

Linked to innovation: Shaping an innovative climate through network intentionality and educators' social network position

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Abstract This study investigates whether educators' cognitive and structural social capital is associated with perceptions of innovative climate in charter schools. We explore a new concept to assess educators' cognitive social capital, namely network intentionality, meaning the extent to which an educator is intentional in connecting and interacting with others. We hypothesize that network intentionality (cognitive social capital) is related to the extent to which educators perceive their school's climate to be innovative, but that this relationship is dependent on the educator's position in their school's social network (structural social capital). Findings suggest that the relationship between cognitive social capital and perceptions of innovative climate is partly mediated by structural social capital. In other words, those educators with high network intentionality, as evidenced by an orientation towards connecting others, also perceive the school's climate as being more innovative, partly because this strong network intentionality is associated with more out-going relational activity. This work provides unique insights into the factors that may be associated with teacher collaboration in successful charter schools serving traditionally underserved populations, and suggests ideas for schools wishing to support teacher collaboration and innovation.

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Background

Educators around the world are looking for new and innovative instructional strategies, processes, and structures to improve student outcomes. This points to the importance of an “innovation orientation” in schools (Moolenaar and Slegers 2010). Yet, how does such an orientation emerge, and what role do educators and school systems play in cultivating an innovative climate? In an effort to foster a climate of innovation and break down teacher isolation (Baumard and Starbuck 2005) there has been an increasing emphasis on restructuring educators’ work environments into collaborative communities of practice and professional learning communities focused on improving outcomes (Bryk and Schneider 2002; Little 1999; Louis et al. 1996; Newmann and Associates 1996; Slegers et al. 2013). Studies on teacher collaboration underline the role of educators’ social interactions in improving the quality and effectiveness of teaching practices, school organizational learning, and student achievement (e.g., Goddard et al. 2007; Moolenaar et al. 2011b; Yasumoto et al. 2001).

In this article, we draw on social capital theory to explore educators’ social interactions and their potential for supporting innovative school climates in which educators are willing to take risks and share ideas as a way to support the implementation of innovation (Geijsel 2001; Van den Berg and Slegers 1996). We view innovation as a social interaction process in which educators communicate, share, develop, and transform ideas in their school’s social networks (cf. Moolenaar et al. 2011a). As educators interact with one another, they form relationships in which resources (such as information, materials, gossip) are exchanged. The pattern of such relationships in a school, or the school’s social network, provides educators and schools with opportunities as well as restrictions to the flow of resources and the emergence and development of innovations (e.g., Dhanaraj and Parkhe 2006; Frank et al. 2004; Obstfeld 2005; Tsai 2001). Recent research using a social network approach to understand educators’ social interactions has yielded additional understanding of how collaboration may support or constrain efforts at sustainable reform (e.g., Coburn and Russell 2008; Coburn et al. 2012; Datnow 2012; Moolenaar and Daly 2012), increased student achievement (Daly et al. in press; Yasumoto et al. 2001), and improved teaching practice (Frank et al. 2004; Penuel et al. 2012). While such research is mainly conducted in elementary schools, our understanding of the relationship between social networks and innovation in other settings, such as higher education and charter schools, is limited.

With this study, we seek to understand schools’ innovative climate by examining characteristics of social networks in a high-performing Charter Management Organization (CMO) in Southern California in the United States (US) that has an explicit focus on teacher collaboration and the development of innovations. The fast growing movement of CMOs in the US provides a promising context for studying innovative climates, because they typically have more autonomy than traditional

public schools in choosing a pedagogical approach, hiring staff, organizing their work, supporting their teachers, and evaluating students' performance (Farrell et al. 2012; Furgeson et al. 2012; Woodworth and Raymond 2013). This freedom has led CMOs to develop a variety of structures as they work to achieve equitable outcomes and meet the needs of a student population that often has a greater concentration of Hispanic, Black, and low-income students than traditional public schools (Furgeson et al. 2012; Lubienski and Weitzel 2011; Woodworth and Raymond 2013). In an era in which there is strong emphasis on improving student performance, as well as equity in education, CMOs have the flexibility to focus more directly on developing innovative climates.

While both the interest in educational innovation and the charter school movement as a promising context for fostering an innovative climate have grown tremendously over the last decade in the US, the amount of empirical research on innovation in these settings has not kept pace (Betts and Atkinson 2012; Lubienski and Weitzel 2011). There remain many questions to the innovative nature, processes, and outcomes of charter schools (Gleason et al. 2010; Lake 2008; Preston et al. 2012). In this study we aim to address this pressing research gap by studying to what extent educators in a high-performing CMO perceive their school's climate as being innovative, and how these perceptions are related to the social relationships formed with colleagues when sharing new ideas about teaching and learning in their schools. More specifically, our study is guided by the following research questions:

1. To what extent are educators' perceptions of their school's innovative climate associated with the intentionality with which they purposefully shape their social network (network intentionality, i.e., cognitive social capital)?
2. To what extent are educators' perceptions of an innovative climate associated with their position within the social network in their school (i.e., structural social capital)?
3. To what degree is the relationship between educators' perceptions of innovative climate and their network intentionality (i.e., cognitive social capital) mediated by their position within the social network in their school (i.e., structural social capital)?

Theoretical framework

In framing our study we argue that two forms of social capital, cognitive and structural, will be positively associated with educators' perceptions of an innovative climate. We will first briefly present the literature behind the study's dependent variable, innovative climate, and then proceed to consider the two main independent variables: cognitive and structural social capital.

Innovative climate

The subject of organizational innovation has been studied extensively in management and organizational research (Hage 1999). Innovation, in general, has been

defined as the development and use of new ideas, behaviors, or practices (Daft and Becker 1978; Damanpour and Evan 1984). In an organizational sense, innovation is not merely transmitting, diffusing, or recycling existing knowledge between members; it is also concerned with the transformation of prevailing knowledge and practices of actors as a means to organizational change (Nonaka and Takeuchi 1995).

Organizational innovation often occurs in an iterative and cyclic process that is established and maintained through social interaction in collaborative environments (Kanter 1983). As such, innovation is regarded as a social process in which social interaction provides multiple opportunities for input and refinement (Calantone et al. 2003; Nohari and Gulati 1996). Communication, sharing ideas, and focusing on larger organizational goals are critical for an orientation towards innovation (Frank et al. 2004; Monge et al. 1992). This suggests that a social process underlies the development of an innovative climate (Paavola et al. 2004), in which the combination of different people, knowledge, and resources triggers the generation of new ideas and practices (Kogut and Zander 1992).

Scholars have argued that organizations with climates that are open to innovation, in which members are willing to take risks and share new ideas to improve the organization, are more successful at implementing actual innovations than organizations with less innovative climates (Geijsel 2001; Van den Berg and Slegers 1996). In the context of schools we define an Innovative Climate as educators' perceptions regarding the practices, procedures, and behaviors that promote the generation of new knowledge and practices (cf. Van der Vegt et al. 2005). Central to this definition are educators' perceptions of the collective willingness to adopt an open orientation toward new practices and change, and to collectively support and develop new knowledge, practices, and refinements to meet organizational goals (Moolenaar 2010; Moolenaar et al. 2011a).

Research into perceptions of innovative school climates offers valuable knowledge on the extent to which organizations may or may not succeed at efforts of school improvement and as such may provide insights about the ground on which innovations may flourish. Focusing on perceptions of innovative climate, instead of innovations per se, also helps to move past the contextual aspect of studying innovations. Whereas innovations are often context specific, given that one school's innovation may be another school's daily practice, studying an innovative climate provides the opportunity to make comparisons between schools and examine the extent to which an innovative climate may be related to certain characteristics of organizational social structure.

Social capital theory

In positing the importance of social interactions for a school's innovative climate we draw on social capital theory. Social capital is generally defined as "the resources embedded in social relations and social structures which can be mobilized to increase the likelihood of success in action" (Lin 2001, p. 24). A social capital perspective extends a focus on solely individuals to include the interactions among them by aiming to understand the resulting larger social infrastructure that may

support and constrain resource flow among these individuals (Borgatti and Foster 2003; Cross et al. 2002; Wellman and Berkowitz 1998). In the literature two dimensions of social capital are often distinguished—*cognitive social capital* and *structural social capital* (Nahapiet and Ghoshal 1998). We argue that these two forms of social capital are related to educators' perceptions of an innovative climate.

Cognitive social capital

The cognitive aspect of social capital encompasses the norms, values, attitudes, beliefs, and narratives of an actor, which influence meaning-making and the actions of that particular individual (Krishna and Uphoff 2002; Uphoff 1999). These cognitive aspects are believed to affect the formation of social relationships (Nahapiet and Ghoshal 1998; Obstfeld 2005; Totterdell et al. 2008). In a school undergoing major reform, one may imagine that educators' interpretations of and beliefs about the change process may differ, firstly about the specific reform effort itself, and secondly about the people they need to approach for understanding the new expectations and exchanging the necessary information about the reform (e.g., Moolenaar et al. 2013). This in turn may affect the way in which educators collaborate, and with whom, in terms of making sense of the reform effort. As such, the way in which individuals think about certain shared topics (e.g., their values, norms, beliefs, relationships, etc.) may shape and reflect the social processes in schools, and their perceptions of the potential (capital) available for successful reform implementation (Coburn et al. 2012; Datnow 2012; Moolenaar and Daly 2012).

We extend the idea of *cognitive* social capital, and argue that individuals likely have varying degrees of “intentionality” in forming their own social networks. Meaning, individuals have a level of intentionality for actively seeking relationships, serving as a source of advice, and actively brokering relationships between disconnected others (Cohen et al. 2011). This suggests that an individual has agency in forming, brokering, and dissolving social relationships given their own cognitions of what makes for a “good” network. Educators may have certain beliefs when it comes to forming and discontinuing relationships or the exchange of resources. For example, an educator may believe that it is important to exchange ideas with his school director about his new teaching approach to increase the chance that through forming this relationship his new teaching approach will be used throughout the school (Cornelissen et al. 2013b). While some educators may be very explicit in shaping their network by choosing to interact with only those that are highly influential in the school's network, other educators may be less intentional in shaping their network.

An orientation towards strategically connecting others (e.g., the *tertius iungens* orientation, see Obstfeld 2005) and being intentionally involved in social relationships has been associated with greater involvement in innovation (Burt 1997; Obstfeld 2005). Similarly, the extent to which educators are explicit in shaping their networks may be related to how innovative they perceive their environments. For example, educators who actively reach out to others and bridge between disconnected individuals (‘broker’) may come in contact with more diverse

opinions and a wider variety of knowledge than educators who are less intentional about shaping their network (e.g., Burt 1992, 2005; Daly et al. 2014). The extent to which educators are intentional in building a diversity of contacts to have access to novel information and knowledge may be related to their perceptions of the innovativeness of their school environment. As such, we posit that cognitive social capital (as network intentionality) is positively associated with educators' perceptions of innovative climate (Hypothesis 1).

Structural social capital

The *structural* aspect of social capital addresses the network of social relationships that surrounds an individual and offers opportunities for the exchange of resources (Wasserman and Faust 1994). For instance, educators may be embedded in multiple networks from which they derive resources such as advice around instruction, instructional materials, new ideas, or social support (Moolenaar et al. 2012). Network members that have more central network positions will likely have greater opportunities to quickly access and receive social resources such as new ideas and practices (Lin 2009). A closely connected network may facilitate the access and timing of information flow of social resources across the network (Coleman 1988; Inkpen and Tsang 2005; Smylie and Hart 1999). Studies suggest that social ties between educators may support innovation, as they offer channels, both incoming and outgoing, for resources to be moved (Coburn and Russell 2008; Coburn et al. 2012; Frank et al. 2004; Moolenaar 2012; Penuel et al. 2012). As such, we hypothesize that educators' structural social capital (i.e., network position) is positively associated with their perceptions of innovative climate (Hypothesis 2).

Finally, we argue that the relationship between network intentionality (cognitive social capital) and perceptions of innovative climate is mediated by the extent to which educators actually are engaged in social relationships and occupy a central position in their school's network (structural social capital). In other words, we suggest that educators who are intentional in shaping their social network are more likely to perceive their environment to be innovative, in part because educators who are more intentional in shaping their network also have greater access to social contacts with which innovative ideas and resources are exchanged. Research suggests that individuals with greater ability to actively make and sustain relations are perhaps in a better position to access unique information and make meaningful connections, which is critical in supporting an innovative climate (Burt 2005; Felicio et al. 2009). Therefore, understanding network intentionality (cognitive social capital) may be important in understanding the degree to which one engages in social relationships (structural social capital), and has an orientation towards sustaining an innovative climate. Yet, this assumption has not been empirically tested.

Building on the available literature base on the relationships between structural and cognitive social capital and innovation, we cautiously assume directionality in the relationships between network intentionality, network position, and perceptions of innovative climate. For instance, research has suggested that a strategic orientation towards connecting others may lead to involvement in innovation,

thereby implying a causal relationship between network intentions, network position, and innovation (Nonaka and Takeuchi 1995; Obstfeld 2005; Uzzi 1997). A different relationship between network intentionality, network position, and perceptions of innovative climate may also be plausible. For instance, perceptions of an innovative school climate may shape educators' intentions to connect with others, which in turn may affect their position in the school's social network, and by virtue of this access to resources, their perceptions of their school's innovative climate may change, providing opportunities for new interactions and intentions. In this first exploration of these relationships, we test the hypothesis that network intentionality affects educators' perceptions of an innovative climate by shaping opportunities for educators to exchange new ideas and resources. The aim of our study is not to test the causality of this assumption, but rather to contribute to theoretical advancement in examining whether such relationships among network intentions, position, and innovation as proposed in other fields of study also can be found in our sample of high-performing charter schools. As such, caution should be exercised in regard to the causal interpretation of our findings.

In sum, we argue that when educators intentionally shape their social network (e.g., by explicitly seeking out others or connecting people), this will be associated with greater access to social resources (e.g., occupying a more central network position). This social network position will in turn be related to educators' perceptions of their school's innovative climate. As such, we hypothesize that educators' structural social capital (network position) mediates the relationship between cognitive social capital (network intentionality) and perceptions of innovative climate (Hypothesis 3). We have graphically represented our conceptual model and the hypothesized relationships in Fig. 1.

Method

Context

We used an instructive case study design to examine networks and innovative climate among educators in 11 schools in a high-performing CMO. A case study approach is most appropriate when the phenomenon of interest has a level of complexity that requires multiple data sources to gain an in-depth understanding (Yin 2003). This study takes place in a high-performing CMO located in Southern California USA. Charter schools in the US are publicly funded schools that are typically considered schools of choice founded by parents, teachers, management groups, or other citizens. These schools do not have to follow many of the regulations and statutes that apply to schools run by local public school districts. In exchange for this autonomy the charter school must explicitly indicate accountability measures for producing certain results and be responsive to a charter board. This approach has been promoted as a solution to the "failures" of public education in the United States (Betts and Atkinson 2012). Given this perception, the number of public charter schools and CMOs has grown tremendously over the last decade, mostly due to growing dissatisfaction with achievement levels at public schools as

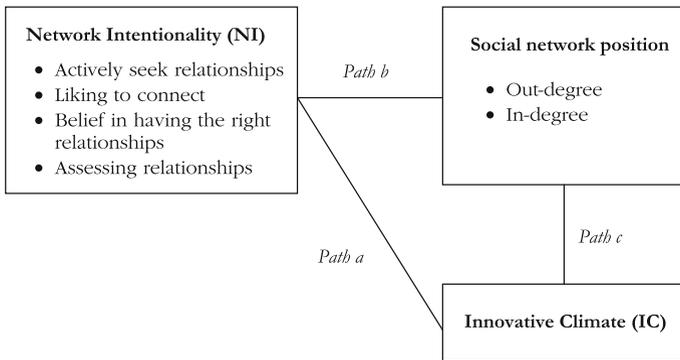


Fig. 1 Path diagram of hypothesized mediation

well as emphasis on more “community control” to innovate and provide diverse approaches to pedagogy (Lubienski and Weitzel 2011). These schools, like their district school cousins, are under pressure to deliver academic results for all student populations, and traditionally marginalized students in particular.

The most impressive student outcomes from some CMOs have to do with post-secondary entry and retention. The National Student Clearinghouse data from 2011 indicated that 77 % of alumni from the CMO schools in this study are still enrolled or have graduated from a post-secondary institution, with 35 % of the college graduates earning degrees in science, technology, engineering, or mathematics (STEM). By way of comparison, fewer than 30 %¹ of adults in their 20 s in California have a college degree according to data from the US Census Bureau and only 17 %² of college students earn degrees in the STEM fields. Clearinghouse data also showed that among the CMO graduates, 69 % of the first generation students (first in their families to go to college), 67 % of the students who qualified for the National School Lunch Program, 69 % of African American and Hispanic students, and 73 % of students with special needs have graduated from university or are still enrolled in higher education.

It is in this context of the growing number of charter schools that we examine one high-performing CMO in Southern California. We purposely selected this CMO as it seems to be outperforming similar schools by a number of measures such as the Academic Performance Index (API)³ and post-secondary outcomes. In addition, the system stimulates innovative practices through teacher collaboration and professional community, which is a growing approach in a number of reform efforts. The CMO in which this study takes place is internationally regarded for its focus on teacher collaboration, innovation, and problem based learning, and for serving a diverse and integrated student population. Beginning with one high school in

¹ <http://chronicle.com/article/Adults-With-College-Degrees-in/125995>.

² <http://www.fas.org/sgp/crs/misc/RL33434.pdf>.

³ API is a California state measure of a school’s academic performance on a scale of 200-1000 with 800 as a target of minimum desired performance.

Table 1 Sample: school characteristics (n = 11)

	Mean	Range
Number of students	425	328–612
Years of operation	6 years	1–12
Academic performance index ^a	811	763–866
Survey response rates (%)	83	79–100
Student ethnicity		
Latino (%)	39	21–64
White (%)	33	9–62
Asian (%)	12	9–18
African American (%)	10	4–15
Other (%)	5	2–6
Free/reduced lunch (%)	39	23–49
English language learners (%)	7	2–19
Special education (%)	12	8–17

^a Retrieved from California Department of Education, 2011–2012 school year

September 2000, the organization now operates five small high schools, four middle schools, and two elementary schools, serving over 4,700 students in a large Southern California county.

Students are admitted by a zip code based lottery so as to reflect the demographics of the county at large. Students are not tracked or streamed by perceived academic ability at any of the CMO schools. All students use technology to engage in scientific, mathematical, literary, historical, and artistic pursuits. This technical-academic integration extends to the broader community: all students engage in various kinds of field study, and all high school students must complete junior-year internships in local businesses or non-profit organizations. Assessment is performance-based, as students identify problems, develop projects, and share their work with public audiences.

This particular CMO is highly ranked (among the top ten) on state level academic measures (see Table 1). Beyond having post secondary success and retention, the CMO's design principles—personalization, adult world connection, common intellectual mission, and teacher as designer—can be considered innovative as they signal a departure from conventional high school structures and practices. The organization pays particular attention to its adult culture, with several organizational structures supporting the principle of the teacher as designer. Teachers work in teams to design interdisciplinary projects and serve the same cohort of students. All teachers arrive at school an hour before the students each day to tune projects, look at student work, and address school issues in teaching teams, academic departments, action groups, and the faculty as a whole. CMO teachers have agency to shape the vision and direction of the school and engage regularly in shared decision-making. The organization runs its own teacher credentialing program, as well as a graduate school of education embedded in the K-12 environment offering masters degrees in Teacher Leadership and School Leadership, providing educators within the CMO (and beyond) further opportunities for professional growth and collaboration.

Table 2 Sample: educator characteristics

<i>Gender</i>	
Male	96 (34.5 %)
Female	182 (65.5 %)
<i>Ethnicity</i>	
Afro-American or black	9 (3.2 %)
Asian/Asian-American	22 (7.9 %)
Latino	25 (9.0 %)
Caucasian or white	192 (69.1 %)
Biracial/multiracial	17 (6.1 %)
Other/unknown	13 (4.7 %)
<i>Role</i>	
Academic coach	21 (7.6 %)
College advisor	4 (1.4 %)
Dean	3 (1.1 %)
Director	11 (4.0 %)
Resource/inclusion specialist	17 (6.1 %)
Teacher	214 (77.0 %)
Other	8 (2.8 %)
<i>Years of experience at the school</i>	
0–1 years	88 (31.7 %)
2–3 years	82 (29.5 %)
4–12 years	103 (37.1 %)
Unknown	5 (1.8 %)
<i>Years of experience in current role</i>	
0–1 years	104 (37.4 %)
2–3 years	87 (31.3 %)
4–12 years	81 (29.1 %)
Unknown	6 (2.2 %)
<i>Years of experience as an educator</i>	
0–3 years	72 (25.9 %)
4–6 years	61 (21.9 %)
7–10 years	70 (25.2 %)
>10 years	68 (24.5 %)
Unknown	7 (2.5 %)

N = 278, n = 11

In sum, this CMO is a good instructive case for our study as apparently it is successful in achieving high student performance through innovative practices. However, as this CMO was purposefully selected, it also means that this CMO offers a case that may not be easily generalizable to other CMOs or more conventional schools, who may be less high-performing and have a less explicit focus on innovation through teacher collaboration. Therefore, the results of this study should be interpreted in the context of our specific sample, a set of high-

performing charter schools that aim to achieve high student performance in a diverse population through employing a range of innovative practices.

A total of 278 educators participated in the study by completing a survey on demographics, network intentionality, social networks, and innovative climate reflecting an overall study response rate of 83 %. Table 1 provides characteristics of the 11 sample schools from the Charter Management Organization (e.g., years of operation, number of students, API, response rates, students’ SES, and students’ ethnicity). In addition, Table 2 includes sample demographics of the 278 educators who participated in the study (e.g., gender, ethnicity, role, and years of experience).

Instruments

Background demographics

We collected school, student, and educator demographic characteristics that were controlled for in the analyses. At the school level, we included students’ SES (% receiving free/reduced lunch), ethnicity, English Language learners (%), and Special Education students (%). We also controlled for school size (number of students), the number of years that the schools had been operating at the time of the study, API at the time of the study, response rate, and average experience of educators as an educator, at the school, and in their current role. At the educator level, we included educators’ gender, ethnicity, current role (teacher/other), and years of experience as an educator, at the school, and in their current role (See Tables 1, 2).

Dependent variable: Innovative climate (IC)

The innovative climate scale was composed of four items, based on earlier research on an orientation to improve, that were modified to fit the charter context (Bryk et al. 1999; Consortium on Chicago School Research 2004). Principal component analysis (PCA) confirmed that the four items loaded highly on a single factor explaining 61.4 % of the variance with sufficient scale reliability ($\alpha = .78$) (see Table 3).

Independent variable: Cognitive social capital—network intentionality (NI)

We used a Network Intentionality scale (on a five-point Likert scale ranging from 1 = strongly disagree to 5 = strongly agree) developed for earlier research (Cohen

Table 3 Innovative climate items and factor loadings

Item	Factor loadings
<i>Innovative climate (a = .78)</i>	
1. Taking constructive action to address issues at my school	.87
2. Promoting and championing new ideas to others	.82
3. Helping colleagues at my school address dilemmas in their work	.75
4. Coming up with new ideas to improve my practice	.67

N = 278

Table 4 Network intentionality items and factor loadings

Item	I	II	III	IV
<i>Network intentionality</i> ($\alpha = .84$)				
Actively seeking relationships ($\alpha = .82$)				
I actively seek new friendships across the organization	.90	.36	.15	.23
I actively seek out professional relationships across the organization	.81	.44	.04	.34
I actively search out new relationships with people who can help me improve my teaching	.76	.42	.17	.33
I actively search out new friendships within the school	.73	.30	.28	.14
Liking to connect ($\alpha = .78$)				
I like to be a source of advice and counsel for many others	.32	.85	.17	.26
I like to be the major point of connection between others in the organization	.42	.82	.16	.35
I like to have many others to turn to for advice and assistance	.31	.71	.36	-.02
I like to put people in touch with the right person when they need something	.39	.69	.08	.26
Belief in having the right relationships ($\alpha = .78$)				
Having the right set of relationships and connections with other staff in the school can be useful in helping me teach better	.13	.16	.87	.06
Having the right set of relationships and connections with other staff in the school can be useful for my general happiness	.20	.85	.82	.01
Having the right set of relationships and connections with other staff in the school can be useful in helping me put forth and champion ideas for change	.22	.21	.80	.21
Assessing relationships ($\alpha = .73$)				
I actively plan out what I want my network to look like	.39	.30	.09	.82
I make assessments about who would be useful to have as an ally and who wouldn't	.09	.23	.05	.80
I periodically evaluate the nature of my connections and networks within the school	.44	.25	.20	.77

N = 278

et al. 2011). The NI scale evaluated the degree to which an individual “intends” to create, broker, maintain, and assess social relationships using four dimensions: (1) actively seeking relationships, (2) liking to connect, (3) the belief in having the right relationships, and (4) assessing relationships. PCA confirmed that the scales together explained 66.3 % of the variance, with a sufficient overall scale reliability ($\alpha = .84$) (see Table 4).

Independent variable: Structural social capital—social network position

To gain insight in the social network for innovation, educators were asked to respond to the following prompt: “With whom do you share new ideas about teaching and learning?” (Cornelissen et al. 2013a; Moolenaar et al. 2012). For each educator we calculated two measures that reflect the centrality of his/her network position: out-degree (the number of people with whom the educator indicates to *share new ideas*) and in-degree (the number of people that identify the educator as someone with whom they *share new ideas*) (cf. Borgatti et al. 1998; Wasserman and

Faust 1994). We used UCINET 6.0 (Borgatti et al. 2002) to analyze and normalize these network measures to facilitate comparisons across schools.

Analysis strategy

Regression analysis

Although the data have been collected within a nested dataset (educators within schools), the intra class correlation for Innovative Climate (IC) was lower than 0.05 ($p < .001$), suggesting that there is no significant school-level variance for the scale of Innovative Climate. As such, this suggests the use of regression analyses to investigate the relationships between Network Intentionality, social network position, and educators' perceptions of Innovative Climate. While causality of the proposed relationships is suggested by the literature, our methods were not intended to validate the causal nature of these relationships. Therefore, the results of our regression analyses should be interpreted in light of this caution towards causal interpretation of the findings, and additional research with longitudinal or experimental designs may be more suited to answer the question of causality. In contrast, we aimed to provide a first exploration of the relationships among the study variables in this unique sample to contribute to conceptual understanding of the role of social relationships in innovative climates in charter schools.

Testing the hypotheses

The proposed hypotheses were tested through a four-step process. First, we examined correlations to analyze the relationships among the study variables. Second, we studied the relationship between demographic variables and Network Intentionality (NI), social network position, and perceptions of Innovative Climate (IC). Third, we conducted regression analyses to test the relationship among NI, social network position, and IC (Hypotheses 1 and 2). Finally, we tested the mediating role of social network position in the relationship between NI and IC (Hypothesis 3).

According to Baron and Kenny (1986), four conditions must be met to support the mediation hypothesis (see Fig. 1 for a path diagram of the hypothesized relationships under study): (1) a significant relationship between network intentionality (NI) and innovative climate (IC) (Path *a* in Fig. 1, addressed by Hypothesis 1); (2) a significant relationship between NI and social network position (Path *b*); (3) a significant relationship between social network position and IC (Path *c*, addressed by Hypothesis 2) while “fixing” the role of network intentionality. Mediation is indicated when the relationship between the independent and dependent variable (NI \Rightarrow IC, Path *a*) is either zero (full mediation) or reduces significantly in absolute size (partial mediation) after adding the mediating variable (social network position) (addressed by Hypothesis 3) (Pearl 2000). Following Krull and MacKinnon (2001) we calculated the size of the mediated effect by multiplying the estimate for Path *b* by the estimate for Path *c* while “fixing” the effect of

network intentionality. The significance of the mediated effect was evaluated by calculating Sobel's test (1982).⁴

Results

Descriptive analysis

Mean scores for the main study variables are provided in Table 5. In a separate school level analysis (not reported here), none of the student and school level demographic variables included in the study were found to be associated with any of the study variables. Therefore, these control variables were excluded from further analysis. Of the educator demographic variables, only years of experience as an educator and educators' role (teacher/other) were found to be associated with study variables and were therefore retained in further analyses.

Correlation analyses (see Table 6) indicate that experience as an educator correlated positively with educators' preference for connecting disconnected others ("liking to connect", $r = .17, p < .01$), indicating that more experienced educators liked to 'broker' slightly more than less experienced educators. In addition, years of experience is positively related to the extent to which educators reach out to others to share new ideas (out-degree, $r = .19, p < .01$), reflecting that more experienced educators were more often seeking out others to share new ideas than less experienced educators. In addition, more experienced educators tended to perceive their school's climate to be slightly more innovative than less experienced educators ($r = .22, p < .01$).

Furthermore, findings suggest that teachers are more intentional in liking to connect others than educators in other roles ($r = -.16, p < .01$). In addition, teacher role was correlated with out-degree ($r = -.12, p < .05$) and in-degree ($r = .19, p < .01$), suggesting that educators in other roles (such as dean, director, and coach) tend to reach out less, but are sought more often, to share new ideas than teachers.

The correlation analyses also yield information on the intra-scale correlations for NI. The NI subscales are found to be low to moderately correlated ($r = .19$ to $r = .49, p < .01$). The social network measures are moderately correlated ($r = .35, p < .01$). Moreover, the analyses render insights in the correlations between NI, the social network measures, and the dependent variable IC. The NI subscales are unrelated to moderately correlated to the measures of network position (in-degree

⁴ It is an important methodological point to note that when conducting regressions using network measures, violations to the basic assumption of independence underlying regression analysis may occur (see Kenny et al. 1998). Since individuals in a social network are by definition interdependent, the measures assessing educators' social network position cannot be considered independent, which may pose an issue of multicollinearity. While multicollinearity does not affect the predictive power of the model as a whole, it may inflate the standard errors of the individual predictors. We checked whether multicollinearity formed a serious threat to the stability of our findings by rerunning the models on different subsets of the data (by alternatively excluding out-degree and in-degree) and found that the results remained largely unchanged across all models. Moreover, we checked the Variance Inflation Factors (VIF) for all variables included in Model 3, which varied between 1.06 and 1.53. As such, and in combination with the substantial size of our dataset, we may assume that multicollinearity did not pose a significant threat to the robustness of our findings.

Table 5 Descriptive statistics for study variables

	N	Min.	Max.	M	SD
<i>Network intentionality</i>					
Actively seeking relationships	278	1.00	5.00	3.36	0.80
Liking to connect	278	1.50	5.00	3.84	0.67
Belief in having right relationships	278	3.00	5.00	4.67	0.46
Assessing relationships	278	1.00	5.00	3.02	0.87
<i>Network position</i>					
Out-degree	278	0.00	100.00	39.4	24.5
In-degree	278	0.00	75.00	36.3	13.7
Innovative climate	278	1.75	5.00	3.93	0.72

N = 278, n = 11

Table 6 Correlations

	1b	2a	2b	2c	2d	3a	3b	4
1 Educator demographics								
1a Years of experience as an educator	.03	-.03	.17**	.02	-.01	.19**	.03	.22**
1b Educator role (teacher/other) ^a		-.09	-.16**	.04	-.10	-.12*	.19**	-.02
2 Network intentionality								
2a Actively seeking relationships			.49**	.22**	.40**	.22**	.08	.42**
2b Liking to connect				.30**	.38**	.30**	.14*	.49**
2c Belief in having right relationships					.19**	.22**	.21**	.24**
2d Assessing relationships						.12	.07	.32**
3 Network position								
3a Out-degree						-	.35**	.31**
3b In-degree							-	.18**
4 Innovative climate								

** $p < .01$; * $p < .05$

^a Point-biserial correlation

and out-degree, $r = .08$, *ns*, to $r = .30$, $p < .01$) and educators' perceptions of innovative climate ($r = .24$ to $.49$, $p < .01$). The extent to which educators occupy central network positions is moderately related to IC (out-degree $r = .18$, $p < .01$ and in-degree $r = .31$, $p < .01$).

The role of background demographics

Regression results mirror the correlational findings, indicating that educators' years of experience was positively and significantly correlated to their perception of their

Table 7 Regression analysis: the relationship between innovative climate and network intentionality (Hyp. 1, Path a) and social network position (Hyp. 2, Path c)

	Model 1			Model 2			Model 3		
	B	SE	β	B	SE	β	B	SE	β
Intercept	0.880	.403		3.166	.160		0.989	.402	
Years of experience as an educator	.107	.033	.170***	.104	.037	.164**	.095	.033	.151**
Educator role (teacher vs. other)	.100	.089	.057	.023	.103	.013	.106	.092	.061
Network intentionality									
Actively seeking relationships	.202	.054	.227***				.191	.054	.214**
Liking to connect	.307	.067	.288***				.277	.067	.260**
Belief in having right relationships	.121	.085	.076				.081	.086	.051
Assessing relationships	.090	.049	.106[#]				.091	.048	.107[#]
Network position									
Out-degree				.007	.002	.250***	.004	.002	.116*
In-degree				.005	.003	.097	.003	.003	.062

Model with only Years of experience as an educator and Educators' role: $R^2 = .047$, $F(2) = 6.54$, $p < .01$

Model 1: $R^2 = .323$, $F(6) = 20.96$, $p < .001$

Model 2: $R^2 = .133$, $F(4) = 10.16$, $p < .001$

Model 3: $R^2 = .342$, $F(8) = 17.03$, $p < .001$

Difference between Model 1 and Model 3; $R^2_{\text{change}} = .020$, $F_{\text{change}}(2, 262) = 3.88$, $p < .05$

Difference between Model 2 and Model 3; $R^2_{\text{change}} = .210$, $F_{\text{change}}(4, 262) = 20.87$, $p < .001$

*** $p < .001$; ** $p < .01$; * $p < .05$; [#] $p = .06$

school's innovative climate (see Table 7, $\beta = .151$ to $.170$, $p < .01$), meaning that more experienced educators are more likely to perceive an innovative climate in their school. In contrast, educators' role was found to be unrelated to IC (See Table 7, $\beta = .013$ to $.061$, *ns*). The findings also suggest a significant positive association between educators' years of experience and out-degree (See Table 8, $\beta = .169$, $p < .01$), indicating that educators with more years of experience tend to reach out to others more to share ideas. In addition, we find a negative relationship between educators' role and out-degree ($\beta = -.125$, $p < .05$), as well as a positive relationship between educators' role and in-degree ($\beta = .172$, $p < .01$), suggesting that teachers tend to seek more new ideas from others, whereas educators in non-teaching roles are more often sought for the exchange of new ideas, thus potentially signaling a pattern in which teachers seek out educators in other roles, such as deans, directors, and coaches.

The relationship between intentionality and innovative climate (H1, Path a)

Regression results indicate that the more educators are intentional about shaping their networks, the more they perceive their school's climate to be innovative (see

Table 8 Regression analysis: the relationship between network intentionality and social network position (Hyp. 3, Path b)

	Out-degree			In-degree		
	B	SE	β	B	SE	β
Intercept	-31.949	15.319		-.058	8.894	
Years of experience as an educator	3.642	1.250	.169**	-.078	.726	-.007
Educator role (teacher vs. other)	-7.425	3.395	-.125*	5.664	1.971	.172**
Network intentionality						
Actively seek relationships	3.337	2.072	.110	.031	1.203	.002
Liking to connect	6.343	2.547	.175*	2.721	1.479	.135[#]
Belief in having right relationships	7.053	3.240	.130*	4.780	1.881	.159*
Assessing relationships	-.127	1.850	-.004	-.130	1.074	-.008

Model Out-degree: $R^2 = .16$, $F(6) = 8.24$, $p < .001$

Model In-degree: $R^2 = .08$, $F(6) = 3.82$, $p < .001$

** $p < .01$; * $p < .05$; [#] $p = .06$

Table 7, Model 1). When we examine the subscales that constitute network intentionality, findings suggest that mainly the intention to actively seek out relationships ($\beta = .227$, $p < .001$), as well as liking to connect others that are themselves unconnected (‘brokering’) ($\beta = .288$, $p < .001$) are aspects of network intentionality that are associated with educator’s perceptions of innovative climate. In addition, we find an almost significant relationship between the NI subscale “Assessing relationships” and perceptions of IC ($\beta = .106$, $p = .06$), meaning that educators who tend to intentionally plan and periodically evaluate their relationships also perceive their school’s climate to be more innovative. As such, these findings suggest that increased perceptions of innovative climates in these charter schools are related to an intentional network orientation of the educators, thereby providing partial support for H1.

The relationship between network position and innovative climate (H2, Path c)

Consistent with H2, findings indicate that educators’ perceptions of IC are positively associated with the extent to which they seek others to share new ideas, as evidenced by a positive effect of out-degree (see Table 7, Model 2) ($\beta = .250$, $p < .001$). Counter to our expectations, however, we find that educators’ in-degree is unrelated to their perceptions of IC, as evidenced by a non-significant in-degree parameter ($\beta = .097$, *ns*). Meaning, the degree in which educators are being sought (‘popular’) to share new ideas is not related to their perceptions of their school’s innovative climate, thereby providing only partial support for H2 (See Table 7).

The relationship between intentionality and network position

As a next step towards examining our mediation hypothesis, we examine the relationship between network intentionality and network position (see Table 8;

Fig. 1). Results suggest that both out-degree and in-degree are related to two subscales of network intentionality. First, network position is related to Liking to connect (out-degree, $\beta = .175$, $p < .05$, and in-degree, $\beta = .135$, $p = .06$), suggesting that educators who like to connect others who are themselves unconnected ('brokers') also seek others, and are sought by others more, to share new ideas. Second, educators' network position is related to Belief in having the right relationships (out-degree, $\beta = .130$, $p < .05$, and in-degree, $\beta = .159$, $p < .05$), suggesting that educators who believe that having the right relationships is important, also seek others, and are sought by others more, to share new ideas. As such, the intentionality with which educators engage in networking is partially related to occupying a more central network position in the school's network around the exchange of new ideas.

Mediating role of educators' position in the relationship between intentionality and innovative climate (H3, Path b)

Finally, we examine the regression model in which we test the relationships between Intentionality, Network position, and Innovative Climate (Table 7, Model 3). Results show that the relationships as described earlier are replicated (i.e., IC is significantly and positively related to three NI subscales and out-degree). As our previous analysis suggests that in-degree is unrelated to IC, preconditions for mediation by this variable are not met. Therefore, a test of mediation is limited to potential mediation by educators' out-degree. Results show that out-degree mediates the relationship between the NI subscale Liking to connect and IC (reducing its parameter from $\beta = .288$ to $\beta = .260$, $p < .001$, see Table 7). The partial mediating effect is small but significant as evidenced by Sobel's test ($\beta = .020$, Sobel test statistic = 1.67, $p < .05$). This suggests that, although this mediating effect is small, the relationship between network intentionality and perceptions of an IC can be in part explained by the extent to which educators actually reach out to others to share ideas. In other words, educators who are more intentional about brokering connections between others, also tend to share new ideas with more others, and in turn perceive their school's climate to be more innovative.

Discussion and significance

Our study examined the relationship between cognitive and structural social capital and perceptions of innovative climate with a sample of educators in a high-performing CMO. We empirically investigated educators' "intentionality" to create, broker, maintain, and assess ties, and related these network intentions with network position and perceptions of innovative climate. Results indicate that network intentions (as cognitive social capital) are associated with educators' perceptions of their school's innovative climate. In specific, educators who perceive the climate as more innovative are more intentional about their network by actively seeking relationships and liking to connect disconnected others ('brokering'). They also tend to believe that relationships are important. Further, we found that

educators who perceive the climate to be more innovative also reach out to more others to exchange new ideas (structural social capital). We will now discuss three key themes that emerge from these findings and may yield suggestions for practice and research.

Linked to innovation

Both educators' network intentionality as well as educators' network position (reaching out to share new ideas with others) are related to educators' perceptions of innovative climate. These findings support existing research that underlines the importance of teacher collaboration for innovation (Bryk and Schneider 2002; Slegers et al. 2013), and more specifically, educators' network position (structural social capital) for perceptions of innovation (Coburn et al. 2012; Moolenaar et al. 2011a) and actual innovations (Frank et al. 2004). Moreover, it extends current literature on cognitive social capital by suggesting that an individual's intentionality to create, broker, maintain, and assess ties is related to not only the structure of the network, but also perceptions of innovative climate. Individuals who "like" to connect others and broker ideas between otherwise disconnected actors tend to reach out to others more, as well as perceive a higher degree of innovative climate. Perhaps this "outward" orientation in actively connecting to others reinforces one's willingness to seek out others to share, promote and advocate for new ideas, a core aspect of innovative climates in schools.

Together, our results highlight the importance of attending to both the cognitive and structural elements of social capital for educators' perceptions of innovative climate. As such, these data would suggest that if organizations aim to cultivate an "innovative climate," it will be critical to find ways to support educators' network intentions as well as "seeking" behaviors. Interestingly, seeking behaviors—those where educators are reaching out to colleagues for new ideas and advice about their practice—seem to matter more than being sought in terms of people's perceptions of innovative climate. Those who "seek" tend to perceive their school's climate to be more open toward innovation, while those who are "being sought" do not necessarily perceive their school's climate to be innovative. This is perhaps not surprising given that seeking behavior could be viewed as an active orientation toward the environment, whereas waiting to be sought for the sharing of new ideas could be construed as more passive and rather a measure of network "popularity" than "activity" (Wasserman and Faust 1994). Given that an innovative climate is one in which people are taking risks and trying new approaches, it may suggest that increased perceptions of innovative climate also reflect a more active process involving greater teacher agency, and thus are more strongly related with "seeking" new ideas than "being sought" for new ideas (Moolenaar et al. 2011a). In addition, this finding may also in part be explained by the fact that the scale we used to measure innovative climate included mostly out-degree or "seeking" oriented behaviors like taking constructive action and promoting new ideas.

Linking structural and cognitive social capital

In addition, our work also suggests that an educator's intentions to seek new ideas (i.e., cognitive social capital) are actually related to educators becoming more central in the "sharing new ideas" network (i.e., structural social capital). Those educators who like to connect others in their networks also tend to share ideas with more colleagues than educators who reported less desire to connect others. In addition, our analyses revealed that the more educators believe that having the right relationships is important, the more they occupy a central position in their school's social networks by seeking out others, as well as being sought out, to share ideas. As such, through reaching out to others and believing in the importance of social relationships, an educator has the possibility to become influential in the network and may end up having disproportionate influence over the system in terms of vision, ideas, and strategies related to an innovative climate.

These findings are consequential as they demonstrate the interplay between cognitive and structural social capital. Current research using a social capital perspective mainly focuses on a structural approach to social capital by examining patterns of interactions among educators while overlooking the significance of cognitive processes in understanding patterns of social relationships (Moolenaar et al. 2013). Our results suggest that if educators take active control over shaping their networks, this may also increase the actual transfer of new ideas and knowledge. School organizations may therefore be advised to support and stimulate educators' network intentions as a strategy to enhance collaboration and the exchange of new ideas. This finding builds on and extends literature on network awareness (e.g., Baker-Doyle 2011; Cross and Parker 2004; Gutwin and Greenberg 2004) to go a step further and argue that not only is the awareness of one's network important for gaining access to new ideas, but so are the intentions with which one actively shapes one's network.

Given that the relationships under study may also be considered to be mutual or circular, there is perhaps also a multiplicative influence. For example, as individual educators work to shape their environment by creating new ties and capitalizing on existing relationships, new knowledge may spread across the system based on those individuals' actions. When these individual actions are multiplied across a system by a number of educators, even an entire school staff, our data would suggest this may have a profound influence on the perceptions of climate experienced by educators in that school in terms of coming up with new ideas to meet challenges and solve problems.

Limitations and implications

Although providing some unique insight, this work has limitations that suggest more study. A first limitation is posed by the extent to which our findings can be generalized to other settings. This study was conducted in a set of high-performing charter schools that was purposely selected for its focus on innovative practices stimulated through teacher collaboration and teamwork, which may have affected the study's findings. Given this focus, the educators in our sample may have been more intentional in shaping their network, seeking out others to share new ideas, and

perceiving their schools to be more innovative than educators in other school settings. In this way, the larger organizational routines (Spillane 2006) appear to pervade all organizational procedures and policies, explicitly influencing aspects such as hiring, professional development, and the structure of the teacher's day. These routines may result in organizational structures that explicitly stimulate and promote building of relationships and seeking others, and the development of new ideas in ways that are not witnessed in more traditional settings (Cornelissen et al. 2013a). This of course also suggests the importance of organizational coherence and approaches that support the development of ties and the exchange of important relational resources such as collaboration, which in turn may facilitate perceptions of an innovative climate.

Moreover, while our findings resemble results from similar recent studies on social networks and innovation (Moolenaar and Slegers 2010; Moolenaar et al. 2011a; Obstfeld 2005), our sample consisted of a set of high-performing US charter schools, and as such our findings may not be generalizable to other countries and educational settings, including other charter schools. It would be interesting to extend this study to include a broader variety of charter schools, as well as to compare and contrast recent findings from various international contexts to explore potential cultural differences in relation to the influence of social network structure on educational change.

Second, causality between the relationships under study was supported by suggestions and evidence from reviewed literature. However, our research design was not aimed at assessing the causality of the relationships under study. Readers should proceed with caution when inferring causal conclusions from our findings. In future empirical studies more attention should be given to the examination of causality, for instance, by complementing quantitative data with data from in-depth qualitative research as well as examining the hypothesized relationships in a longitudinal framework. In contrast to the cross-sectional nature of our data, social networks are dynamic and change over time (Kilduff and Tsai 2003). Therefore, longitudinal studies are needed to enhance our understanding of the dynamic exchange of different types of content in social networks, the implementation of change strategies, and resulting outcomes over time.

Regardless of our particular sample of high-performing charter schools with an explicit focus on collaboration and innovation, these results make a unique contribution to the existing body of literature and suggest two possible pathways to supporting innovative climates in charter schools. First, systems may intentionally seek out and hire individuals who want to actively reach out, and connect otherwise disconnected others ('brokering' new ideas). The schools in this study have a rigorous hiring process designed to identify teachers who are not only adept at their craft and reflective about their practice, but who also have the skills and dispositions for working effectively with others and building meaningful relationships. Most teachers within the organization work in teams and share a common group of students for the entire year. Within the organization, a teacher's success is determined not just by the work s/he does with students, but also her/his work with colleagues.

Second, our findings may suggest that systems may benefit when they are intentional about creating structures for collaboration and the exchange of

resources. The organization of the schools themselves, as reported on the CMO website, suggests multiple structures and practices that both support and encourage teachers to reach out to colleagues, in effect potentially allowing educators to craft their networks in ways that support instruction. In each of the schools studied, teachers meet an hour before school at least three times a week in various configurations to collaboratively design curricula, discuss student work, and work on school issues. The system also emphasizes peer observation and collegial coaching so that teachers can serve as resources to one another. This type of intentionality at the organizational level may also influence individuals' intentions and perceptions of the climate in which they work. However, as we found individual differences in network intentionality, network positions, and perceptions of innovative climate within these schools, this suggests that the interplay of both organizational routines as well as individual characteristics deserve further attention in future research (Cornelissen et al. 2013b).

By examining perceptions of innovative climate in a high-performing CMO, our work sheds light on a fast growing and understudied segment of the educational sector, charter schools. Many charter schools, like the schools studied here, serve populations of economically and linguistically diverse students, potentially providing promising contexts for the development of innovative climates that may improve student performance. Gaining a better understanding of such climates, and the adult networks that support them, is imperative for transforming our schools and improving outcomes for traditionally marginalized students.

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