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# Know-who? Linking faculty's networks to stages of instructional development

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**Abstract** Research into faculty members' instructional development has primarily focused on individual skills and knowledge. As collegial interactions may support or constrain faculty's professional development in higher education, this study compared and contrasted the networks of faculty members in different stages of instructional development (novice, experienced non-expert, and experienced expert teachers). Faculty networks comprised the relations that teaching faculty members used to communicate about their teaching practice. To capture these networks, a total of 30 faculty members were interviewed. We used an egocentric network approach to examine the differences between the networks in network size, tie strength, and network diversity. Results based on analyses of

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variance and multilevel analyses suggested three key findings: (a) Faculty members in different stages of instructional development varied in the size of their network; (b) faculty members in different stages of development had access to different types of networks in terms of tie strength; and (c) faculty members in different stages of development varied in the diversity of teaching experience in their networks. Experienced expert teachers had larger, stronger, and more diverse networks compared with experienced non-experts. Novices also had larger networks, but they were characterized by lower tie strength and less diversity. These findings demonstrate that network development is not just a time–age effect, but suggests arrested development for experienced non-experts linked to limited network input. This provides important evidence for the role of collegial interactions throughout faculty's development as a teacher. We further discuss the implications of this study in light of faculty members' instructional development.

**Keywords** Higher education · Faculty development · Social network · Expert · Experienced non-expert · Novice

## Introduction

In times of growing accountability, improving teaching quality in higher education is receiving increasing attention (Biggs 2003; Devlin and Samarawickrema 2010). Therefore, the development of faculty members from novice to experienced or expert teacher has come to the fore (Baume 2006). This type of faculty development has been called *instructional development* (Centra 1989). Instructional development explicitly aims to develop faculty in their role as a teacher (Taylor and Rege Colet 2010). While studies on faculty's instructional development have primarily focused on the skills and knowledge of individual faculty members, based on individual abilities and dispositions (Cox 2004), recent educational studies have supplemented this individual approach with a social focus on educators' professional interactions and exchanges (Lieberman and Pointer Mace 2008). This line of research acknowledges the importance of professional interactions for the teaching practice, which ultimately affect student learning and achievement (Goddard et al. 2007; Moolenaar et al. 2012; Yasumoto et al. 2001). This research answers a growing call to enhance educators' teaching and learning through a variety of collaborative initiatives, such as professional learning communities (Stoll et al. 2006) and communities of practice (Little 2002). This shift to a supplementary focus on the social aspect of instructional development has also taken place within the context of higher education (Kezar 2005). As empirical studies on this social aspect are scarce, this study explores faculty members' instructional development using a social network perspective.

Social network theory provides a valuable lens and the tools to explain the role and nature of professional interactions (Scott 2000). An increase in network research has been described as part of a general shift away from individualist explanations toward more relational, contextual, and systemic understandings (Borgatti and Foster 2003). Network theory offers a powerful framework to capture faculty's professional interactions. Scholars have demonstrated the importance and power of social networks in the development of professionals at the workplace (Carpenter et al. 2012; Cross and Parker 2004) and, in particular, of educators in K-12 schools and school districts (Carolan 2013). However, there are few studies in higher education that adopt a social network perspective (Kezar

2014), and only a handful of scholars have examined faculty's professional interactions related to their teaching practice (Brower and Brower 2013). Moreover, scholars have paid little attention to the relationship between educators' professional networks and stages of instructional development. As such, there is a growing need to understand how faculty's professional interactions shape their instructional development. Building on existing research in educational and workplace learning studies, this study is, to our knowledge, the first to compare the instructional networks of novice, experienced non-expert, and experienced expert faculty. We used a social network approach to grasp the structure and multilevel nature of faculty's networks. To this end, semi-structured interviews were conducted with 30 teaching faculty members in a mid-sized university in Belgium.

## A social take on the development of professionals

Investigations into the development of faculty's instructional quality in higher education have long been primarily confined to individual faculty members (e.g., by focusing on individual faculty members' conceptions and approaches to teaching, see Kember 1997; Stes et al. 2010; Trigwell et al. 1994). In the last decade, studies on professionals' workplace learning are increasingly taking a social perspective on professionals' development (Tynjälä 2008) by focusing on its interactive nature (Boshuizen et al. 2004; Hakkarainen et al. 2004). According to these scholars, competence and expertise cannot be attributed to the individual level alone. They emphasize the socially distributed nature of high performance and the importance of learning from others' experiences. High performance is determined not only by an individual's know-what (i.e., declarative knowledge) and know-how (i.e., procedural knowledge), but also by *know-who* (Borgatti and Cross 2003).

In education, this social take on professional development resonated in a call for a fundamental change in the individualistic norm of teaching and advocated a social perspective on educators' instructional development (Clement and Vandenberghe 2000; Lieberman and Miller 1999). In the context of higher education, issues of privacy, autonomy, and even isolation of faculty have been quite prominent (Cox 2004). Faculty members often collaborate on research projects, but university teaching remains a relatively solitary business (Gizir and Simsek 2005; Ramsden 1998). Recently, scholars have acknowledged that university teaching is both individually constructed as well as socially influenced (e.g., Roxå and Mårtensson 2009). Studies on faculty's communities of practice and learning communities have demonstrated the value of social exchanges between faculty for pedagogical innovation and effective teaching (Anderson and McCune 2013; Furco and Moely 2012). However, to date, there has been little research on how professional interaction at higher education institutions takes shape (Kezar 2005). Therefore, we will now elaborate on social network theory to explore the nature and role of professional interactions in supporting faculty's instructional development in higher education.

## Social network theory in education

Social network theory provides a valuable lens and the tools to capture the professional interactions or networks of educators (Daly 2010; Moolenaar 2012). One of the key assumptions of network theory is that individuals' behavior and performance are significantly affected by the way that they are tied into a larger web of social connections (Carrington et al. 2005). In other words, the overall structure and individuals' positions in their social networks matter for a range of outcomes (Wasserman and Faust 1994).

Scholarship on understanding faculty members' social networks in higher education is still in its infancy. This contrasts with research in other educational settings, such as studies on K-12 schools and school districts (Moolenaar 2012). In recent years, social network theory established its usefulness in K-12 research by demonstrating the importance of educators' professional interactions for school reform and improvement (Daly et al. 2010; Penuel et al. 2009), policy implementation (Coburn et al. 2012), school leadership (Daly and Finnigan 2011; Pitts and Spillane 2009), and professional development programs (Baker-Doyle and Yoon 2011; Hofman and Dijkstra 2010). Similarly, social network research in the field of higher education scholarship has started to gain traction (Kezar 2014). Most network studies in higher education focus on student networks (Eggens et al. 2008; Rienties et al. 2013), and studies that investigated faculty networks mostly focused on research networks (Finkelstein et al. 2013) or departmental networks (Roebken 2007). There is, however, a scarcity of empirical studies on faculty's teaching networks (Brower and Brower 2013). Roxå and Mårtensson (2009) explored the interactions of 106 faculty members about teaching. They showed that most faculty members relied on a relatively small network of significant people to discuss their teaching practice. Pataraia et al. (2013) found that faculty's networks equipped them with a diverse pool of knowledge and skills about teaching, offering both professional and emotional support. Furthermore, faculty's network participation resulted in changes in their teaching and learning practice. Other studies have examined faculty's interactions in professional development activities (Jippes et al. 2013; Rienties and Kinchin 2014).

## Characteristics of faculty's social networks

The characteristics of faculty's networks determine whether they can access valuable resources or whether they are disconnected from the flow of resources. In this study, we specifically explored three key network characteristics to gain insight into faculty's professional interactions around teaching: (a) the size of faculty's networks, (b) the strength of faculty's relationships, and (c) the similarity between individual faculty members and the people they interacted with.

*Network size* can be defined as the number of people with whom a faculty member interacts. Studies in workplace learning have demonstrated that when professionals received information or feedback from a larger number of people, the information received is richer and more informative (Burt 1992; Smither et al. 2005).

*Strength of relationships* reflects the network concept 'strength of ties' (Granovetter 1973), where 'tie' means relationship. Tie strength denotes how close or strong a relationship is and can be measured by, for instance, the frequency, the length, or the duration of contact (Marsden and Campbell 1984). Strong relationships connect people that are close, whereas weak ties indicate looser contacts or acquaintances. Studies have shown that strong ties are necessary to tackle tacit, non-routine, or complex matters (Reagans and McEvily 2003; Uzzi 1996). In contrast, weak ties have proved to be important for the formation of novel ideas and non-redundant information (Hansen 1999; Levin and Cross 2004).

*Similarity between individuals* mirrors the network concept 'homophily,' also quoted by the proverbial expression 'birds of a feather flock together' (McPherson et al. 2001). Studies have demonstrated that people tend to develop relationships with people similar to them (e.g., Marsden 1988). Similarity can influence the information people receive, the attitudes they form, and the interactions they experience, which may eventually cause network decay (Burt 2000), while people with more diverse networks tend to demonstrate

increased innovation (Kilduff and Krackhardt 1994; Mehra et al. 2001). In sum, these three key social network characteristics may be used to explore faculty's professional interactions around teaching in various stages of their career.

## The link between social network characteristics and stages of development

Social network research in other educational settings has indicated that networks differ depending on individuals' stages of development (e.g., Moolenaar et al. 2014). To gain insight into faculty's teaching networks in different stages of instructional development, we will now review research on differences between novice, experienced non-expert, and expert networks.

*Experts* are often defined as experienced top performers who excel in a particular field, or as professionals who achieve at least a moderate degree of success in their occupation (Boshuizen et al. 2004). Workplace literature has increasingly argued that a combination of individual and social aspects is crucial in early expertise development (Hakkarainen et al. 2004), and therefore, several studies have adopted a network perspective to examine expert performance (e.g., Gruber et al. 2008). Cross and Thomas (2008) identified key features of expert performers' networks. Experts tended to invest in relationships that extended their expertise and helped them avoid learning biases and career traps. Their networks were characterized by diversity rather than similarity. Moreover, experts engaged in behaviors that lead to high-quality networks, not just large networks. They positioned themselves at key points in a network and leveraged the network around them when implementing plans. In K-12 education, studies identified 'access to expertise' as a key element in the development of networks (Coburn et al. 2010; Spillane et al. 2003) and advocated transparency in expertise in teacher networks (Baker-Doyle and Yoon 2010). However, research on expert educators' interactions is scarce.

Extensive experience of activities in a domain is necessary to reach high levels of performance. Yet, having many years of experience does not invariably lead to expert levels of achievement. Some experienced workers remain experienced and do not develop into experts. They are often described as *experienced non-experts* (Bereiter and Scardamalia 1993). Their stagnated development is called 'arrested development' and is associated with automaticity, i.e., their behavior becomes routine and reaches a stable plateau without further improvement (Ericsson 2006). Studies in K-12 on experienced teachers have examined the role of social exchanges on their teaching and learning (Bakkenes et al. 2010; Zwart et al. 2007). They reported on the value of exchanging experiences and getting ideas from colleagues, but did not go into detail on what these interactions look like and provided limited information on the relationship with teaching practices. The comparison of experienced non-expert and experienced expert educators' professional interactions is an unexplored area, which will be addressed in this study.

*Novice* faculty just started their teaching career and thus have little teaching experience. K-12 research has indicated that proactive networking provided novice teachers with higher levels of support (and thus stronger ties) in the beginning of their teaching career. Moreover, novice teachers were proactive in creating more expansive and supportive learning environments through the development and use of their networks (Fox et al. 2011). Up to date, however, studies on the networks of beginning faculty members are scarce.

We believe that this study is the first to provide a detailed understanding of teaching faculty's networks in different stages of instructional development. The purpose of this article is explorative and theory-building. Novice, experienced non-expert, and experienced expert faculty's networks were compared on three key network characteristics,

namely (a) network size, (b) strength of relationships (i.e., frequency, length, and duration of contact), and (c) similarity between people in the networks (i.e., age, teaching experience, and gender).

## Method

### Sample

This study was conducted in a mid-sized, multidisciplinary public university in Belgium, serving 15,000 students and employing 2,855 faculty members, among whom 830 were teaching faculty members (most of them combining teaching and research). A total of 30 faculty members (31 % female, with a minimal teaching appointment of 50 %; one participant was Russian, and all others were Belgian) were selected (response rate 93,75 %), aiming for maximum variety across different university departments.

### Data collection

#### *Instructional development*

Faculty members in different stages of instructional development were purposively sampled, representing three stages: novice, experienced non-expert, and experienced expert teachers. We defined these stages by combining high and low levels of teaching experience and expertise (Bereiter and Scardamalia 1993; Ericsson 2006). *Experienced experts* had both high teaching experience and expertise, *experienced non-experts* had high teaching experience and low expertise, and *novices* had low teaching experience and low teaching expertise. An overview of the faculty members' age and teaching experience is provided in Table 1.

*Experienced experts* had at least 10 years of teaching experience (Ericsson 2006). We used a thorough strategy to define *teaching expertise* that combined both supervisor nominations and student evaluations. Firstly, the chair of education and the educational advisor were asked to nominate four expert teachers in their department. These nominations were based on five criteria: pedagogical content knowledge, subject knowledge, innovative educational ideas, involvement in educational boards, and commitment toward students (Berliner 2004; Shulman 1987; Tsui 2009). Secondly, faculty's scores on student evaluations were taken into account. At the end of courses, students regularly fill out

**Table 1** Age and teaching experience of faculty in different stages of instructional development

| Stages | Min | Max | *M* | SD |
|---|---|---|---|---|
| Experienced experts | | | | |
| Age | 34.00 | 64.00 | 43.75 | 8.17 |
| Teaching experience | 11.00 | 35.00 | 17.67 | 7.11 |
| Experienced non-experts | | | | |
| Age | 37.00 | 60.00 | 49.56 | 7.96 |
| Teaching experience | 12.00 | 31.00 | 21.00 | 7.09 |
| Novices | | | | |
| Age | 25.00 | 33.00 | 27.88 | 2.85 |
| Teaching experience | 3.00 | 5.00 | 3.31 | 1.41 |

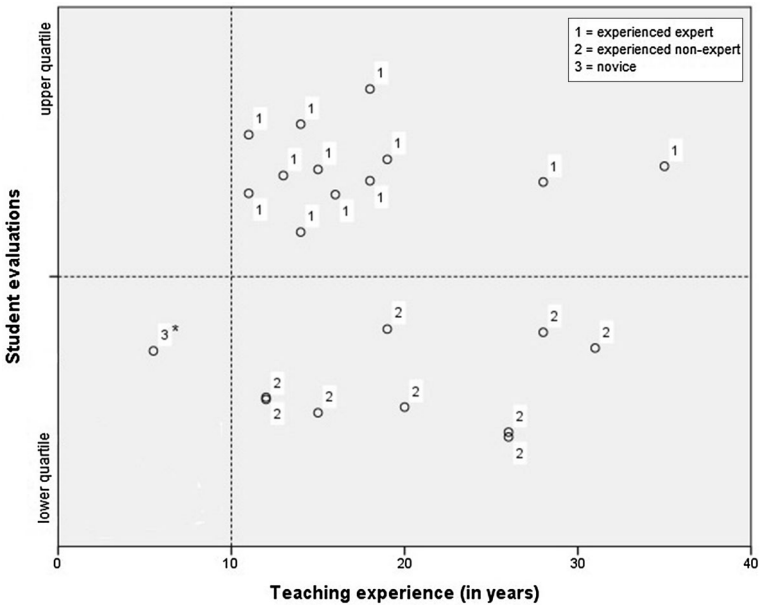


**Fig. 1** Overview of faculty's stages of instructional development based on their teaching experience and expertise. *Note* All experienced experts (i.e., '1') were also peer nominated by their chair of education or the educational advisor. The *upper left quadrant* is empty as only one faculty member was found with high expertise combined with low experience. He/she was identified as an outlier as this teacher had little teaching experience within university, but did have several years of work experience outside university. *Asterisk* indicates only one novice was found that had already received sufficient student evaluations. Therefore, the other novices could not be plotted

questionnaires on their teachers' teaching performance. It concerns a validated questionnaire consisting of 31 items, comprising 12 Likert scales (based on Spooren et al. 2007). To be selected as 'expert teachers', teachers both had to score in the upper quartile of their department on the student evaluations and had to be nominated by the educational chair or advisor.[1]

*Experienced non-experts* (Bereiter and Scardamalia 1993) also had at least 10 years of teaching experience. However, having many years of experience does not invariably lead to expert levels of achievement. Therefore, these teachers were selected on low teaching expertise. They scored in the lower quartile of their department on the student evaluations and were not nominated as 'expert teacher'. Experienced non-experts ($M = 57.24$; $SD = 1.02$) and experienced experts ($M = 62.72$; $SD = 0.92$) differed significantly in their scores on student evaluations ($p < 0.01$; see Fig. 1).

*Novices* are beginning teachers with three to five years of teaching experience. As most of them had not received (sufficient) student evaluations, we randomly selected beginning teachers across departments, none of which were nominated as expert teacher.

[1] Twenty-four chairs of educational boards and educational advisors of the departments across the university nominated 96 people in total; 13 people were nominated twice, so 83 unique teachers were nominated. Fourteen of the nominated teachers did not meet the criteria for inclusion in our sample, as they did not have enough student evaluations or courses evaluated. Of the 69 remaining teachers, 49 had outstanding student evaluations (upper quartile in department). We then selected the top performers in each department, maintaining a spread across departments.

*Social network data*

We took an egocentric approach to social network analysis. This means that we mapped networks that were centered on an individual (*ego*) (Wellman 1993). The people that an individual interacts with in his/her personal network are called *alters*. The focus of egocentric analysis is the structure and content of the relationships between ego and a set of alters. In this study, we explicitly opted for an egocentric network approach as our goal was to understand how a unique faculty member's contacts relate to variables at the individual level of analysis (Morrison 2002), rather than obtaining an overall description of faculty networks within a university. Moreover, an egocentric approach allows respondents to set their own boundaries (Cross and Cummings 2004), which made it possible to ask about professional contacts outside the university. Ego-networks are typically informal and unstructured, which matched our research design as we did not want to limit our data collection to formal or required relationships (Palonen 2005).

The respondents were interviewed using a semi-structured interview guide (see "Appendix, Table 6"). Interviews lasted between 45 and 90 min, depending on the size of respondents' networks. Beforehand, several pilot interviews were conducted. The interview guide contained questions designed to gain insight into the kind of people faculty members communicated with about their teaching practice. The name-generating question of the interview asked respondents with whom they interacted in regard to their teaching practice. Subsequently, the respondent noted the names of these people on post-it notes. A sheet of A3-sized paper with three concentric circles was placed on the table to visualize the respondent's ego-network (see Fig. 2; adapted from Hogan et al. 2007). Respondents were asked to stick the post-it notes onto the network map, where each circle determined

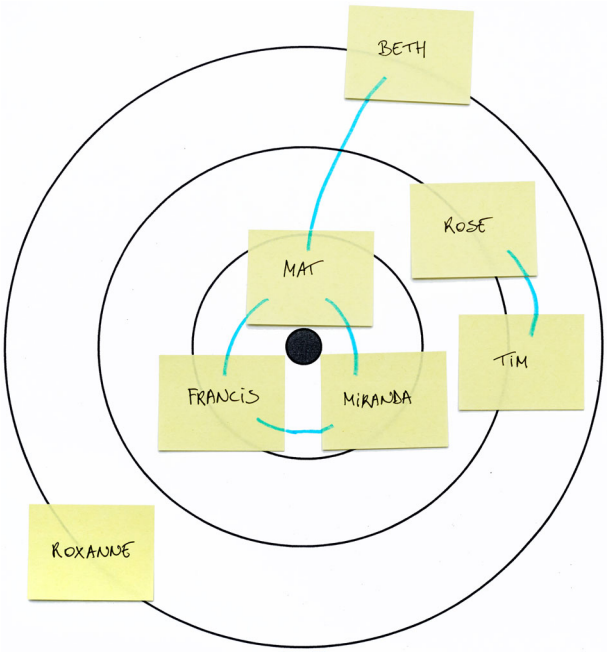


**Fig. 2** Anonymized example of a network map to visualize faculty members' network

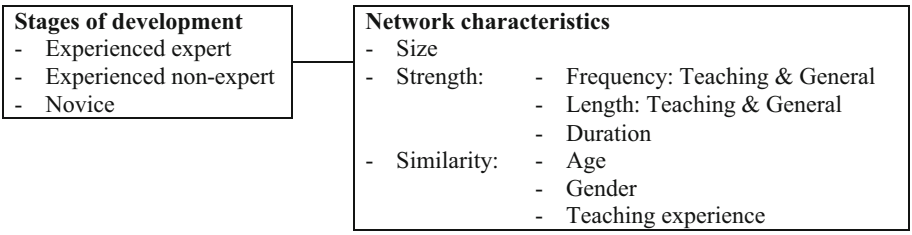


**Fig. 3** Overview of variables

the degree of closeness with the contact. After the network map was constructed, name-interpreting questions were asked to gain insight into the size of the network, the strength of the relationships, and the similarity of the people in their network. The interviews were recorded and transcribed verbatim. Pictures of the personal network maps were then used for member checking procedures.

## Variables

The main independent variable in this study is faculty's stages of instructional development (novice, experienced non-expert, and experienced expert teachers). The dependent variables are faculty's network characteristics (network size, strength, and similarity; see Fig. 3). For the current study, the interview data were quantified (Chi 1997) and a logit transformation was applied on all the continuous dependent variables as they did not have a normal distribution (Fox 1997).

We measured the *size* of faculty's networks by counting the number of people in the networks. The *strength* of ties was measured by three variables: frequency, length, and duration of contact. Frequency indicates how often teachers communicated with the people in their network, both in general and regarding their teaching. Frequency was coded into a 12-point ordinal scale ranging from daily to yearly communication. Length of contact implies how many years ago the relationship with this person started. Again, we both asked about contact in general and regarding their teaching. Duration refers to the average amount of time that conversations about teaching lasted. Duration was coded into an 11-point ordinal scale ranging from short exchanges of 1 min to interactions that lasted an entire day. Finally, the *similarity* between the faculty and the people in their networks was measured by comparing their age, teaching experience, and gender. Age and teaching experience were coded in number of years, and gender was coded as a dummy variable.

## Data analysis

To compare the networks of novice, experienced non-expert, and experienced expert faculty, we performed an analysis of variance for the variable *network size*. Equal variances between the three stages could not be assumed, so nonparametric Kruskal–Wallis and Dunnett C post hoc tests were performed. For the variables regarding *strength* and *similarity*, we drew on multilevel analyses (MLWIN 2.25) as these variables concern nested data (people within relationships). Multilevel modeling enabled us to explore both the characteristics of the respondent and of the relationships of the respondent in the same analysis. In network and educational research, there has been a growing awareness of the advantages of using multilevel analysis (Wellman and Frank 2008). "Multilevel or

hierarchical linear models explicitly take into account the nested data and the related dependency structure by allowing unexplained variability between ties (i.e., at level one) and also between egos (at level two)" (van Duijn et al. 1999, p. 188). The data of this study have a two-level hierarchical structure. The first level reflects characteristics of relationships (e.g., strength), whereas the second level involves ego's characteristics (e.g., teaching experience). Random residuals were estimated for both levels, yielding a variance parameter between egos (i.e., describing differences between faculty members in different stages) and a variance parameter within egos (i.e., describing differences between relationships within the networks of faculty members). In the analyses presented,[2] data on a total data of 287 ties and 29 egos were used. We ran separate models for strength and similarity. The first step of the modeling was the estimation of a random intercept *null model*. This model only contained an estimation of the intercept for the dependent variable (faculty's network strength, and similarity) and error terms for both levels. The null model acted as a benchmark of comparison for the following models. In the next step, *model 1*, the independent variable (faculty's stages of development) was included in the model in order to test whether these three stages differed on average regarding strength and similarity. In *model 2*, a separate level 1 variance was estimated for each of the three stages to explore whether the variance of certain network characteristics within egos differed between stages (e.g., whether the networks of experienced non-expert faculty are characterized by more similarity than networks of novice or experienced expert teachers). In *model 3*, we examined whether faculty members were similar to the people they interacted with. We elaborated model 2 by adding the similarity characteristics of the ego (i.e., respondent's age, teaching experience, and gender) as independent variables to the fixed part of the model. These ego characteristics are the counterpart of the dependent variable at alter level (i.e., age, teaching experience, and gender of the alters). For instance, if the independent variable is alters' teaching experience, then the teaching experience of the ego is introduced as explanatory variable. Moreover, we estimated the effects of these characteristics for each group separately. As such, we could examine the extent to which ego's characteristics differ from their alters' characteristics (e.g., do faculty have the same teaching experience as the people in their network?), and whether this differed in the three stages. For all models, Chi-square tests were used to test differences within and between the stages.

## Results

### Network size

We first examined whether faculty's network size varied across the different stages of instructional development. Results from the analysis of variance indicated significant differences between the three stages concerning network size, i.e., the number of people in their network ($F[2, 36] = 8.57$, $p < .01$; Kruskal–Wallis $p = .006$). The effect size is large ($\eta^2 = .88$). Experienced non-experts on average had the smallest networks, whereas experienced experts on average had the largest networks, followed by the novices (see Table 2). The Dunnet C test showed large mean differences between experienced non-

[2] We also analyzed the alter-by-alter information (i.e., do the people in faculty's networks also know each other?), using the ego-network software E-NET (Halgin and Borgatti 2012). We examined whether the density, effective size, efficiency, constraint, and hierarchy of the networks in the different stages differed, but this was not the case.

**Table 2** Descriptive statistics of network size

| Group | *n* | *M* | Mdn | SD |
|---|---|---|---|---|
| Experienced experts | 12 | 11.91 | 9.50 | 5.23 |
| Experienced non-experts | 8 | 6.00 | 10.00 | 2.60 |
| Novices | 9 | 9.87 | 7.00 | 1.55 |

**Table 3** Results of Dunnet C analysis of network size

| Group (I) | Group (J) | $M_{diff}$ (I–J) | SE |
|---|---|---|---|
| Experienced experts | Experienced non-experts | 5.92* | 1.74 |
| | Novices | 2.04 | 1.61 |
| Experienced non-experts | Experienced experts | −5.92* | 1.74 |
| | Novices | −3.87* | 1.02 |

* The mean difference is significant at the $p < .05$ level

experts and experts, and between experienced non-experts and novices (see Table 3). These findings demonstrate that faculty in different stages of instructional development differ in the size of their network. Specifically, the experienced non-expert faculty stand out as they had the smallest networks.

## Strength

### *Frequency of contact on teaching*

Experts talked to others about their teaching about once a month and did not differ from the other stages. Novice faculty communicated more often about their teaching practice than experienced non-experts ($\chi^2$ (1, $N = 96$) = 4.07, $p < .05$). On average, novices discussed their teaching practice every 2 weeks, and experienced non-experts every month or every 2 months.

### *Frequency of contact in general*

The stages differed in how often faculty interacted with the people in their networks. Novices had the most frequent contact as they talked once or twice a week with the people in their network, whereas experienced experts had interactions with their contacts every 1 or 2 weeks ($\chi^2$ (1, $N = 208$) = 7.66, $p < .01$), and experienced non-experts every 2 weeks ($\chi^2$ (1, $N = 123$) = 17.23, $p < .001$). Experienced experts in general tended to communicate more often than experienced non-experts ($\chi^2$ (1, $N = 179$) = 3.71, $p = .05$).

### *Length of contact on teaching*

Novices showed to have more recent relationships about their teaching practice than experienced experts ($\chi^2$(1, $N = 211$) = 18.66, $p = .0001$) and experienced non-experts ($\chi^2$(1, $N = 124$) = 25.31, $p < .0001$). This is plausible as they have less teaching experience. On average, novices had relationships of two and a half years long, experts of 8 years, and experienced non-experts of five and a half years. Furthermore, experienced

non-experts' networks contained both longer and shorter contacts on teaching, as their networks displayed more variance than experienced experts ($\chi^2(1, N = 177) = 3.75$, $p = .05$) and novices ($\chi^2(1, N = 124) = 13.17$, $p < .0001$). Experienced experts' networks showed more variation than novices ($\chi^2(1, N = 211) = 21.47$, $p < .001$).

*Length of contact in general*

Novices had shorter lasting contacts than experienced experts ($\chi^2(1, N = 206) = 9.19$, $p < .01$) and experienced non-experts ($\chi^2(1, N = 126) = 9.19$, $p < .001$). Novices, on average, had relationships of 4 years and experienced experts and non-experts of 8 years.

*Duration of contact on teaching*

Experienced experts had longer contacts than novices when discussing their teaching ($\chi^2(1, N = 217) = 5.76$, $p < .05$). On average, experienced experts' conversations about teaching lasted about 45 min, whereas experienced non-experts' interactions took up to 30 min on average, and novices' 15–20 min.

Table 4 provides an overview of the significant differences in network strength between the stages, based on the multilevel analyses. All the models with fixed and random coefficient estimates and standard errors for similarity can be found in "Online Appendix A".

Similarity

*Age*

There were differences between the stages regarding the age of the alters in faculty members' networks. In general, novices were connected to younger alters than experienced non-experts ($\chi^2(1, N = 120) = 12.70$, $p < .001$) and expert faculty ($\chi^2(1, N = 222) = 8.70$, $p < .01$), which is plausible as they are younger themselves. There were, however, no significant differences between experienced non-experts and expert faculty. These results indicate that novices, on average, were connected to younger people ($M = 35.62$), whereas experienced non-experts ($M = 42.95$) and experts ($M = 40.33$) interacted with older people.

*Teaching experience*

The alters in the networks of experienced non-experts in general had more teaching experience ($M = 12.32$) compared with the alters in the networks of novice faculty ($M = 7.85$) ($\chi^2(1, N = 96) = 5.19$, $p < .05$). Moreover, networks of experienced non-expert faculty showed less variance in teaching experience than experienced expert faculty ($\chi^2(1, N = 148) = 6.82$, $p < .01$) and novice faculty ($\chi^2(1, N = 96) = 5.68$, $p < .05$), meaning that experienced non-experts tended to interact about their teaching with people that had similar teaching experience. In contrast, novices and experienced experts talked about their teaching with people that varied considerably in teaching experience. Finally, the higher the teaching experience of experienced non-experts, the higher the teaching experience of the people in their network (ratio is t-distributed $> 1.96$, $p < .05$).

**Table 4** Overview of differences between stages for strength

| Best model fit | Frequency contact teaching Model 1 | Frequency contact general Model 1 | Length contact teaching Model 2 | Length contact general Model 1 | Duration contact teaching Model 1 |
|---|---|---|---|---|---|
| Difference between stages (means) | Novices > Non-experts | Novices > Experts<br>Novices > Non-experts<br>Experts > Non-experts | Experts > Novices<br>Non-experts > Novices | Experts > Novices<br>Non-experts > Novices | Experts > Novices |
| Difference between stages (variance) | | | Non-experts > Novices<br>Non-experts > Experts<br>Experts > Novices | | |

Only differences significant at the $p < .05$ level are displayed

**Table 5** Overview of differences between stages for similarity

| Best model fit | Alters' age<br>Model 1 | Alters' teaching experience<br>Model 3 | Alters' gender<br>Null model |
|---|---|---|---|
| Difference between stages (means) | Experts > Novices<br>Non-experts > Novices | Non-experts > Novices | |
| Difference between stages (variance) | | Novices > Non-experts<br>Experts > Non-experts | |
| Interaction effect (addition of ego characteristics) | | Novices > Non-experts<br>Experts > Non-experts | |

Only differences significant at the $p < .05$ level are displayed

*Gender*

There were no differences between the stages regarding gender of the alters in the networks. On average, novice, experienced non-expert, and expert faculty were connected to as many women as men in their networks.

Table 5 provides an overview of the significant differences in network similarity between the stages, based on the multilevel analyses. All the models with fixed and random coefficient estimates and standard errors for similarity can be found in "Online Appendix B".

## Conclusions and implications

The aim of this study was to explore and compare characteristics of faculty's teaching networks (size, strength, and similarity) in different stages of instructional development, from novice to experienced non-expert and expert faculty. We will discuss several major themes related to faculty's networks and their instructional development, as suggested by our study.

Our findings showed that development of networks is not just a time–age effect. Experienced expert faculty had the largest networks, followed by novice and experienced non-expert faculty. This relates teaching expertise to network size, which is in line with network research outside education showing that experts have access to more and diverse resources within their networks, enabling them to more optimally leverage their network when implementing plans (Cross and Thomas 2008). This study nuances previous findings related to network size (Pataraia et al. 2013; Roxå and Mårtensson 2009) by contrasting experienced with non-experienced faculty, and expert with non-expert faculty. The smaller network size of experienced non-expert faculty could be due to less time for interactions on teaching in their career phase or to complacency. Possibly, experienced non-experts lapse into arrested development (Ericsson 2006) because of the limited input they get from their small and homogeneous networks. This in turn may cause isolation (Bakkenes et al. 1999), limiting network opportunities and new impulses to enhance teaching. Networks might settle after a while or become stagnant if they are not actively worked on and supported. As such, institutes of higher education may be advised to support faculty in the development, maintenance, and diversification of their teaching networks in order to overcome potential arrested development and stimulate experienced faculty to become expert teachers.

Our results also demonstrated that novices have large networks. Inexperienced teachers have been shown to seek out many people because of their lack of experience. Their network may help them to broaden their conceptions on teaching and provide didactic strategies from experiences of others in their network (Fox et al. 2011). Experts tend to be sought out because of their experience and expertise. Both result in large networks but because of different reasons. This also has implications for inter-developmental contact or contact between people in different stages of instructional development, as novices have been shown to enrich experts' networks (Fuller and Unwin 2004). As such, higher education institutions that aim to support faculty instructional development may specifically target inter-developmental contact between faculty members at different stages.

Experienced experts also demonstrated more diversity in their networks. They took significantly more time to talk to people in their network about their teaching, and they interacted with people that have little teaching experience as well as with people with a lot of experience in teaching. These findings are in line with studies indicating that high performers have diverse networks that target and extend their abilities (Cross and Thomas 2008). People with more diverse networks demonstrated more innovation (Mehra et al. 2001), which could translate to experts' teaching in terms of evolved teaching conceptions and approaches. In contrast, a lack of network diversity might cause experienced non-expert faculty to stagnate in their development toward expertise. Experienced non-experts' networks were characterized by homophily, which is important for discussing complex matters, but little diversity may also cause decay of networks or limit innovation (Burt 2000). As experienced faculty had smaller networks and redundant knowledge in their networks due to homophily, a possible policy implication might be to raise their 'network awareness.' When people are more aware of their networks and their benefits, they can actively shape them (Burt and Ronchi 2007; de Laat and Schreurs 2013). For example, professional development activities can raise teachers' network awareness (Van Waes et al. in press) toward shaping sufficiently large and diverse networks that target and extend their abilities. Some scholars suggested that enhanced networks should be regarded as an important outcome of training programs (Hatala and Fleming 2007; Van den Bossche and Segers 2013). This study serves to further specify the characteristics of these targeted networks, such as size, strength, and similarity. The network maps used in this study can provide the tools to enhance insight and transparency in existing networks and expertise that can be tapped into.

## Delimiters and areas for further research

This study offers a unique contribution by drawing on social network theory as a lens to examine faculty's instructional development. It defined teaching expertise in a novel way, enabling the comparison between experienced non-experts and experts. Moreover, this study adopted an innovative way to elicit and visualize faculty's networks during interviews, which provide both a rich data source for research as well as an instructional tool that may help raise faculty's network awareness during training programs to support faculty's instructional development. The role of a network perspective in higher education is in its infancy, and the area is ripe for further exploration. Research in other institutions in higher education or post-secondary education may offer additional insights into the generalizability of our findings. Other contextual variables that should be taken into account in future research are the role of teaching culture at the workplace and the importance of a

supportive departmental climate that enhances the exchange of resources. In terms of boundary crossing and interdisciplinary learning, it should be further examined whether faculty tend to develop social networks based upon similarity of disciplines. Furthermore, this study provides insight into faculty's teaching networks; however, future work should explore how research and teaching networks are intertwined.

Future studies should also question causal explanations for our findings: Do experts have larger networks because they are sought more for their expertise, or do these larger networks better support them in becoming expert teachers? Besides structural network characteristics as studied here, the quality of faculty networks should also be subject of further examination (Coburn et al. 2012) to increase our understanding of qualitative differences (e.g., the content and nature) in the networks of novice, experienced non-expert, and expert faculty members. Combining structural and qualitative networks methods is recommended to capture networks in their totality (Fuhse and Mützel 2011). Furthermore, it would be interesting to supplement our findings from a social perspective on faculty members' networks with insights from studies using an individual focus on faculty's knowledge and skills, to examine the interplay between the knowledge and skills of an individual faculty member and his/her network. Finally, we gathered cross-sectional data to examine different developmental stages. This approach is in line with research on expertise development in workplace learning. However, networks are dynamic (Snijders 2005), so longitudinal data may allow us to further grasp the networks in different developmental stages over time and yield additional insight into the social side of faculty's instructional development.

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## Appendix 1

See Table 6.

**Table 6** Interview guide

| | |
|---|---|
| Introductory script | What we are interested in learning about, is with whom you as a teacher talk to about your teaching practice |
| Demographics of respondent | Teaching experience? Age? |
| Central name-generating question | In the past half year, who did you talk to about your teaching? More specifically, who do you talk to about the preparation of courses, teaching courses, student guidance or assessment, experiences with students and/or teaching? You do not have to include administrative or judicial aspects of teaching |
| Construction of network map | Do you talk to others about your teaching? Do you talk to people inside your department? Within the university? From other universities? With friends or family |
| Questions for each person mentioned in turn | Gender? Age? Teaching experience?<br>How long do you know each other? How long have you been taking about teaching? In the last half year, how often have you had contact with this person (in general)? In the last half year, how frequently have you talked about teaching (face-to-face/e-mail/telephone)? In the last half year, how long have your conversations about teaching lasted on average? |

## References


Anderson, C., & McCune, V. (2013). Fostering meaning: Fostering community. *Higher Education, 66*(3), 283–296.

Baker-Doyle, K. J., & Yoon, S. A. (2010). Making expertise transparent: Using technology to strengthen social networks in teacher professional development. In A. Daly (Ed.), *Social network theory and educational change* (pp. 115–126). Cambridge, Massachusetts: Harvard Education Press.

Baker-Doyle, K. J., & Yoon, S. A. (2011). In search of practitioner-based social capital: A social network analysis tool for understanding and facilitating teacher collaboration in a US-based STEM professional development program. *Professional Development in Education, 37*(1), 75–93.

Bakkenes, I., De Brabander, C., & Imants, J. (1999). Teacher isolation and communication network analysis in primary schools. *Educational Administration Quarterly, 35*(2), 166–202.

Bakkenes, I., Vermunt, J. D., & Wubbels, T. (2010). Teacher learning in the context of educational innovation: Learning activities and learning outcomes of experienced teachers. *Learning and Instruction, 20*(6), 533–548.

Baume, D. (2006). Towards the end of the last non-professions? *International Journal for Academic Development, 11*(1), 57–60.

Bereiter, C., & Scardamalia, M. (1993). *Surpassing ourselves: An inquiry into the nature and implications of expertise*. Chicago: Open Court.

Berliner, D. C. (2004). Describing the behavior and documenting the accomplishments of expert teachers. *Bulletin of Science, Technology and Society, 24*(3), 200–212.

Biggs, J. B. (2003). *Teaching for quality learning at university*. Buckingham: Open University Press.

Borgatti, S. P., & Cross, R. (2003). A relational view of information seeking and learning in social networks. *Management Science, 49*(4), 432–445.

Borgatti, S. P., & Foster, P. C. (2003). The network paradigm in organizational research: A review and typology. *Journal of Management, 29*(6), 991–1013.

Boshuizen, H., Bromme, R., & Gruber, H. (2004). *Professional learning: Gaps and transitions on the way from novice to expert*. Dordrecht: Kluwer Academic Publishers.

Brower, R. L., & Brower, R. S. (2013). What the network research tradition can tell us about higher education. *Paper presented at the meeting of the American Educational Research Association (AERA), San Francisco, CA*. ISSN 0163-9676.

Burt, R. S. (1992). *Structural holes: The social structure of competition*. Harvard: University Press.

Burt, R. S. (2000). Decay functions. *Social Networks, 22*(1), 1–28.

Burt, R. S., & Ronchi, D. (2007). Teaching executives to see social capital: Results from a field experiment. *Social Science Research, 36*(3), 1156–1183.

Carolan, B. V. (2013). *Social network analysis and educational research: Theory, methods, and applications*. Thousand Oaks, CA: SAGE Publications.

Carpenter, M. A., Li, M., & Jiang, H. (2012). Social network research in organizational contexts. *Journal of Management, 38*(4), 1328–1361.

Carrington, P. J., Scott, J., & Wasserman, S. (2005). *Models and methods in social network analysis*. New York: Cambridge University Press.

Centra, J. A. (1989). Faculty evaluation and faculty development in higher education. In J. C. Smart (Ed.), *Higher education: Handbook of theory and research* (pp. 155–179). New York: Agathon Press.

Chi, M. (1997). Quantifying qualitative analyses of verbal data: A practical guide. *Journal of the Learning Sciences, 6*(3), 271–315.

Clement, M., & Vandenberghe, R. (2000). Teachers' professional development: A solitary or collegial (ad)venture? *Teaching and Teacher Education, 16*(1), 81–101.

Coburn, C., Choi, L., & Mata, W. (2010). "I would go to her because her mind is math". Network formation in the context of a district-based mathematics reform. In A. J. Daly (Ed.), *Social network theory and educational change* (pp. 33–50). Cambridge: Harvard Education Press.

Coburn, C., Russell, J. L., Kaufman, J. H., & Stein, M. K. (2012). Supporting sustainability: Teachers' advice networks and ambitious instructional reform. *American Journal of Education, 119*(1), 137–182.

Cox, M. D. (2004). Introduction to faculty learning communities. *New Directions for Teaching and Learning, 97*, 5–23.

Cross, R., & Cummings, J. N. (2004). Tie and network correlates of individual performance in knowledge-intensive work. *The Academy of Management Journal, 47*(6), 928–937.

Cross, R., & Parker, A. (2004). *The hidden power of social networks: Understanding how work really gets done in organisations*. Boston, Massachusetts: Harvard Business Press.

Cross, R., & Thomas, R. J. (2008). How top talent uses networks and where rising stars get trapped. *Organizational Dynamics, 37*(2), 165–180.

Daly, A. J. (Ed.). (2010). *Social network theory and educational change*. Cambridge, Massachusetts: Harvard Education Press.
Daly, A. J., & Finnigan, K. S. (2011). The ebb and flow of social network ties between district leaders under high-stakes accountability. *American Educational Research Journal, 48*(1), 39–79.
Daly, A. J., Moolenaar, N. M., Bolivar, J. M., & Burke, P. (2010). Relationships in reform: The role of teachers' social networks. *Journal of Educational Administration, 48*(3), 359–391.
de Laat, M., & Schreurs, B. (2013). Visualizing informal professional development networks: Building a case for learning analytics in the workplace. *American Behavioral Scientist, 57*(10), 1421–1438.
Devlin, M., & Samarawickrema, G. (2010). The criteria of effective teaching in a changing higher education context. *Higher Education Research and Development, 29*(2), 111–124.
Eggens, L., Werf, M., & Bosker, R. (2008). The influence of personal networks and social support on study attainment of students in university education. *Higher Education, 55*(5), 553–573.
Ericsson, K. A. (2006). The influence of experience and deliberate practice on the development of superior expert performance. In K. A. Ericsson, N. Charness, R. R. Hoffman, & P. J. Feltovich (Eds.), *The Cambridge handbook of expertise and expert performance* (pp. 685–706). New York: Cambridge University Press.
Finkelstein, M., Walker, E., & Chen, R. (2013). The American faculty in an age of globalization: Predictors of internationalization of research content and professional networks. *Higher Education, 66*(3), 325–340.
Fox, J. (1997). *Applied regression analysis, linear models, and related methods*. Thousand Oaks: Sage Publications.
Fox, A., Wilson, E., & Deaney, R. (2011). Beginning teachers' workplace experiences: Perceptions of and use of support. *Vocations and Learning, 4*(1), 1–24.
Fuhse, J., & Mützel, S. (2011). Tackling connections, structure, and meaning in networks: Quantitative and qualitative methods in sociological network research. *Quality and Quantity, 45*(5), 1067–1089.
Fuller, A., & Unwin, L. (2004). Young people as teachers and learners in the workplace: Challenging the novice-expert dichotomy. *International Journal of Training and Development, 8*(1), 32–42.
Furco, A., & Moely, B. E. (2012). Using learning communities to build faculty support for pedagogical innovation: A multi-campus study. *Journal of Higher Education, 83*(1), 128–153.
Gizir, S., & Simsek, H. (2005). Communication in an academic context. *Higher Education, 50*(2), 197–221.
Goddard, Y. L., Goddard, R. D., & Tschannen-Moran, M. (2007). A theoretical and empirical investigation of teacher collaboration for school improvement and student achievement in public elementary schools. *Teachers College Record, 109*(4), 877–896.
Granovetter, M. (1973). The strength of weak ties. *American Journal of Sociology, 78*(6), 1360–1380.
Gruber, H., Lehtinen, E., Palonen, T., & Degner, S. (2008). Persons in the shadow: Assessing the social context of high abilities. *Psychology Science Quarterly, 50*(2), 237–258.
Hakkarainen, K., Palonen, T., Paavola, S., & Lehtinen, E. (2004). *Communities of networked expertise: Professional and educational perspectives*. Amsterdam: Elsevier.
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.
Hansen, M. T. (1999). The search-transfer problem: The role of weak ties in sharing knowledge across organization subunits. *Administrative Science Quarterly, 44*(1), 82–111.
Hatala, J., & Fleming, P. (2007). Making transfer climate visible: Utilizing social network analysis to facilitate transfer of training. *Human Resource Development Review, 6*(1), 33–63.
Hofman, R. H., & Dijkstra, B. J. (2010). Effective teacher professionalization in networks? *Teaching and Teacher Education, 26*(4), 1031–1040.
Hogan, B., Carrasco, J. A., & Wellman, B. (2007). Visualizing personal networks: Working with participant-aided sociograms. *Field Methods, 19*(2), 116–144.
Jippes, E., Steinert, Y., Pols, J., Achterkamp, M., van Engelen, J., & Brand, P. (2013). How do social networks and faculty development courses affect clinical supervisors' adoption of a medical education innovation? An exploratory study. *Academic Medicine, 88*(3), 398–404.
Kember, D. (1997). A reconceptualisation of the research into university academics' conceptions of teaching. *Learning and Instruction, 7*(3), 255–275.
Kezar, A. (2005). Redesigning for collaboration within higher education institutions: An exploration into the developmental process. *Research in Higher Education, 46*(7), 831–860.
Kezar, A. (2014). Higher education change and social networks: A missing link. *Journal of Higher Education, 85*(1), 91–125.
Kilduff, M., & Krackhardt, D. (1994). Bringing the individual back in: A structural analysis of the internal market for reputation in organizations. *The Academy of Management Journal, 37*(1), 87–108.

Levin, D. Z., & Cross, R. (2004). The strength of weak ties you can trust: The mediating role of trust in effective knowledge transfer. *Management Science, 50*(11), 1477–1490.
Lieberman, A., & Miller, L. (1999). *Teachers: Transforming their world and their work*. New York: Teachers College Press.
Lieberman, A., & Pointer Mace, D. H. (2008). Teacher learning: The key to educational reform. *Journal of Teacher Education, 59*(3), 226–234.
Little, J. W. (2002). Locating learning in teachers' communities of practice: Opening up problems of analysis in records of everyday work. *Teaching and Teacher Education, 18*(8), 917–946.
Marsden, P. V. (1988). Homogeneity in confiding relations. *Social Networks, 10*(1), 57–76.
Marsden, P. V., & Campbell, K. E. (1984). Measuring tie strength. *Social Forces, 63*, 482–501.
McPherson, M., Smith-Lovin, L., & Cook, J. M. (2001). Birds of a feather: Homophily in social networks. *Annual Review of Sociology, 27*, 415–444.
Mehra, A., Kilduff, M., & Brass, D. J. (2001). The social networks of high and low self-monitors: Implications for workplace performance. *Administrative Science Quarterly, 46*(1), 121–146.
Moolenaar, N. M. (2012). A social network perspective on teacher collaboration in schools: Theory, methodology, and applications. *American Journal of Education*, *119*(1), 7–39.
Moolenaar, N. M., Daly, A. J., Sleegers, P. J. C., & Karsten, S. (2014). The social forces of elementary school teams: How demographic composition shapes social networks. In T. Wubbels, J. van Tartwijk, P. den Brok, J. Levy & D. Zandvliet (Eds.), *Interpersonal relationships in education: From theory to practice*. Rotterdam, The Netherlands: SENSE Publishers.
Moolenaar, N. M., Sleegers, P. J. C., & Daly, A. J. (2012). Teaming up: Linking collaboration networks, collective efficacy, and student achievement. *Teaching and Teacher Education*, *28*(2), 251–262.
Morrison, E. W. (2002). Newcomers' relationships: The role of social network ties during socialization. *Academy of Management Journal, 45*(6), 1149–1160.
Palonen, T. (2005). How to study personal networks? In H. Gruber, C. Harteis, R. H. Mulder, & M. Rehrl (Eds.), *Bridging individual, organizational and cultural aspects of professional learning* (pp. 345–348). Regensburg: Roderer.
Pataraia, N., Margaryan, A., Falconer, I., & Littlejohn, A. (2013). How and what do academics learn through their personal networks. *Journal of Further and Higher Education*, *39*(3), 336–357.
Penuel, W., Riel, M., Krause, A., & Frank, K. (2009). Analyzing teachers' professional interactions in a school as social capital: A social network approach. *Teachers College Record, 111*(1), 124–163.
Pitts, V. M., & Spillane, J. P. (2009). Using social network methods to study school leadership. *International Journal of Research and Method in Education, 32*(2), 185–207.
Ramsden, P. (1998). Managing the effective university. *Higher Education Research and Development, 17*(3), 347–370.
Reagans, R., & McEvily, B. (2003). Network structure and knowledge transfer: The effects of cohesion and range. *Administrative Science Quarterly, 48*(2), 240–267.
Rienties, B., Héliot, Y., & Jindal-Snape, D. (2013). Understanding social learning relations of international students in a large classroom using social network analysis. *Higher Education, 66*(4), 489–504.
Rienties, B., & Kinchin, I. M. (2014). Understanding (in)formal learning in an academic development programme: A social network perspective. *Teaching and Teacher Education, 39*, 123–135.
Roebken, H. (2007). Departmental networks: An empirical analysis of career patterns among junior faculty in Germany. *Higher Education, 54*(1), 99–113.
Roxå, T., & Mårtensson, K. (2009). Significant conversations and significant networks: Exploring the backstage of the teaching arena. *Studies in Higher Education, 34*(5), 547–559.
Scott, J. (2000). *Social network analysis* (2nd ed.). London: Sage.
Shulman, L. S. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review, 57*(1), 1–22.
Smither, J. W., London, M., & Reilly, R. R. (2005). Does performance improve following multisource feedback? A theoretical model, meta-analysis, and review of empirical findings. *Personnel Psychology, 58*(1), 33–66.
Snijders, T. (2005). Models for longitudinal network data. In P. J. Carrington, J. Scott, & S. Wasserman (Eds.), *Models and methods in social network analysis* (pp. 215–247). New York: Cambridge University Press.
Spillane, J. P., Hallett, T., & Diamond, J. B. (2003). Forms of capital and the construction of leadership: Instructional leadership in urban elementary schools. *Sociology of Education, 76*(1), 1–17.
Spooren, P., Mortelmans, D., & Denekens, J. (2007). Student evaluation of teaching quality in higher education: development of an instrument based on 10 Likert-scales. *Assessment and Evaluation in Higher Education, 32*(6), 667–679.

Stes, A., Coertjens, L., & Petegem, P. (2010). Instructional development for teachers in higher education: Impact on teaching approach. *Higher Education, 60*(2), 187–204.

Stoll, L., Bolam, R., McMahon, A., Wallace, M., & Thomas, S. (2006). Professional learning communities: A review of the literature. *Journal of Educational Change, 7*(4), 221–258.

Taylor, L., & Rege Colet, N. (2010). Making the shift from faculty development to educational development: A conceptual framework grounded in practice. In A. Saroyan & M. Frenay (Eds.), *Building teaching capacities in higher education: A comprehensive international model*. Sterling, Virginia: Stylus Publishing.

Trigwell, K., Prosser, M., & Taylor, P. (1994). Qualitative differences in approaches to teaching first year university science. *Higher Education, 27*(1), 75–84.

Tsui, A. (2009). Distinctive qualities of expert teachers. *Teachers and Teaching, 15*(4), 421–439.

Tynjälä, P. (2008). Perspectives into learning at the workplace. *Educational Research Review, 3*, 130–154.

Uzzi, B. (1996). The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *American Sociological Review, 61*(4), 674–698.

van Duijn, M., van Busschbach, J., & Snijders, T. (1999). Multilevel analysis of personal networks as dependent variables. *Social Networks, 21*(2), 187–210.

Van den Bossche, P., & Segers, M. (2013). Transfer of training: Adding insight through social network analysis. *Educational Research Review*, *8*, 37–47.

Van Waes, S., Van den Bossche, P., Moolenaar, N. M., Stes, A., & Van Petegem, P. (in press). Uncovering changes in university teachers' professional networks during instructional development. *Studies in Educational Evaluation*.

Wasserman, S., & Faust, K. (1994). *Social network analysis: Methods and applications*. Cambridge: University Press.

Wellman, B. (1993). An egocentric network tale: Comment on Bien et al. (1991). *Social Networks, 15*(4), 423–436.

Wellman, B., & Frank, K. (2008). Network capital in a multilevel world: Getting support from personal communities. In N. Lin, K. Cook, & R. S. Burt (Eds.), *Social capital: Theory and research*. New Jersey: Transaction Publishers.

Yasumoto, J. Y., Uekawa, K., & Bidwell, C. E. (2001). The collegial focus and high school students' achievement. *Sociology of Education, 74*(3), 181–209.

Zwart, R., Wubbels, T., Bergen, T., & Bolhuis, S. (2007). Experienced teacher learning within the context of reciprocal peer coaching. *Teachers and Teaching, 13*(2), 165–187.