quantitative and qualitative personal network data - which we describe in the following paragraphs.

Our interviews started with a large piece of paper, a pencil and some post-its on a table. The piece of paper contained a central dot, and several concentric circles (see Figure 16.2). The interviewer explained to the respondent that we were interested in the people they interact with around their teaching. The specific name-generating question was: “In the past half year, have you talked to anyone about your instructional practice?” (see Table 16.1 for an excerpt from the interview guide). We told them that they could use the post-its to write down the names of these people in order of free recall, and use as little or as much post-its as they deemed necessary. The post-its remained pasted together in a bundle, not suggesting a certain amount of names/alters. We did not encourage respondents to achieve a baseline of number of alters. Another option to generate names - instead of using post-its - is to work with name

tags within template bundles (Hogan et al., 2007); though this approach may implicitly suggest listing a certain amount of alters given the number of template cells.

Next, the interviewer told the respondent that s/he could stick the post-its onto the paper with the concentric circles. The interview explained that the central dot represents the respondent him/herself (the ego), and the concentric circles indicate the closeness of contact; where the inner circle stands for frequent, intensive interactions and the outer circles for less frequent and intensive interactions around teaching. Depending on the focus of the research, the circles may of course vary in meaning; for example, they can stand for degrees of trust (high/low trust) or friendship (best friend/acquaintance), but also different physical locations (same house/street/village/country), affiliations (class, grade, school), or significance for the workplace setting (partly significant/significant/very significant). The meaning and interpretation of the circles will determine the number of circles that are useful.

We used A3-sized paper, as it allows sufficient spacing for the post-its between the circles. Respondents were asked to group the people that knew each other. The interviewer also indicated that if any additional names would come up during the interview, these could still be added. We did not hint at the respondents that mentioning extra names would mean extra work. When the respondent had finished writing down names (usually this went fairly quickly), the interviewer went across several possible categories to recall names that may have been forgotten (e.g., are there still people within your department, faculty, within the university, outside the university, friends or family that may be missing?). An interesting approach in this regard, is the 'stimulus cue cards' used by Hogan et al. (2007) to check if respondents have forgotten anyone. Hereby the interviewer shows respondents a card listing different roles as a prompt (e.g., immediate family outside the house, other relatives, neighbors, people you only know online etc.), and asks whether people in any of these role may be missing.

< INSERT FIGURE 16.2 ABOUT HERE>

When the network map is constructed, name interpreting questions can be asked to gain insight into various aspects of the constructed personal network. In our research, the respondents were interviewed using a semi-structured interview guide (see excerpt in Table 16.1). This guide contained name-interpreting questions designed to gain insight into the kind of people instructors interacted with about their teaching practice, the size of the network, the similarity of the people in their network (homophily), and the strength and quality of the ties. Depending on the research focus, the CC method allows the researcher to ask the respondent questions on different levels of the personal network:

1) **Questions about the respondent him/herself** (*the ego-level*); for instance, the respondent's gender, age, experience, education, background;

2) **Questions about the people the respondent interacts with** (*the alter-level*), for instance, whom they go to for advice, whom discuss their professional practice with, whom their friends are, whom they collaborate with; and the gender, age, experience, education, background characteristics of these people;
3) **Questions about the type, quality and nature of their relationships** (*the tie-level*), for instance, the frequency and intensity, the level of trust, the level of interdependence, the depth, the value created, the affective and or instrumental nature of their relationships;
4) **Questions about the relationships between the named people** (*the alter-by-alter level*), for instance, the existence of a relationship between the people on the map, whether they are friends, know each other, interact about their teaching practice.

<INSERT TABLE 16.1 ABOUT HERE>

Information about the alter-by-alter level can be obtained by asking the respondent to draw a line between the people on the map, or to draw a circle about subgroups as perceived by the respondent. This type of network information allows researchers to identify brokers, hubs and bridge builders later on. In addition, respondents can be asked to use different colors to highlight features on different levels, for example by highlighting names pertaining to certain roles (e.g., friends, family, colleagues) or to indicate different types of ties (e.g., work-related/trust-relationship).

Interviews lasted between 45 and 90 minutes, depending on the size of respondents' networks. Beforehand, several pilot interviews were conducted. The interviews were recorded and transcribed verbatim. An additional option would be to ask respondents to tape the interview, and construction of the network map. Pictures of the personal network maps were then used for member checking procedures, where the respondents were sent a picture of their network map by e-mail. A follow-up telephone call was scheduled to verify the completeness of the network, based on the picture of the network map. Additions (of one to four alters) were made by four out of 30 respondents.

The CC method and mixed network data

The CC method offers unique possibilities to mix quantitative and qualitative data (Froehlich, in this volume). The CC method can be used in any mixed design as it enables researchers to collect and analyze quantitative and qualitative network data simultaneously and/or consecutively. For example, in our own research, the interviews using the CC method simultaneously generated qualitative (e.g., content and value of interactions) and quantitative network data (tie strength, network size) on teaching networks. In the analysis phase, the qualitative data were analyzed using content analysis (Van Waes et al., 2016), and the quantitative data were analyzed using multilevel analyses after conversion (Van Waes, Van den Bossche, Moolenaar, De Maeyer, et al., 2015). These rich data allowed us to mix results in the

conclusion and discussion phase (Van Waes, 2017). Other examples of data conversion when using the CC method is, for instance, quantifying the distance between the circles as a metric for network closeness, or quantifying data related to network composition and structure (e.g., to betweenness measures).

The data gathered using the CC method may serve as the primary data source or may be complementary, supplementary or contradictory to other research data. For example, we set up a sequential explanatory design (Van Waes, Van den Bossche, Moolenaar, Stes, et al., 2015), where we consecutively collected quantitative (network survey) and qualitative data (interviews using the CC method) to gain insight into network change processes. Following-up on longitudinal network surveys, we conducted interviews with specific network change profiles using the CC method. This approach allowed mixing in the analysis phase, using the qualitative data as a complementary data source to study network change processes. The stories about the narratives behind change patterns offered rich qualitative insights. For example, our mixed approach brought to light how less favorable network constellations, and negative or so-called 'difficult ties' developed.

The CC method for various research purposes

The concentric circles method can be used to collect network data for various research purposes. We go over several of these purposes and illustrate them with examples.

- To gather insight into the quality of ties

The CC method can be applied to gain in-depth insight of personal networks. Most extant network research focuses on quantitative network features related to the composition and structure of networks. While that is important, often questions about the quality of social relationships are less examined (e.g., the content, meaning and significance of ties) (Bellotti, 2014; Fuhse & Mützel, 2011). The CC method helps to capture networks in their totality as it supports the interaction of quantitative network techniques aimed at explaining and describing social structures, with qualitative techniques offering extensive explorative powers and understanding of meaning in networks. Working with the concentric circles adds that respondents recognize their social world in the visualizations, and are able to give meaning to the compositions and structures represented. As such, the interview is more reflexive and interpretative, and better reflects the actual content and arrangement of the network based on the co-constructed visualization (Molina et al., 2014). This innovative approach to capture the quality of networks may offer enhanced insight in what flows through ties, or may result in a nuanced picture of the variation and spread of ties, or may show how respondents perceive and value their interactions.

- To deepen understanding of network dynamics

Recent work is paying increasing attention to network dynamics (Borgatti, Brass, & Halgin, 2014; Clegg, Josserand, Mehra, & Pitsis, 2016). Not treating network processes as static givens is timely. On the other hand, changes in the network tend to be interpreted as positive per se. Yet, network change does not automatically imply that, for example, learning has taken place or that development is impacted. When a new tie is formed, it does not necessarily mean that new knowledge is created in the network. Nothing may have happened, or it may mean that conflicting information was brought in. A dropped tie does not always imply that knowledge is lost, and a kept tie may not add anything or become redundant (Halgin & Borgatti, 2012). The CC method can be used to map the underlying mechanisms that support or hinder network change to collect narratives and reasons about network change. In our own work, we selected teachers with different profiles of network change for interview, based on the analyses of the network questionnaires. The profiles were selected based on changes in network size (i.e., number of people in the network), and on the stability or change ratio's in the network (Cornelissen et al., 2014; Van Waes, Van den Bossche, Moolenaar, Stes, et al., 2015, p. 18). We anticipated that by investigating different profiles of network change, possible mechanisms could be uncovered that might support or constrain network change. For the interview, we used four network maps visualizing the respondent's network change from measurement moment 1-4 (see Figure 16.3). The CC maps were constructed based on previous results of network questionnaires. A semi-structured interview guide probed for mechanisms underlying change in teachers' networks, such as reasons for new/ lost/kept ties, the supporting or constraining influence of climate and culture. This helped us to gain better understanding of network dynamics and the associated supporting and constraining mechanisms in the social context.

<INSERT FIGURE 16.3 ABOUT HERE>

- To build network visualizations from

As the CC method is a visual method it can also be used as a basis to build network visualizations from. Few network visuals represent both quantitative and qualitative network strands. Most visualizations display features of network composition and structure, and do not depict qualitative network features. We built on the concentric circles maps to generate network visualizations that also depict the value created in network ties and the interdependence within network ties (see Figure 16.4) (Van Waes et al., 2016). In these visualizations (using Gephi 0.8.2) the nodes in the network maps stand for the people, and the lines represent the ties or relationships between the instructor and the people in his or her personal teaching network. The length and thickness of the lines in the network maps display the interdependence, where thick and short lines stand for ties in which highly interdependent interactions were reported (i.e., sharing, joint work), whereas thin and long lines indicate ties with low interdependence (i.e., storytelling, aid and assistance). The size of the nodes represents the created value. Where small nodes represent immediate and potential value, which respectively stand for interactions that produce value in and of themselves (e.g., interactions that are experienced as useful or enjoyable),

and for interactions whose value lies in the potential to be realized later (e.g., interactions producing ideas, material or advice). Large nodes stand for applied, realized or reframing value, which refer to interactions that cause actual changes.

<INSERT FIGURE 16.4 ABOUT HERE>

- To gain insight into network agency

Traditionally, network research considers changes in networks as resulting from an interplay between self-organizing properties of networks (Agneessens & Wittek, 2012; Brennecke & Rank, 2016). This means that networks develop because of the properties they have and the way they are structurally embedded in the larger network (e.g., if someone offers you help, you are likely to reciprocate this tie to maintain the structural balance). Social theorists have long debated this assumption, and have been discussing the relative contributions of structure and human agency to social interactions and network dynamics (Bourdieu, 1986; Giddens, 1984). In this regard, Granovetter (1985) wrote about 'under-socialized and over-socialized' accounts of social relationships. Some scholars have recently questioned whether structure has overwhelmed agency in empirical network studies (Gulati & Srivastava, 2014; Kilduff & Brass, 2010). The use of the CC method also shed light on this matter, as the method helped us to probe into respondents' agency and intentionality. In specific, our research demonstrated how expert teachers displayed higher agency, as they described to frequently re-evaluate their networks and to act intentionally on them (Van Waes et al., 2016). Apparently, they somehow 'learned' to manage their network. The reactions and interpretations of respondents reflecting on their personal networks (as displayed by the CC method) allowed us to gain insight into the degree of awareness about their network, and how intentional they acted upon their network. In other words, the method helped to uncover the perceived social world that respondents see. Related to this observation, Mehra et al. (2014, p. 313) wrote the following: "Seeing the trees (i.e., ties) does not mean that one sees the forest (i.e., larger network configurations, such as bridging positions)." The CC method could prove a promising avenue to further unpack the concept of network agency in relation to structure, using a mixed method approach.

- To design network interventions

Recently, network interventions have been developed to support professionals and organizations to intentionally act on their networks (Cross & Thomas, 2009; Parise, 2007). Network interventions are purposeful efforts to use social network data to accelerate behavior change, to improve performance, or diffuse innovations (Valente, 2012). Scholars have provided evidence that professionals who learned the properties of an effective network, achieved greater performance and career advancement (Burt & Ronchi, 2007). Following up on this research, we designed an intervention to strengthen university instructors' networks in support of their professional development as teachers (Van Waes, De Maeyer, Moolenaar, Van Petegem, & Van den Bossche, 2018). At its core, the intervention consisted of a

network training session to raise teachers' network awareness (Baker-Doyle, 2011; Cross, Singer, Colella, Thomas, & Silverstone, 2010; Uzzi & Dunlap, 2005). In the training session a group of instructors was introduced to the idea of 'teaching networks' and how these may help them to improve their practice. Based on a network survey, the instructors received a personal network map using the concentric circles to visualize their teaching network. These network maps served as a tool during the training session to introduce and apply several network concepts (related to network composition and network content) and to examine if and how their network could support and/or hinder them in their practice. Strategies were introduced to rewire and maximize the networks in light of their professional development. Results showed that the instructors in the trained network group developed stronger networks, compared to a control group. This example highlights the power of using the CC method in the design of network interventions.

Conclusion

This chapter demonstrated how the concentric circles method offers a straight-forward and dynamic way to visualize and co-construct personal network information with respondents. It extends the use of network visualizations from the research lab to the field, co-constructing networks with respondents. The research examples illustrate that the CC method concerns a powerful tool to collect and analyze quantitative and qualitative network data, which can be used in different mixed method designs for various research purposes. To conclude, we highlight the main advantages and pitfalls when using the CC method.

Advantages of the CC method:

- *Low cost*: Interviewers only need a sufficiently large table, a large piece of paper and post-its;
- *Low threshold*: respondents experience the method as enjoyable and intuitive. They are not confronted with technological challenges as is sometimes the case with online data collections;
- *Holistic view*: The real-time visualization enables respondents to see all of the alters at once, and as such allows to simultaneously assess a great amount of information;
- *Multiple levels*: Data on multiple network levels can be collected in one go, i.e. on ego-level, alter-level, tie-level, and alter-by-alter level;
- *Boundaries*: The method helps respondents to map personal networks from the ground up, and thus allows them to define their own network boundaries during the interview;
- *Flexibility*: Respondents can easily move around post-its during the interview. They can place the post-its onto the network in their own way, according to their own perception;
- *Adaptability*: Researchers may tweak the method according to their own research focus. The method can be used to map different types of networks and alters. The meaning of the circles may vary;

- *Reduced errors due to forgetfulness*: Names can be added at any time during the interview, which is often more complex with network questionnaires. Prompts based on roles may be used to stimulate the name recall process (cf. supra);
- *Enjoyable for respondents*: Respondents described the CC method as intuitive, enjoyable and insightful. Several respondents also described having experienced an immediate feedback effect;
- *Network map for member checking*: Pictures of the network maps constructed during the interview may also serve for member checking procedures.

Potential pitfalls of the CC method:

- *Time intensive*: The method takes up considerable time for both the interviewer and the respondent. A combination of a network survey (to examine the composition and structure) combined with the CC method (to explore the meaning) may partially meet this pitfall;
- *Training of the interviewer*: As with any interview, the method may be subject to interviewer effects (Marsden, 2003). Interviewers first need to be made familiar with the method, and conduct several guided pilot interviews; which may be time-intensive as well;
- *Definition of circles*: It is not always easy to provide clear meaning for the different circles on the network map. Circles may be interpreted differently by respondents (e.g., the difference between "somewhat close" and "very close" alters);
- *Self-reported data*: As the method concerns self-report, we may also assume that the most salient and important relationships are reported, as these are most easily recalled (Almquist, 2012). The method may be combined with a follow-up snowball method, i.e. by interviewing/surveying the alters in the network as a member check (Handcock & Gile, 2011; Rice et al., 2014).

References

Agneessens, F., & Wittek, R. (2012). Where do intra-organizational advice relations come from? The role of informal status and social capital in social exchange. *Social Networks, 34*(3), 333-345.

Almquist, Z. W. (2012). Random errors in egocentric networks. *Social Networks, 34*(4), 493-505. doi:http://dx.doi.org/10.1016/j.socnet.2012.03.002

Antonucci, T. C. (1986). Measuring social support networks: Hierarchical mapping technique. *Generations, 10*, 10-12.

Baker-Doyle, K. J. (2011). *The networked teacher: How new teachers build social networks for professional support*. New York: Teachers College Press.

Bellotti, E. (2014). *Qualitative networks: Mixed methods in sociological research*. London: Routledge.

Borgatti, S. P., Brass, D. J., & Halgin, D. S. (2014). Social network research: Confusions, criticisms, and controversies. In *Contemporary perspectives on organizational social networks* (Vol. 40, pp. 1-29): Emerald Group Publishing Limited.

Bourdieu, P. (Ed.) (1986). *Distinction: A social critique of the judgment of taste*. Cambridge, MA: Harvard University Press.

Brandes, U., Kenis, P., & Raab, J. (2006). Explanation through network visualization. *Methodology, 2*(1), 16-23. doi:10.1027/1614-2241.2.1.16

Brennecke, J., & Rank, O. N. (2016). The interplay between formal project memberships and informal advice seeking in knowledge-intensive firms: A multilevel network approach. *Social Networks, 44*, 307-318. doi:http://dx.doi.org/10.1016/j.socnet.2015.02.004

Burt, R. S., & Ronchi, D. (2007). Teaching executives to see social capital: Results from a field experiment. *Social Science Research, 36*(3), 1156-1183. doi:http://dx.doi.org/10.1016/j.ssresearch.2006.09.005

Clegg, S., Josserand, E., Mehra, A., & Pitsis, T. S. (2016). The transformative power of network dynamics: A research agenda. *Organization Studies, 37*(3), 277-291. doi:10.1177/0170840616629047

Cornelissen, F., Daly, A. J., Liou, Y., Caillier, S., Riordan, R., Wilson, K., . . . Canrinus, E. (2014). *Network building in the master's program: The social dimension of developing a teacher leader-researcher identity*. Paper presented at the ECER, Porto, Lissabon.

Cross, R., Singer, J., Colella, S., Thomas, R. J., & Silverstone, Y. (2010). *The organizational network fieldbook: Best practices, techniques, and exercises to drive organizational innovation and performance*. San Francisco: Jossey-Bass.

Cross, R., & Thomas, R. J. (2009). *Driving results through social networks: How top organizations leverage networks for performance and growth*. San Francisco: Jossey-Bass.

Crossley, N., Bellotti, E., Edwards, G., Everett, M. G., Koskinen, J., & Tranmer, M. (2015). *Social network analysis for ego-nets*. London: SAGE Publications Ltd.

Fitzgerald, M. (1978). *The content and structure of friendship: An analysis of the friendships of urban Cameroonians*. (Unpublished doctoral dissertation), University of Toronto.

Freeman, L. C. (2004). *The development of social network analysis*. Vancouver, British Columbia: Empirical Press.

Freeman, L. C. (2005). Graphic tecniques for exploring social network data. In P. J. Carrington, J. Scott, & S. Wasserman (Eds.), *Models and methods in social network analysis* (pp. 248-269). New York: Cambridge University Press.

Fuhse, J., & Mützel, S. (2011). Tackling connections, structure, and meaning in networks: Quantitative and qualitative methods in sociological network research. *Quality & Quantity, 45*(5), 1067-1089. doi:10.1007/s11135-011-9492-3

Giddens, A. (1984). *The constitution of society: Outline of the theory of structuration*. Berkeley and Los Angeles: University of California Press.

Halgin, D. S., & Borgatti, S. P. (2012). An introduction to personal network analysis and tie churn statistics using E-NET. *Connections, 32*(1), 37-48.

Handcock, M. S., & Gile, K. J. (2011). On the concept of snowball sampling. *Sociological Methodology, 41*(1), 367-371. doi:10.1111/j.1467-9531.2011.01243.x

Hogan, B., Carrasco, J. A., & Wellman, B. (2007). Visualizing personal networks: Working with participant-aided sociograms. *Field Methods, 19*(2), 116-144.

Kahn, R. L., & Antonucci, T. C. (1980). Convoys over the life course: Attachment roles and social support. In P. B. Baltes & O. Brim (Eds.), *Life-span development and behavior* (Vol. 3, pp. 253-286). New York: Academic Press.

Marsden, P. V. (2003). Interviewer effects in measuring network size using a single name generator. *Social Networks, 25*, 1-16.

Mehra, A., Borgatti, S. P., Soltis, S., Floyd, T., Ofem, B., & Kidwell, V. (2014). Imaginary worlds: Using visual network scales to capture perceptions of social networks In D. J. Brass, G. Labianca, A. Mehra, D. S. Halgin, & S. P. Borgatti (Eds.), *Research in the Sociology of Organizations* (Vol. 40). Bradford, UK: Emerald Publishing.

Molina, J. L., Maya-Jariego, I., & McCarty, C. (2014). Giving meaning to social networks: methodology for conducting and analyzing interviews based on personal network visualizations. In S. Domínguez & B. Hollstein (Eds.), *Mixed methods social network research* (pp. 305-335). New York: Cambridge University Press.

Parise, S. (2007). Knowledge management and human resource development: An application in social network analysis methods. *Advances in Developing Human Resources, 9*(3), 359-383. doi:10.1177/1523422307304106

Rice, E., Holloway, I. W., Barman-Adhikari, A., Fuentes, D., Brown, C. H., & Palinkas, L. A. (2014). A mixed methods approach to network data collection. *Field Methods, 26*(3), 252-268. doi:10.1177/1525822x13518168

Uzzi, B., & Dunlap, S. (2005). How to build your network. *Harvard Business Review, 83*(12), 53-60.

Valente, T. W. (2012). Network interventions. *Science, 337*(6090), 49-53. doi:10.1126/science.1217330

Van Waes, S. (2017). *The ties that teach: Teaching networks in higher education.* Doctoral dissertation, University of Antwerp, Belgium.

Van Waes, S., De Maeyer, S., Moolenaar, N. M., Van Petegem, P., & Van den Bossche, P. (2018). Strengthening networks: A social network intervention among higher education teachers. *Learning and Instruction, 53*, 34-49. doi:https://doi.org/10.1016/j.learninstruc.2017.07.005

Van Waes, S., Moolenaar, N. M., Daly, A. J., Heldens, H. H. P. F., Donche, V., Van Petegem, P., & Van den Bossche, P. (2016). The networked instructor: The quality of networks in different stages of professional development. *Teaching and Teacher Education, 59*, 295-308. doi:http://dx.doi.org/10.1016/j.tate.2016.05.022

Van Waes, S., Van den Bossche, P., Moolenaar, N. M., De Maeyer, S., & Van Petegem, P. (2015). Know-who? Linking faculty's networks to stages of instructional development. *Higher Education, 70*(5), 807-826. doi:10.1007/s10734-015-9868-8

Van Waes, S., Van den Bossche, P., Moolenaar, N. M., Stes, A., & Van Petegem, P. (2015). Uncovering changes in university teachers' professional networks during instructional development. *Studies In Educational Evaluation, 46*, 11-28. doi:10.1016/j.stueduc.2015.02.003