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Teaching-focused social networks among college faculty: exploring conditions for the development of social capital

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Abstract
Scholars have long recognized that teachers' social interactions play an important role in their learning and professional development. Still, while a growing body of research shows that teaching-focused social ties can give precollege educators access to valuable information, knowledge, and advice—or "social capital"—that improves professional practice and student learning, empirical, mixed methods studies on the phenomenon in the higher education sector are rare, and few investigate what conditions are necessary for these social ties to develop among college instructors. Focusing on college faculty in 17 associate- and baccalaureate-level institutions in one U.S. city, this study uses survey and interview data to explore the connections between structural and positional educator characteristics and the "social networks," or compilations of social ties, in which faculty reported discussing teaching. Regression analyses of survey responses ($n = 244$) indicate that fewer years of teaching experience, the time faculty take preparing to teach, discipline, and institution type are correlated with social network dimensions linked to improved professional practice. An inductive analysis of interview data from a subset of faculty ($n = 22$) supplements survey findings with descriptions of how teaching experience, organizational support, and other factors constrain and reinforce the development of teaching-focused social ties. Results confirm and extend prior research indicating that the development of teaching-focused social networks and the accrual of ties linked to social capital demand faculty and organizational investment. Findings also suggest that leaders hoping to foster beneficial ties should tailor instructional initiatives to more closely align with faculty experience and time commitments.

Keywords Social networks · Higher education · Faculty · Professional development · Mixed methods · Social capital

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Introduction

For almost as long as teacher learning has been considered a key facet of successful educational reform (e.g., Borko and Putnam 1995), scholars have recognized that a teacher's social environment, specifically the teaching-focused interactions that he or she has with others, is integral to this learning and, more generally, professional development (Lieberman and Miller 1999; McLaughlin and Talbert 2001).[1] In light of longstanding efforts to reform college instructional practices to improve student access and retention (e.g., Wieman et al. 2010), the social connections through which faculty learn to become more proficient in their work is an issue of continuing significance. In this paper, we focus on how these beneficial social connections develop.

In recent years, educational scholars using social network analysis (SNA)—a research perspective and set of techniques mapping relationships or "social ties" to better understand how interactions influence behavior (Wasserman and Faust 1994)—have advanced scholarship on teacher social learning in important ways. While studies focusing on demarcated "communities of practice" (Gehrke and Kezar 2017) and "inquiry communities" (Roblin and Margalef 2013), for instance, have helped researchers better understand collaborative learning, work investigating a wider range of formal and informal social learning opportunities in faculty members' daily lives and the mechanisms by which these opportunities become available is uncommon. SNA, however, allows just this type of approach. Operating from the premise that bundles of social ties called "social networks" can shape an individual's access to valuable information, support, and advice, a substantial body of SNA research has shown that particular configurations among teaching-focused networks not only enhance teachers' professional development (Baker-Doyle and Yoon 2011) and ability to implement reforms (Daly et al. 2010) but also improve teaching (Supovitz et al. 2010) and student achievement (Pil and Leana 2009). Indeed, when teachers develop social ties that let them discuss their work with others, whether in groups or one-on-one, by design or by accident, evidence suggests that the information, support, and advice they access can act as a critical foundation for job satisfaction, self-efficacy, and higher-quality practice that improves student outcomes (e.g., Moolenaar 2012).

Still, there are a number of opportunities to expand on the state of knowledge in this regard, especially at the college level where much less is known about beneficial teaching-focused social ties and the conditions that allow them to develop among faculty (Fleming et al. 2016). Though findings from a nascent body of research literature that investigate faculty social networks have indicated that teaching-focused discussions bring similar professional advantages to faculty as they do to precollege teachers (Pataraia et al. 2015; Rienties and Kinchin 2014; Roxå and Mårtensson 2009a, b; Van Waes et al. 2015, 2016, 2018), precollege findings may or may not transfer reliably to college settings, underlining the need for more theoretically informed, empirical studies regarding how these beneficial ties take shape among faculty members across formal and informal settings. Furthermore, no faculty-centered research, to our knowledge, has used both quantitative and qualitative methods—an advantageous combination in SNA that triangulates precise, mathematical network measures with the meaning respondents make of their own social interactions (e.g., Hollstein 2014)—to explore this issue

[1] We use the term "teacher" to refer to people who teach in educational institutions at all levels. We use the term "faculty" to refer specifically to people who teach in higher educational institutions. We use the term "precollege" to refer to K-12 schools and "college" to refer to higher educational institutions.

empirically across multiple institutions, even though such methods have proven effective in other work linking faculty social networks and professional development (Rienties and Kinchin 2014). Considering that international efforts meant to improve college student learning may rest, in part, on faculty members successfully developing teaching-focused social networks (e.g., Austin and Sorcinelli 2013; Gast et al. 2017), these limitations are problematic.

With these gaps in mind, this paper uses a convergent parallel mixed methods case study design (Creswell 2014; Merriam and Tisdell 2016) to better understand the conditions under which beneficial teaching-focused social network ties develop among college faculty in one large U.S. city. We frame our complementary analysis of faculty surveys ($n = 244$) and semi-structured interviews ($n = 22$) with Lin's (1999, 2001) concept of "social capital," defined as valued, actionable resources, like information, advice, or support, that people access, mobilize, and benefit from through social ties. Specifically, we focus on answering two research questions:

(1) What faculty conditions are associated with the development of beneficial teaching-focused social networks?
(2) How do faculty members perceive various conditions influencing the development of beneficial teaching-focused social networks in their daily lives?

We answer the first question by testing the correlations between independent variables—focused on faculty "positional" and "structural" conditions that Lin (2001) theorizes allow one to access beneficial social ties—and dependent variables—including measures for faculty personal network *size* (i.e., how many people one talks to about teaching), *diversity* (i.e., how heterogeneous these people are), and *tie strength* (i.e., how close one feels to these people) connected theoretically and empirically to social capital accrual (Borgatti and Halgin 2011; Burt 1992; Crossley et al. 2015; Lin 1999, 2001; Reagans and McEvily 2003). We answer the second question through inductive analysis of faculty interviewee descriptions of how beneficial teaching-focused ties developed in their daily lives, presenting eight conditions faculty members reported as either constraining or affording the development of social ties linked to social capital (Lin 2001). Quantitative and qualitative results are compared and contrasted, with findings confirming and extending prior research indicating that faculty teaching experience, time allocation, and organizational support for formal and informal teaching discussions are often associated with the development of beneficial teaching-focused social networks linked to the accrual of social capital. Results also suggest that college leaders hoping to foster beneficial faculty ties should tailor instructional initiatives, again based on both formal *and* informal teaching-focused discussions, to more closely align with faculty experience and time commitments.

We begin here by discussing research on social learning and social network findings among faculty, with a particular focus on how teaching-focused discussions benefit faculty and how these ties develop across settings. We conclude this background with a description of the social capital- and social network-oriented theory that underpins our mixed methods analysis of conditions that allow teaching-focused social network ties to form among faculty.

Faculty social learning

Scholarship spanning more than three decades has underlined the important connections between precollege teachers' social learning and improved professional practice, with claims

converging on the idea that student learning and educational reforms can be enhanced when teachers generatively reflect on their work with others in a supportive environment (Little 1982; Louis et al. 1996). Research on the social learning of college faculty has been much less voluminous, however. Though teaching discussions through formal "professional learning communities" (Hilliard 2012), "inquiry communities" (Roblin and Margalef 2013), "peer observation" or "peer coaching" processes (Fletcher 2018), and most frequently "communities of practice" (Gehrke and Kezar 2017; McDonald and Cater-Steel 2016)—a frame with particular resonance in conceptualizing how new faculty members learn from colleagues—have received more attention, scholars have also acknowledged the significance of more private, informal forms of social learning among faculty. Specifically, this research has focused on informal conversations in which college faculty are able to discuss tacit assumptions underlying teaching and student learning with mentors (Ambler et al. 2016; De Janasz and Sullivan 2004), colleagues (Ponjuan et al. 2011), and contacts within or outside one's department (Pifer et al. 2015), discipline (Quinlan and Åkerlind 2000), or institution (Niehaus and O'Meara 2015). Researchers have also pointed to *time*—in regards both to the hours college faculty members are able to devote to such discussions as well as the years they have been teaching—as important to the development of social networks and, ultimately, the social learning process (Gehrke and Kezar 2017; Green et al. 2013; Houghton et al. 2015; Kezar et al. 2017).

Ultimately, studies support the notion that conversations among college faculty members are beneficial to professional practice when they are purposeful, firmly grounded in professional practice, fixed on student learning, and, most importantly, *reflective* (García and Roblin 2008; Harwood and Clarke 2006; Kitchen et al. 2008; Knight et al. 2006; Viskovic 2006), a term that has been conceptualized and used by researchers and practitioners in a wide spectrum of fields (Hatton and Smith 1995; Hubball et al. 2005). Dewey (1933), for example, described "reflective thought" as the "active, persistent, and careful consideration of any belief or supposed form of knowledge" (9) while Schön (1983), building on Dewey's work, defined reflection as the thorough contemplation of one's past and current experiences to continually learn and develop. In this study, we seek to shed light on how reflection can be represented in social interactions in which faculty members discuss, in an iterative fashion, one another's knowledge and experience as well as the possible incorporation of this knowledge and experience into practice. Such discussions, research shows, allow faculty members to think critically about their work and what makes good teaching, think more deeply about their understanding of the subject matter, and continually refine practices to improve student learning (Hammersley-Fletcher and Orsmond 2005; Martin and Double 1998; Manouchehri 2002).

Despite considerable advancements and increased sophistication in the study of social learning among college faculty, there has been little work exploring how particular conditions associate with the development of valuable teaching-focused ties providing such reflection. As noted, while researchers have shown a range of social interactions to be beneficial to college faculty members' professional development, studies on faculty social learning often focus on demarcated group interactions within single organizations to the detriment of smaller and more informal interactions across organizational boundaries, underutilizing the more precise measurements network researchers and theorists have developed to catalog (and compare) relationships across the spectrum of faculty experience. As we next discuss, we believe these tactics offer the kind of methodological workability and accuracy ideally suited for this issue.

Social network analysis and faculty ties

SNA, a set of methods and concepts focused on the analysis of relationships or "social ties" between actors, is based on three key assumptions: first, that actors and the actions they take are interdependent; second, that social ties between individuals, compilations of which are referred to as "social networks," are a conduit for resources; and, third, that the social networks in which actors are nested confer constraints and affordances on their actions (Wasserman and Faust 1994: 4). SNA analyses, which rely on precise data gathered from respondents on the characteristics of social ties, usually focus on one of two different kinds of social networks. One group of studies looks at "whole" networks made of social ties among bounded groups of interconnected individuals (Jan 2018). The second group of studies, of which this paper is a part, look at "ego" or "personal" networks that focus on the social ties of selected individuals in a larger population who are usually not connected to one another (Borgatti et al. 2013; Crossley et al. 2015). Here, respondents, as "egos," are able to report certain kinds of social ties regardless of formal, organizational, or geographic boundaries, a particular strength of the method when one wants to study influential ties wherever they may reside (Wellman 2007).

While social network studies among college faculty have most often focused on research collaboration relationships (e.g., Newman 2001), there are a handful of studies documenting formal and informal ties in colleges that shed light on departmental collaboration (Quardokus and Henderson 2015), online forums (Cela et al. 2015; Jordan 2016; Tirado et al. 2015; Veletsianos and Kimmons 2013), academic career advancement (Niehaus and O'Meara 2015), and other outcomes (Heldens et al. 2015; Rienties and Kinchin 2014; Van Waes et al. 2018). More importantly for our purposes, a few other studies provide important direction with regard to teaching-focused networks among college faculty. Work by Roxå and Mårtensson (2009a, b), in particular, set an early tone in this regard, showing how the analysis of more precise data on discussion ties spanning formal and informal settings could provide insights into the development, structure, and impact of faculty learning interactions. Referring to data on social learning discussions among 109 college faculty, they suggested that "faculty rely on a network of a few significant others as they construct, maintain, or change their understanding of the teaching and learning reality" (2009b: 214). Through such conversations, they argued, faculty were able to engage in reflective exchanges that provided them with the knowledge and support to grow professionally—especially when local departmental or institutional cultures were perceived to be supportive (2009b).

More recent research documenting teaching-focused social ties among college faculty supports these findings. Using qualitative and quantitative techniques, for instance, Pataraia et al. (2015) explored how faculty members' social networks supported professional learning, finding that a prevalence of local relationships among faculty supplemented various professional practices (344–346). Rienties and Kinchin (2014) focused on measuring the contours of social networks among faculty participating in an academic development program, concluding that informal ties outside respondents' formal programmatic groups were integral to their perception of how much they learned. Van Waes et al. (2015), studying the teaching-focused ties of college faculty at varying career stages in one university, found more experienced, "expert" instructors to have network characteristics which respondents thought yielded more beneficial input. Van Waes et al. (2016) also showed how some faculty respondents viewed such teaching-focused discussions as another form of "preparation" for teaching their courses (302–303).

Indications that teaching-focused ties across formal and informal settings ultimately help college faculty improve their professional practice—a key objective of international efforts to

improve undergraduate learning—lead to the question, once more, of what conditions facilitate the formation of such ties. A number of scholars have used SNA tools to explore this issue among precollege teachers (Moolenaar et al. 2012, 2014; Penuel et al. 2012; Spillane et al. 2015), but not among college faculty, a more autonomous group whose work may very well stand to benefit from building social links to others with whom they can reflect on their teaching (Van Waes et al. 2015). Next, we show how the concept of social capital, and associated social capital-related theory from research on personal networks, helps us conceptualize and investigate this important issue.

Social capital theory

Our analysis of the development of beneficial faculty social networks is based on the concept of "social capital," or valued, actionable resources accessed and mobilized through interpersonal relationships (Bourdieu 1986; Lin 1999, 2001; Lin et al. 1999). The term is based on the economic idea of returns on investments. Instead of monetary investments, however, here an individual "invests" by *cultivating social ties*. If properly tended, these social ties may eventually be used by the individual to accrue benefits or "returns."

Lin (1999, 2001), whose approach has informed most recent social capital research in education (Carolan 2013), specifically grounds this theory in SNA, conceiving of social capital as resources embedded in social networks that can be accessed through social ties (2001: 24–25). This means that social capital is not "possessed" by individual actors, at least not in the common sense of the term. Instead, social capital flows through social ties between friends, coworkers, family members, discussion partners, and others and directly or indirectly provides material or non-material resources like information, support, knowledge, advice, prestige, or wealth. These social resources, in turn, allow one with social ties to act in self-interested ways that help him or her accrue real benefits, with some important caveats. Social capital is neither unlimited nor wholly positive. Instead, it is unequally distributed from individual to individual (Bourdieu 1986; Lin 2001) and by no means, as Bourdieu (1986) wrote, "a natural … or even a social given" (286). One can have a social tie that takes support but does not give it in return, for instance. Other ties can be burdensome or even detrimental (Portes and Landolt 1996), as scholars investigating the "dark side of social capital" have shown in regard to the inflexibility of certain kinds of management relations (Gargiulo and Benassi 2000) or buyer-seller collaborations (Villena et al. 2011). In this way, like other forms of capital, social capital should be understood in a relative rather than an absolute sense depending on social context and outcome of interest (e.g., Carolan 2013: 217).

With all this in mind, how does *beneficial* social capital develop? Lin (2001) causally models the process in three stages defined by embededness, use, and return. During the first stage, "preconditions and precursors" (245) help one develop (or not) beneficial social ties that, in the second stage, allow an individual to access and mobilize social capital. In the third stage, the successful individual receives beneficial "returns" from this social capital deployment (246–247). In the context of a faculty member's daily life and with reference to faculty social learning literature, this theoretical process could unfold thusly: first, certain conditions allow a beneficial teaching-focused social tie to develop; second, this social tie allows the faculty member to regularly "construct, maintain, or change their understanding" (Roxå and Mårtensson 2009b: 214) of teaching through conversation which eventually facilitates improved professional practice; third, improved professional practice enhances student outcomes and bestows professional advantage on the faculty member.

While the entire process is important, our research questions center on *antecedents to social capital*—how beneficial social ties develop among faculty—represented in the model's first stage. On this point, Lin (1999, 2001) and Lin et al. (1999) clarify further, contending that social ties that enable an individual to accrue social capital are differentially accessed and mobilized based on two critical conditional factors: "position"—defined as an individual's place within broader social exchanges based on their life experience, credentials, professional or familial roles, and identity—and "structure"—defined as the multi-layered, meso- to macro-level systems that impose normative values and hierarchies on individuals and their interactions, like workplace structures, organizations, communities, and wider institutions and traditions. This particular part of the process, through which "structural elements and positional elements in the structure affect opportunities to construct and maintain social capital" (Lin 1999: 41), is our focus herein (Fig. 1).

Measuring social capital-facilitating ties

Our operationalization of these ideas, which requires observable measures, rests on decades of empirical and theoretical integration in SNA (Lin 2001: 76–77) connecting patterns in personal social networks to the accrual of beneficial social capital (Borgatti and Halgin 2011; Burt 1992; Lin 1999, 2001; Reagans and McEvily 2003). While such measures are ultimately only proximal variables, we can use them to conservatively explore the association between certain positional and structural conditions (Lin 2001) of faculty respondents, on the one hand, with variables representing social capital access of these same respondents, on the other. In the quantitative portion of our analysis, social network measures linked to social capital will be represented by three simple personal network variables that Lin (2001) and other SNA scholars recognize as significant: network size, diversity, and tie strength.[2]

Network size "Network size" represents how many social ties one has. Lin (2001), among others, theorizes that a person's "network location," or whether one has social ties accessing different kinds of information or knowledge, increases the likelihood of a good return on one's social investment. Indeed, the number of social ties within a particular individual's social network is correlated with a wide variety of outcomes in SNA, and workplace learning studies have found that the larger the number of people from whom an individual receives information, advice, or feedback, the more rich and informative that information (Burt 1992; Smither et al. 2005).

Diversity The "diversity" of a personal network refers to the homogeneity or heterogeneity—by attributes or group affiliation—of contacts within a social network. People usually establish social ties with others who are similar to themselves (Marsden 1987), and information coming from such relationships is more often redundant than information coming from relationships with contactswith different attributes (Burt 2000). Greater network diversity, however, often offers the individual access to a wider variety of information and resources that can lead to more innovation and change in practice (Burt 2004; Kilduff and Krackhardt 1994). Lin (2001) notes that "heterophilous" interactions, or interactions between actors with dissimilar resources

[2] As we explain in more detail below, length limitations in our survey design did not allow for more elaborate "structural" measures of personal networks.

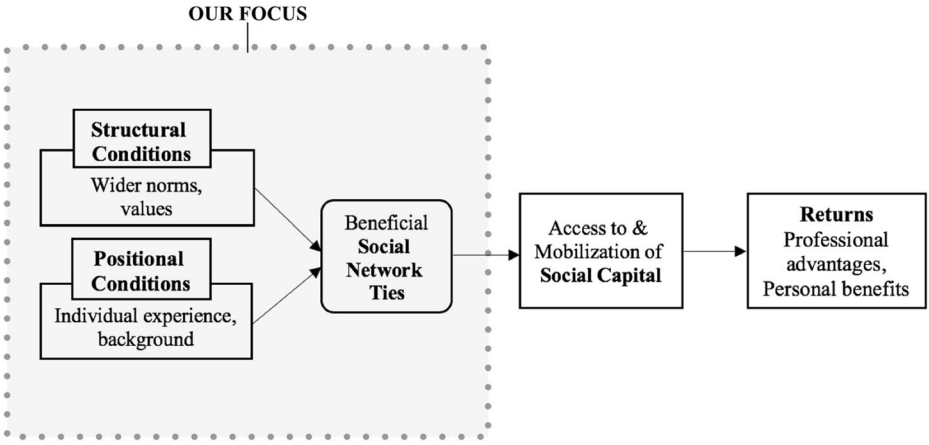

Fig. 1 Modeling conditions for social capital development (based on Lin 2001: 246)

(47), is much preferred for gaining (as opposed to defending) social resources, as such interactions allow access to new social locations (58).

Tie strength Studies show that measures of how close an individual feels to people within his or her social network—called "tie strength"—correlate with trust and reciprocity and therefore the nature of the social capital to which one has access, though strong or weak ties are beneficial in different ways. On one hand, stronger network ties have been shown to lead to the more efficient exchange of complex, non-routine information (Coburn and Russell 2008; Reagans and McEvily 2003). Conversely, it has also been shown that stronger ties represent greater network overlaps between respondents and their contacts, which in turn limit one's access to new, non-redundant information (Granovetter 1973). Lin (2001) concludes that strong ties, based on trust and sentiment, provide support for the maintenance of resources, while weak ties are associated with dissimilar and therefore more heterogeneous resources (65–69).

Methods

Based on data collected as part of larger study on workforce-oriented college instruction in one American city characterized by a high proportion of science, technology, engineering, mathematics, and medical (STEMM) employment (see Rothwell 2013), our analysis focuses on faculty social network-oriented survey responses, meant to answer the first research question, and semi-structured interview responses, meant to answer the second research question.

We use a convergent parallel mixed-methods case study approach (Creswell 2014; Merriam and Tisdell 2016)—distinguished by the investigation of a specific bounded issue using quantitative and qualitative sources—to answer these research questions. The approach utilizes two sets of data, collected simultaneously but analyzed separately, to look at the same issue from different perspectives, comparing and contrasting results side-by-side to "see if the findings confirm or disconfirm each other" (Creswell 2014: 219).

Sampling

Our sampling procedure first focused on identifying associate's- ("2-year") and baccalaureate- ("4-year") level college degree programs in one large U.S. city educating students to enter two broad occupational fields corresponding to the focal city's most populous areas of STEMM employment: energy and health care (U.S. Bureau of Labor Statistics 2016).[3] Using data from the U.S. Department of Labor's Employment and Training Administration on college programs in the city explicitly linked to several of these prevalent 2-year and 4-year credentialed occupations (Occupational Information Network 2016)—including departments training licensed practical and vocational nurses and registered nurses, petroleum and chemical engineers, geological technicians, and chemical plant and systems operators—we systematically scanned institutional websites to compile a list of all local faculty-of-record currently teaching in these educational programs. These included 1255 full-time, part-time, tenured, tenure-track, and adjunct faculty members. Researchers emailed online surveys in March 2017 to this group of faculty across seven 2-year and ten 4-year institutions in the focal city, and a total of 244 faculty respondents completed the survey for an overall response rate of 19.54%. While we conclude that this response rate limits our ability to generalize findings to the larger faculty population, we believe it is sufficient to establish preliminary findings regarding the development of teaching-focused social networks among faculty respondents.

At about the same time we administered the survey, researchers visited three cooperating college institutions in the city—two 4-year universities and one 2-year college chosen for their energy and nursing programs and differing student populations—and conducted 22 in-person interviews with a subset of faculty who had separately responded to recruitment emails asking for qualitative volunteers.

Survey instrument

Online surveys included a subsection pertaining to gathering indicators for the size, diversity, and tie strength of respondents' teaching-focused social networks across settings. These items followed established SNA "ego" or "personal" network techniques (Halgin and Borgatti 2012; Milardo 1992) that gather network data on individual respondents' significant social ties, allowing respondents to characterize their own social stimuli—formal or informal, within or outside of their organizations—as they believe they are influential, wherever they may reside. We chose this approach because our goal is to better understand how faculty positional and structural conditions (Lin 2001) influence the development of patterns in respondents' teaching-focused social networks linked to social capital accrual, instead of describing the patterns of "whole," bounded organizational networks (Carolan 2013).

This inquiry was only one part of a larger study, so we needed to truncate social network data collection methods to avoid respondent fatigue. This is a commonly discussed challenge in SNA because each question added needs to be answered across each social tie a respondent lists (e.g., Burt 1984; Grunspan et al. 2014). This led us to limit items to the four questions that were absolutely necessary to construct measures of size, diversity, and tie strength for each

[3] In the U.S., associate-level college degrees entail 2 years of study after high school graduation and typically focus on applied career skills and knowledge. Graduates usually gain entry-level jobs in industry or transfer into bachelor-level degree programs, which entail 4 years of general education as well as focused disciplinary study.

respondent's teaching-focused social network. The first question, based on Burt's (1984) seminal "important discussions" personal network inquiry, asked whether the faculty member discussed "methods or techniques they can use to better teach their students important skills, knowledge, or abilities" with anyone. If faculty answered yes, they were then asked to list between one and six people with whom they typically had such discussions. We limited respondents to listing six ties because social network methodological research has shown that six is the optimal maximum number of possible contacts necessary to both accurately capture significant personal network ties and reduce respondent burden (Marsden 1987). Previous research (Roxå and Mårtensson 2009b), as well, tells us that beneficial teaching-focused social ties are made with only "a few significant others" (214), as Roxå and Mårtensson put it in reference to Berger and Luckmann's (1966) notion of core discussion partners. The number of contacts listed here, between zero and six, acted as our measure for network size (Milardo 1992) or "degree" (Freeman et al. 1979). The next items constituted "name interpreter" questions meant to collect information on the listed teaching-focused social ties (Burt 1984). The first of these two questions asked faculty to indicate the organizational affiliation of each contact, an important but understudied characteristic of diversity in teaching-focused networks (e.g., Baker-Doyle and Yoon 2011), from various categories based on the North American Industry Classification System (U.S. Census Bureau 2016). We developed a network diversity variable for each respondent from this data using Krackhardt and Stern's (1988) E-1 Index, a standard SNA measure, equaling

$$\frac{E-I}{E+I}$$

where E is the number of ties in one's social network to contacts from "external" groups—here including people professionally affiliated with educational institutions at other degree levels and business, government, and advocacy organizations—and I is the number of ties to contacts from "internal" groups—here including people professionally affiliated with college organizations at the same degree level. To ease interpretation of this score, the measure was transformed into a bounded quantity between 0 (total network homophily) and 1.00 (total heterophily). The second name interpreter question asked faculty to indicate whether they would characterize their relationship with each listed tie as distant, less than close, close, or very close, a question designed to best represent the theoretical concept of tie strength using only one survey item (Marin and Hampton 2007). Following Morrison (2002), we created our tie strength measure by averaging responses to this survey question on a 4-point scale, with zero equaling "distant" and three equaling "very close."

With these network indicators as dependent variables representing proxies for faculty social capital access, primary independent variables were comprised of two predictor categories we conceptualized as "positional" and "structural" conditions allowing beneficial social ties to develop among faculty (Lin 2001). *Position* is a vector of four variables linked to faculty professional practice: time allocated to teaching—including measures for student advising, teaching preparation, and scheduled teaching (e.g., Milem et al. 2000)—and teaching experience (e.g., Fleming et al. 2016). For these measures, respondents were asked to indicate their teaching experience in years as well as the number of hours per week they spent preparing to teach, advising or counseling students, and doing scheduled teaching. *Structural* predictors included two contextual variables commonly associated with faculty professional practice: institution type (e.g., Leslie 2002; Wright et al. 2004), characterized as either a 2-year or a 4-year institution, and discipline (e.g., Neumann 2001), characterized as "energy" (including engineering and geoscience faculty) or "health care" (including nursing faculty). We also used two

control variables in our statistical models—race and gender—to adjust for other factors that may have influenced respondents' social network development. Table 1 displays descriptive statistics comparing dependent and independent measures across survey respondents (Table 1).

Regression models for social network development

We estimated our regression model to examine the association between college faculty members' positional and structural conditions and social network development. Specifically, for network size or "degree," we regressed a discrete count of reported network contacts on the explanatory variables using a negative binomial regression model, a formulation originally proposed for accommodating over-dispersion in count outcomes (Lawless 1987). We fitted a logit model to identify whether the diversity of faculty networks was associated with teaching-related factors and examined the association between tie strength and individual teaching related factors fitting ordinary least squares (OLS) regressions.

Qualitative interviews

Qualitative data were collected from faculty in three college programs in the city, including one 4-year nationally recognized nursing education center, one large, urban 4-year public university petroleum engineering program, and one urban, 2-year, Hispanic-serving community college chemical operations program. We aimed here for a "diversity of contexts" (Stake 2006: 24) and chose health care and energy programs for the contrasts in their institutional types, their research and teaching foci, and their student populations (Table 2).

Interviews each lasted about 45 minutes and were based on a semi-structured interview protocol including questions about respondents' background, approach to teaching, and formal and informal teaching-focused social network ties. Each interview was digitally recorded, transcribed, and loaded into NVivo 11 for coding focused on one social network question in

Table 1 Descriptive statistics for survey sample

Variable	N	Mean (SD)
Gender		
Female	105	0.44
Male	132	0.56
Race		
White	150	0.63
Non-White	88	0.37
Discipline		
Energy	153	0.63
Health care	89	0.37
Institution type		
2-year	72	0.30
4-year	172	0.70
Teaching experience	240	2.24 (0.92)
Time allocation		
Time preparing to teach	244	1.92 (1.41)
Time teaching	243	1.42 (1.45)
Time spent on advising	244	1.05 (1.24)
Network size	236	3.30 (2.21)
Diversity	188	0.18 (0.33)
Tie strength	189	1.98 (0.58)

Note: "Time allocation" measures range from 0 (1 to 4 hours per week) to 5 (more than 21 hours per week). Teaching experience ranges from 0 (less than 1 year) to 3 (more than 10years)

Table 2 Description of interview sample

	Interview *N*
Gender	
Male	8
Female	14
Race	
White	9
Non-White	12
Discipline	
Energy	12
Health care	10
Institution type	
2-year	5
4-year	17
Teaching experience	
Less than 1 year	1
1–5 years	2
5–10 years	3
Over 10 years	16

particular from the interview protocol. This question, which was asked of all respondents in regard to interactions in which they discussed instructional methods or techniques with others, read as follows: "What specific barriers or opportunities, if any, have there been for you in developing these kinds of teaching-focused relationships?"

Our inductive analysis of qualitatively reported conditions allowing for the development of beneficial social ties (Lin 2001) began with open coding at the manifest level (Charmaz 2014) of data from five representative interview transcript segments (about 23% of the corpus), through which we outlined a preliminary list of codes keeping as close to the interviewee data as possible. These codes, which represented stated conditions constraining or affording social network development, included "leadership positions," "campus teaching centers," "co-teaching," "formal teaching councils," "teaching experience," and "institution guidelines on tenure-review." This step was followed by a second round of coding of these same five transcripts utilizing the constant comparative method (Glaser and Strauss 1967) in which successive instances of previously open codes in the data were compared to previous instances to further confirm, alter, or expand code names and their definitions. At this stage, for example, codes for "campus teaching centers," "institution guidelines on tenure-review," and "formal teaching councils" were combined into one category, "institutional priorities." We next used "codemapping" to further reorganize extent codes into more refined categories (Saldaña 2015). Here, we combined code categories from the previous pass for "departmental priorities" and "institutional priorities," for instance, into one overarching category called "organizational support," defined as institution- or program-level priorities as revealed through teaching-related policies, funding, extra-institutional partnerships, and time allocation. This step finalized the codebook, which we then applied to all 22 social network-oriented transcript segments using simultaneous coding methods. Second cycle analytic techniques based on tallying respondent repetition of conditions and the association of emergent conditional categories with our research questions and social capital framework followed (Ryan and Bernard 2003), allowing us to distill qualitative data into eight prominent conditions interviewees reported as supporting or constraining beneficial teaching-focused social tie and social capital development. We display and discuss these positional and structural conditions in answer to our second research question below.

Results

In answer to our first research question, quantitative results are reported to show correlations between faculty positional and structural conditions and personal social network attributes linked to social capital accrual (Lin 2001). In answer to our second question, qualitative results show what conditions faculty interviewees reported as influencing whether or not they developed beneficial teaching-focused social ties. In the paper's next section, quantitative associations will be supplemented with qualitative findings to better understand how our application of social capital theory extends prior research and applies in the college context.

RQ1: Faculty conditions associated with the development of beneficial social networks

Associations between positional and structural independent variables and faculty social network dependent variables linked to social capital accrual are displayed in Table 3.

Network size The first column shows that the number of hours a faculty member commits to preparing to teach is positively associated, at the 0.05 significance level (0.085), with network size, or how many teaching-focused ties one reported. That is, college faculty in our sample who reported spending more time preparing to teach discuss teaching with 0.085 more teaching-related contacts on average. We also see here that teaching experience is negatively associated with network size at the 0.05 significance level, suggesting that college faculty with more years of teaching experience are likely to have fewer teaching-focused social network contacts. No significant difference, however, is observed in network size between faculty in energy- and health-care related fields. Hours spent on scheduled teaching, hours spent on advising, gender, and race were also not significant predictors of the size of faculty members' teaching-focused social networks.

Diversity The next two columns reveal that the coefficient of logit regression for 4-year colleges and network diversity is negative and significant at the 0.001 level, implying that 2-year faculty are more likely to have more diverse network contacts, in terms of organizational affiliation, than 4-year faculty. While time for scheduled teaching, time spent on advising, teaching experience, gender, and race have a negative average marginal effect on network diversity and time spent preparing to teach and discipline have a positive average marginal effect, these associations were not statistically significant.

Tie strength Coefficients in the final column show that faculty members' years of teaching experience is positively associated with tie strength, or how close respondents felt to listed contacts, at the 0.01 level (0.117). This suggests that less experienced faculty tend to feel more distant from teaching-focused network contacts than more experienced faculty. This model also predicts, at the 0.01 significance level, that a faculty member in a health care related field will be more likely to have stronger teaching-focused social ties. Faculty time allocation, institution type, gender, and race do not predict a statistically substantial association with either strong or weak teaching-focused social ties.

Table 3 Quantitatively associations between conditions and teaching-focused social network variables

Variables	Network size	Diversity		Tie strength
	Negative binomial	Logit	AME	OLS
Positional conditions				
Time preparing to teach	0.085*	0.141	0.026	0.014
	(0.033)	(0.142)	(0.026)	(0.032)
Time teaching	0.031	− 0.061	− 0.011	− 0.016
	(0.035)	(0.147)	(0.027)	(0.030)
Time spent on advising	− 0.000	− 0.014	− 0.003	0.031
	(0.035)	(0.135)	(0.025)	(0.033)
Teaching experience	− 0.096*	− 0.028	− 0.005	0.117**
	(0.048)	(0.185)	(0.034)	(0.043)
Structural conditions				
Discipline (energy)	− 0.071	0.372	0.069	− 0.336**
	(0.108)	(0.440)	(0.081)	(0.117)
Institution type (4-year institution)	− 0.162	− 1.831***	− 0.338***	− 0.021
	(0.111)	(0.479)	(0.073)	(0.109)
White	0.099	− 0.527	− 0.097	0.008
	(0.096)	(0.395)	(0.072)	(0.092)
Female	0.132	− 0.469	− 0.087	− 0.111
	(0.109)	(0.464)	(0.084)	(0.112)
Constant	1.214***	0.607		1.951***
	(0.197)	(0.792)		(0.199)
Observations	227	184	184	185
R-Squared				0.099
Pseudo *R*-squared	0.0338	0.127		
Adjusted *R*-squared				0.0582

Note. Standard errors in parentheses

AME: estimated average marginal effect

*$p < 0.05$

**$p < 0.01$

***$p < 0.001$

Overall, faculty positional conditions (Lin 2001), represented here by weekly teaching preparation hours and years of teaching experience, have both positive and negative associations with the network size and tie strength among teaching-focused social ties. In contrast, whether one works in a 4-year institution or is in an energy-related disciplinary field, factors we associate with structural conditions, are correlated negatively with network diversity and tie strength.

RQ2: Perceptions of conditions influencing the development of beneficial social networks

In describing their teaching-focused social network ties, faculty respondents spoke to several conditions influencing the development of relationships associated with social capital deployment (Lin 2001). The different conditions we detected in the interview data included "positional affordance," or network ties precipitated by TA assignments or co-instructor, lead instructor, and department chair positions bringing faculty into contact with others; "content dependent" ties, or teaching-focused ties constrained or buttressed by the teaching-related content of a specific course or the disciplinary knowledge (or lack thereof) of one's

potential discussion contact; "professional society membership," referring to ties triggered by involvement in extra-institutional disciplinary or professional association membership bringing one into contact with others; "physical proximity," or ties facilitated by offices or workspaces being close to one another; "industry background," referring to inter-organizational ties enabled by faculty members' experience working in industry in the past; and "innate ability," or two faculty members' perceptions that discussions centered on teaching are not helpful because one either can teach well or not. Here, we outline these conditions in order from top to bottom based on the number of faculty respondents who spoke to each (Table 4).

Because of space limitations, we present deeper analyses on only the two most salient conditions from interviews, based on the number of faculty members who spoke to them: "teaching experience" and "organizational support." As we discuss below, these two conditions give important context to quantitative findings.

Teaching experience Nine faculty interview respondents described connections between their teaching discussions and teaching experience. One new 4-year engineering faculty member, for instance, said, "I certainly talk to other professors since I'm relatively new in the academia world … I do try to understand more about … the best way" to teach, while a more experienced 4-year health faculty member told us she spoke to others about teaching much less frequently than she had when she first started teaching. "It was more often early on because I wasn't real familiar with the course," she said. Unless teaching-focused discussions were directly applicable to their current position or teaching responsibilities, the experienced faculty to whom we spoke often indicated disinterest in them. Their experience, some told us, made such conversations of little practical value. This seems to substantiate quantitative findings regarding the negative association of teaching experience with social network size, a variable often linked to social capital accrual (Burt 1992).

There were a few counter-examples, however. One nursing faculty member at a 4-year institution told us she learned early in her career to ask more experienced faculty members for advice. Instead of withdrawing from such discussions as she became more experienced herself, she now purposefully offered novice faculty members advice on teaching techniques. "I have certain things that I found out work well for me, and every time we get a new clinical instructor

Table 4 Qualitatively reported conditions influencing teaching-focused social network development

Condition	*N*	Description
Teaching experience	9	The length of time one has taught in the higher education sector
Organizational support	8	Institution- or program-level priorities as revealed through teaching-related policies, funding, extra-institutional partnerships, and time allocation
Positional affordance	7	Teaching-related discussions are a part of one's job or official position
Content dependent	6	Opinion that teaching discussion contacts need to be content experts in the disciplinary field
Professional society membership	5	Respondent is an active member of a professional or disciplinary association and regularly attends meetings
Physical proximity	4	Conversations are more or less likely when offices, classrooms, or program facilities are close to one another
Industry background	3	Work experience in private industry helps one develop extra-institutional contacts
Innate ability	2	Opinion that one either is a good teacher or not, and discussions do not help one improve instruction

Note. Conditions listed in order from top to bottom by number of respondents speaking to each

in … I come in and say, 'Hi,' and this is what I use and this is why I do it.'" While other experienced practitioners reported acting more as mentors than mutual discussants, this faculty member saw teaching conversations as an opportunity to offer early career faculty support based on her teaching experience.

Organizational support Eight faculty members, representing all three colleges, described several kinds of organizational or programmatic supports that facilitated beneficial teaching-focused social ties associated with the development of social capital, including formal centers for teaching and learning, instructional development workshops, and peer teaching councils. Whether or not respondents saw such resources as available *and* accessible, however, differed from respondent to respondent. Some interviewees, for instance, perceived a lack of adequate structural support, such as one 4-year engineering faculty member. "There are, quite frankly, a lot of resource constraints," he said. "Lots of students, lots of work, no time. These professors here, I don't know how much time they have to network." Others reported that teaching and learning resources were available, at least theoretically, but they did not have the time to use them. "There's emails and stuff that come through from the college level," one 2-year operations faculty member reported in regard to campus-wide teaching network activities, "but to be honest … I just don't think we have the time."

In one instance, interviewee perceptions of organizational support varied within the same program. One 4-year nursing faculty member indicated teaching-focused social ties were available and accessible, saying she was involved in "many committees" and collaborative discussions providing teaching discussion, advice, and feedback. Another faculty member in her department, however, said that while several formal program mechanisms supported teaching-focused social ties, physical "isolation," and myriad research and student responsibilities, kept him from having as many teaching discussions as he would like. For faculty in the department, he concluded, "the biggest barrier is how busy we are."

Conclusions and implications

Based on Lin's (1999, 2001) conceptual model of social capital development, this mixed methods study focused on how teaching-focused social ties form among college faculty confirms and extends findings from precollege and college research. Confirming preliminary SNA findings from Van Waes et al. (2015), we quantitatively find a significant association between longer faculty careers—conceptualized here as a positional condition underlying social capital access (Lin 2001)—and smaller teaching-focused social networks with strong ties. Such networks are characterized, somewhat contradictorily, by reduced access to new information (Roxå and Mårtensson 2009b) and increased access to more complex, non-routine information (Coburn and Russell 2008). On the qualitative side of the analysis, our interviewees did not speak to the natural tendency for ties to be stronger for those with more professional longevity, but did suggest that teaching experience helped mitigate faculty members' apprehension of their classroom teaching skill, thus limiting advice-seeking behavior (and, possibly, social capital accrual) through potentially new sources of professional information. Two interviewees, both of whom had taught for over two decades, expressed the related belief that teaching-focused discussions could not improve a person's teaching because one was either a good teacher or not.

Quantitatively, structural conditions (Lin 2001) for faculty members teaching in 2-year colleges were significantly correlated with social tie development and social capital accrual through more diverse inter-organizational network ties, which research has shown can lead to more professional innovation (e.g., Burt 2000). Given the stronger connections U.S. 2-year faculty have with industry representatives through required industry experience, employer advisory boards, and the co-op, internship, and apprenticeship programs typical of these institutions, as reported by three faculty interviewees here in our qualitative analysis (Table 4), this finding is unsurprising and indicative of faculty members' everyday lives in 2-year colleges. Though qualitative respondents did not speak to structural contrasts between fields, one's disciplinary status as nursing faculty instead of energy faculty, conceptualized as a structural condition (Lin 2001) in our quantitative analysis, also significantly predicted increased social network tie strength and access to tacit, complex information (Reagans and McEvily 2003), pointing perhaps to the traditional value afforded interpersonal communication in health care (e.g., Street et al. 2009) as compared to engineering and the geosciences. "I think in nursing, communication as has to occur at so many different levels," one nursing faculty respondent told us, explaining the multiple levels at which nurses need to communicate with patients, family members, team members, and other medical professionals. "Communication would definitely be an important skill."

Unexpectedly, our regression analysis also shows a strong association between a particular kind of faculty time allocation and positional variable—the number of hours each week faculty members prepare to teach—and social capital accrual through increased network size. While this suggests an important distinction between fixed teaching hours, ordinarily prescribed by one's academic unit, and the hours a faculty member chooses to spend outside of a course preparing, it also highlights the views of some respondents in Van Waes et al. (2016) who perceived teaching-focused discussions, and the exchange of information they allow, as a form of teaching "preparation." Importantly, this finding also speaks to studies linking faculty time allocation to individual-, departmental-, institutional-, and even disciplinary-level factors (e.g., Singell and Lillydahl 1996), reminding us not only that social capital development demands extensive personal *and* organizational investment (Lin 1999) but also that strictly demarcating "positional" and "structural" conditions is a somewhat quixotic task. Indeed, our mixed methods results highlight the complex associations and interactions between these conditions in faculty members' everyday lives (Fleming et al. 2016). Though the number of hours faculty reported preparing to teach on our survey was significantly associated with social tie development in our quantitative analysis, faculty qualitative interviewees across institutions told us that the sheer weight of responsibility they carried, often explained in obligatory rather than discretionary terms, was what most constrained their teaching-focused social interactions. "Time," from this perspective, was both a positionally *and* structurally limited resource that, a few interviewees suggested, would only become more restricted with continued structural (i.e., departmental, institutional, or political) transformations.

This point speaks more broadly to the theoretical contribution of this work. Our results generally support the applicability of two core conditions from Lin's (1999, 2001) model of social capital development through social network ties, here in the context of faculty members and their teaching-focused social networks. But while the strengths of Lin's (1999, 2001) social capital theory lie in its clarity, precision, and applicability across settings—which helped us model the process through which beneficial social ties form—"positional" and "structural" constructs also represent one possible confounding factor for those hoping to test this social capital theoretical proposition empirically, especially with qualitative data. Indeed,

qualitatively reported conditions we refer to as "content dependent," "professional society membership," "physical proximity," and "industry background" can be conceptualized in both positional and structural terms, tracking closely to what Lin (1999) describes as "positional elements in the structure" (41). While the theory holds, its application to the qualitative results underline how the messiness and complexity of everyday social life can sometimes strain even the most robust model.

Still, these findings have important implications for faculty teaching and student learning in higher educational institutions. Our quantitative results suggest, for instance, that faculty members at 2-year colleges engage in teaching-focused discussions with social ties from more diverse organizations than those at 4-year institutions. One faculty member interviewee at a 2-year college, to use an example, described teaching-focused interactions facilitated through professional association links with private industry representatives. In light of a wide body of social network theory and empirical findings indicating that interaction with more diverse others implies access to new sources of information and perspective (Burt 2003), this may indicate that 2-year faculty have more diverse, socially assembled insights about teaching and learning than faculty in 4-year colleges. Student experiences, although not entirely defined by classroom learning, may fluctuate accordingly. In light of these findings, administrators and policymakers hoping to encourage the development of beneficial relationships among college faculty may find they are more successful by openly and determinedly promoting the importance of teaching-focused social ties, both formal and informal, among faculty teaching in their institutions. They may also benefit by more closely aligning departmental and institutional professional development measures, be they teaching conferences or mentorship, peer assessment, or campus-wide opportunities, as closely as possible with faculty experience and teaching, research, and service commitments.

Limitations and scholarly significance

These findings should be interpreted with a few limitations in mind. First, our results were obtained from a single U.S. city and a sample population with a low survey response rate, indicating that respondents may differ from the population of U.S. college faculty they were selected to represent. This therefore puts limitations on our ability to generalize findings to the wider population. Second, we had to limit social network survey items to reduce respondent burden, which prohibited us from using more advanced diversity, tie strength, and structural personal network measures in our analysis. Third, while our study adopted Lin's (1999, 2001) theoretical model that conceptualizes a causal sequence leading from positional and structural elements to the formation of social capital, we cannot infer causal relationships between conditions and social network development from our findings. Finally, due to the study's survey sample size, we could not adjust for a number of variables in these exploratory analyses that, when considered with other factors, may generate different insights into how valuable social ties—and therefore social capital—are developed among college faculty. Varying levels of faculty teaching expertise (Van Waes et al. 2015), the perceived quality of teaching-focused interactions (Van Waes et al. 2016), and the departmental context (Quinlan and Åkerlind 2000) are three such variables.

Still, as research from precollege contexts continues to show the connection between teacher social networks and improved professional practice, this study makes a unique contribution by drawing on social capital theory, empirical social network data across formal and informal settings,

and mixed method analyses to explore how college faculty develop beneficial teaching-focused ties across colleges. Such analyses, we hope, will help scholars better understand the association between faculty access to social capital, on the one hand, and student engagement and achievement, on the other, an area of continued significance among college faculty and scholars hoping to improve undergraduate education around the world. Future research can build on this and other recent studies by expanding faculty samples and data collection techniques to include more in-depth and robust tie measures as well as variables that would allow scholars to test the association between patterns in teaching-focused networks and particular aspects of faculty professional practice, including, most importantly, instruction. Associated qualitative work, furthermore, can explore respondent perceptions of the content and influence of teaching-focused discussions and social ties as well as the role teaching-focused social networks can play in professional development.

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