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ABSTRACT

This exploratory study foregrounds the important, but often understudied social side of pre-service teacher development and its relation to teaching performance in one university-based teacher preparation program in the US. We examine the extent to which pre-service elementary teachers' social relationships and perceptions of peer trust and efficacy are associated with performance on a high stakes mathematics teaching assessment. Findings suggest that social and emotional support through close social ties, peer trust, and self-efficacy are significantly and positively associated with pre-service teachers' teaching performance. Our work further contributes to the development and discourse about teacher education in university-based teacher preparation programs.

Introduction

Across the globe and in the United States, governments and education policy-makers are demanding higher levels of accountability by evaluating the quality of teaching as linked to student learning outcomes. Countries and governing bodies expect educators to possess a wider variety of knowledge and skills to meet the twenty-first century trends and challenges (Greenhill and American Association of Colleges of Teacher Education [AACTE], 2010; Organisation for Economic Co-operation and Development [OECD], 2013). This increased accountability is placing additional pressure on both student-teachers (hereafter we use the term 'pre-service teachers') and teacher education programs.

Given the greater expectations for teachers, a number of studies and reports have raised concerns about several social and emotional factors resulting from these pressures, such as teacher (both pre-service and in-service) anxiety (Bursal & Paznokas, 2006), and low self-efficacy due to a lack of peer support (Organisation for Economic Co-operation and Development, 2014). For instance, the recent OECD report on teaching and learning

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indicates that over half of the teachers, reflecting 34 countries, report a sense of low self-efficacy in their work due to a lack of collaboration in their current school (Organisation for Economic Co-operation and Development, 2014). In addition, a recent survey report on US teacher preparation shows that less than two-thirds of pre-service teachers report being well prepared for classroom management and discipline, and even more report being anxious about meeting the diverse needs of students (Burke, 2010).

Although many teacher preparation programs prioritize an orientation toward performance-based trainings with a focus on test scores (Crowe, 2011; Greenhill and American Association of Colleges of Teacher Education, 2010), what has been often overlooked is the social and cognitive aspects of pre-service teachers, such as a safe and supportive environment conducive to collaborative sharing and experimenting as well as opportunities to develop increased efficacy (Jimenez-Silva, Olson, & Jimenez Hernandez, 2012). We argue that it may be the social and cognitive factors in teacher preparation which may influence the quality of pre-service teacher performance during their development (Trapp, 2010).

To date, much of the current work in pre-service teacher preparation programs in many countries, rightly so, focuses on the instructional and pedagogical development (e.g. Beyer & Davis, 2012; Wong, Chong, Choy, & Lim, 2012). However, fewer studies explore the social and cognitive conditions of pre-service teacher preparation in relation to their teaching performance (e.g. Bates, Latham, & Kim, 2011). We argue that social and cognitive factors do not supplant the importance of technical instructional skills, but rather supplement the development of these critical instructional skills. In this exploratory study, we test this argument by intentionally foregrounding social and cognitive factors, and backgrounding instructional skill sets. In doing so, we examine the degree to which social and cognitive conditions are related to the performance of pre-service teachers on a high-stakes mathematic teaching performance event. We draw on both the literature on social capital (social aspect) and self-efficacy (cognitive aspect) to serve as our framework in understanding the relationship between social and cognitive factors and pre-service teachers' performance. We believe that results from this work may be transferable to similar preparation settings as well as deepen our understanding of pre-service teachers' teaching performance in disciplines other than mathematics.

Theoretical framework

Social capital theory

Although policy-makers and researchers indicate social support as vital in improving pre-service teachers' professional practice (McCarthy & Youens, 2005; Steele, Brew, Rees, & Ibrahim-Khan, 2013), the research community offers little understanding as to the type and extent of social support necessary for better performance. To fill this gap, we draw on social capital theory as it addresses the structure and quality of interpersonal relationships from which social support may be developed. Social capital focuses on the relational resources that flow between and among individuals that can be leveraged for purposive actions, in this case, teaching performance. The concept of social capital is generally defined as the resources embedded in social networks that are formed by social relations which can be mobilized across the network to increase the likelihood of success (Burt, 1992; Daly, Moolenaar, Liou, Tuytens, & del Fresno, 2015; Lin, 2009). In this sense, it addresses two core dimensions of social capital: social network structure and relational trust (Nahapiet & Ghoshal, 1998).

Social network structure

Social network structure refers to the overall pattern of social relations between actors across a network (Wasserman & Faust, 1994). A social network consists of sets of actors and relational ties between actors that define the network (Wasserman & Faust, 1994). In general, network scholars posit that a closely connected network structure may facilitate and constrain the access and timing of information and the flow of social resources across a network (Burt, 1992; Inkpen & Tsang, 2005). Actors in a densely connected system may be able to more quickly access resources (Lin, 2009) as compared with a sparse network. While a dense network structure enables resources to efficiently travel across a network, this type of structure may also reinforce recourses that carry negative influence such as negative gossip, adversaries, and distrust (Grosser, Lopez-Kidwell, & Labianca, 2010). Network studies in education suggest that a closely connected network of advice-seeking relations enables teachers to work collaboratively to improve student performance (Daly, Der-Martirosian, Moolenaar, & Liou, 2014). Such networked collaboration allows teachers to access and exchange useful resources (e.g. instructional advice/materials) with their colleagues to improve their practices (Penuel, Sun, Frank, & Gallagher, 2012), which in turn may benefit the learning of their students (Çelik & Ekinci, 2012; Pil & Leana, 2009). Mounting research evidence supports the positive effect of professional collaboration on education outcomes (Çelik & Ekinci, 2012; Pil & Leana, 2009), and this may well be the case for pre-service teacher education (Klassen, Perry, & Frenzel, 2012).

Research on pre-service teacher education suggests that a cohort-based model, which fosters a collaborative learning environment from which positive social ties between and among pre-service teachers are formed, is valuable (Nobles, Dredger, & Gerheart, 2012). Pre-service teachers who are socially connected to their peers through collaborating on course projects and/or engaging in informal interpersonal communication with their peers (e.g. social networking) tend to have more opportunities to exchange and hone their instructional ideas and build relational ties for ongoing social support (Jensen, 2012; Steinbrecher & Hart, 2012). This line of research suggests a number of positive outcomes as a result of collaborative efforts particularly in virtual settings. Another line of research suggests the importance of face-to-face interactions that allow learners to engage in developing and exchanging more tacit and complex knowledge (Pearcy, 2009), providing emotional support to one another (Richards, Levin, & Hammer, 2011), and generating positive outcomes (Cakiroglu, 2012). Regardless of the type of interaction, be it virtual or face-to-face, it is likely the role of social and emotional support that plays a critical part in pre-service teachers' performance. It is with this important idea in mind that we examine the structure of pre-service teachers' social and emotional ties and its influence on teaching performance. We define actors as individual pre-service teachers and the network structure as the social and emotional support ties between these actors. Therefore, we hypothesize that *pre-service teachers who are closely connected with one another (closeness) in their support network will be associated with higher performance levels on a statewide mathematics teaching performance assessment* (Hypothesis 1).

Relational trust

Although the first aspect of social capital has to do with the quantity of ties and network structure, the second dimension of social capital, relational trust, addresses the quality of social ties between network members (Bryk & Schneider, 2002). A considerable amount

of research on social capital and social networks suggests that trust is an important adhesive that connects individual actors, as trust can influence the extent to which members are willing to exchange resources and information based on a certain level of risk (Bryk & Schneider, 2002; Liou & Daly, 2014). Research in the field of teacher education has identified several ways in which trust has positively impacted individual and collective performance, for example better communication and knowledge sharing (Curşeu, Janssen, & Raab, 2012), improved mentoring relationships between student-teachers and mentor teachers (Stanulis & Russell, 2000), a reduction in anxiety during learning processes (Spector, Burkett, & Steffen, 2002), and an increase in team collaboration (Forbes & Billet, 2012).

Despite these positive outcomes of trust in education in general, empirical studies around pre-service teacher preparation that focus on relational trust are rare. Most of the work in teacher education focuses on trust in the relationships between teacher preparation institutes and universities at the organizational level (Sutherland, Scanlon, & Sperring, 2005) and/or between student-teachers and their mentors (Stanulis & Russell, 2000). To our knowledge, little research has been done to explore the extent to which trusting relationships among and between pre-service teachers may support their own teaching and learning outcomes. Since a trusting relationship plays a critical role in facilitating the development of a more collaborative and supportive environment, which in turn may yield productive outcomes, trust appears an important condition for successful collaboration. Therefore, we hypothesize that *pre-service teachers who perceive trusting relationships with peers will be associated with higher performance levels on a statewide mathematics teaching performance assessment* (Hypothesis 2).

Self-efficacy

Self-efficacy is an intrapersonal disposition and it has to do with one's internal capacity for cognitive processes in learning development, which is critical and contextually specific to constructing knowledge and skills necessary for purposive outcomes (Siwatu, 2011). The concept of self-efficacy helps us understand how teachers' beliefs in their ability to perform tasks for specific goals may influence the outcomes of their actions (Bandura, 1995). In this sense, self-efficacy refers to one's judgment of whether one is capable of reaching specific goals within a certain period of time, not whether the actual skill sets are present (Bandura, 1995). As such, there is direct influence of one's cognitive beliefs on behavior (Bandura, 1995), meaning that an individual's performance may be dependent upon one's efficacy beliefs. In addition, self-efficacy is concerned with the role social context has in mediating one's approaches to goals, tasks, and challenges (Bandura, 1977). That is, an individual's efficacy is shaped through the interactions and reactions of others to observed experience and as such, social behaviors and cognitive processes are influenced by the interactions between situated experiences and self-perception. Supportive interactions with others can strengthen self-efficacy, and where opportunities for supportive interactions exist, it is more likely to impact personal performance; for example how long a person will persist with a task, and thus meet desired outcomes (Siwatu, 2011). Finally, supportive interactions that increase self-efficacy can potentially reduce one's sense of work-related anxiety (Good, 2009).

In education, researchers have shown that teachers' self-efficacy beliefs influence work-related stress and job satisfaction (Canrinus, Helms-Lorenz, Beijaard, Buitink, & Hofman, 2012; Klassen & Chiu, 2010) and professional commitment (Rots, Aelterman, Vlerick, & Vermeulen, 2007). Teachers who are less efficacious in managing their classroom may have

difficulties in regulating their work-related stress and may be more likely to leave the profession (Rots et al., 2007). On the contrary, teachers who perceive a stronger sense of efficacy are more likely to engage in positive teaching behaviors that may result in greater academic achievement of their students (Bates et al., 2011). However, greater levels of self-efficacy may also lead to a decrease in work performance due in part to complacency, underestimation of the complexity of task and resources necessary for completing the work (Vancouver, More, & Yoder, 2008). Another line of recent work examines teachers' self-efficacy and its relation to their performance in different subject areas, suggesting that teachers who perceived themselves to be more efficacious in a particular area of expertise were also more likely to obtain better outcomes in areas such as teaching and pedagogical change (Lee, Cawthon, & Dawson, 2013) and classroom management (Putman, 2012). Although this body of work provides insights into 'in-service' teacher efficacy and teaching performance, there remains a dearth of works that demonstrates the same for 'pre-service' teachers.

A few studies on pre-service teacher education suggest that pre-service teachers with higher self-efficacy beliefs tend to be more effective teachers (Bates et al., 2011; Leader-Janssen & Rankin-Erickson, 2013). For instance, a specific line of research on pre-service teachers in mathematics indicates a significant and positive relationship between pre-service teachers' self-efficacy in mathematics and their actual teaching of mathematics (Bates et al., 2011; Bursal & Paznokas, 2006), suggesting that those pre-service teachers with greater confidence in their ability to teach have a greater positive impact. In addition, the more efficacious a pre-service teacher perceives her- or himself in terms of teaching and managing a classroom, the more likely that s/he sees her/himself to be well prepared and able to integrate new learning and approaches (Anderson & Maninger, 2007), which results in more effective teaching behaviors (Putman, 2012). As such, pre-service teachers' self-efficacy is an important factor requiring further exploration. Given that pre-service teachers' efficacy may boost their teaching performance and that very few studies to date investigate this phenomenon in pre-service teacher education, we hypothesize that *pre-service teachers who report being more efficacious in their ability to teach will be associated with higher performance levels on a statewide mathematics teaching performance assessment* (Hypothesis 3).

Method

We undertook an exploratory case study (Yin, 2013) research design using multiple quantitative data sources to explore the case of pre-service teachers from a large public university in California that uses a cohort model of development. We purposely selected this program as a potentially instructive case given its standing at the national, state, and local levels in the US. In addition to being a nationally ranked program, it is recognized at the state and local level as having a rigorous credentialing process, which adds to its reputation as a well-regarded program (Greenberg, Walsh, & McKee, 2014). Over the course of the preparation program, graduates have consistently outperformed the state average in terms of certification scores and completion rates (Suckow & Purdue, 2015). As we have no formal relationship with the program in terms of teaching responsibility, supervisory duties, or evaluation, we have no conflict of interest in the research study. All participation was voluntary. During data collection, we also ensured confidentiality and anonymity for participants in an effort to limit vulnerability to risks. Our goal is to add to the limited

empirical base both in pre-service teacher education and in the social network literature regarding the interplay between social networks, peer trust, and self-efficacy in support of pre-service teacher performance.

Sample and procedure

The sample of this study includes 48 pre-service teachers enrolled in a fifth-year cohort-based elementary education program in a public university in California. The program aims to provide a learning environment that is safe, equitable, reflective, and intellectually challenging using a combination of innovative technology and research-based techniques. The pre-service teachers in the cohort attended all instructional methods courses and student teaching seminar meetings together. During the coursework, they were provided with various collaborative opportunities to engage in team-based hands-on instructional experiences in authentic laboratory situations as well as serve as teacher leaders in coordinating collective practices around major areas of teaching practice such as classroom management, interpersonal relations, curriculum development, and multi-cultural and -lingual education preparation. The pre-service teachers completed two field placements in local schools during the academic year, serving as part-time classroom assistants while completing methods courses prior to full-time student teaching. The program provides a fertile ground for a more in-depth understanding of the potential impacts of this intentional focus on collaboration, embedded within a rigorous program.

We administered an online survey to the 48 pre-service teachers asking them to report demographic information (e.g. Grade Point Average [GPA], Graduate Record Examination in verbal reasoning, gender, and ethnicity.), perceptions about peer trust and self-efficacy, and social network interactions. For the social network data, we asked the pre-service teachers to assess the frequency of interactions (from 1 = 'once in the past two months' to 4 = '1–2 times a week') regarding social and emotional support through a question prompt: '*Who do you turn to when you need someone to listen to your feelings and thoughts?*' Respondents were able to select names from a complete roster of their peers. Such bounded approach reduces measurement error, provides a more complete picture and more reliable results than generating a name list from people's memory (Scott, 2000). In addition, we collected outcomes using the pre-service teacher rubric scores on a performance assessment (The Performance Assessment for California Teachers [PACT]) of mathematics teaching event (TE). The PACT performance assessment, perception survey, and social network data were all collected during the spring of 2012, which allowed us to investigate whether pre-service teachers' social support relationships, perceived peer trust and efficacy were associated with mathematics teaching performance.

The PACT TE is a high stakes assessment that fulfills the Teaching Performance Assessment required for licensure in California. The TE consists of five integrated performance task categories (Planning, Instruction, Assessment, Reflection, and Academic Language) documenting segments of learning and demands of academic language in a given content area embedded within the pre-service teachers' student teaching field placement. Each category is based on a four-point rating scale ranging from level 1 (poor/low performance) to level 4 (advanced/high performance) measuring distinct teaching competences.[1] A rubric score of 2 indicates proficient practice at the novice level while a score of 4 represents competencies expected of a beginning first-year teacher. Teacher candidates must

Table 1. Sample characteristics.

	Frequency	Valid %
Gender		
Female	40	83.3
Male	8	16.7
Ethnicity		
1. African-American or Black	2	4.2
2. Asian/Pacific Islander	20	41.7
3. Latino	7	14.6
4. Native American/American Indian	2	4.2
5. Caucasian or White	13	27.1
6. Mix/Other	4	8.3
GPA		
1. 0.00-3.26	16	33.3
2. 3.27-3.52	16	33.3
3. 3.53+	16	33.3
Mathematics teaching score		
1. 0.00–2.50	15	31.3
2. 2.51–3.00	17	35.4
3. 3.01+	16	33.3

Note: $n = 48$.

pass all rubric categories in order to be recommended for a credential. Thus, this outcome is of importance to pre-service teachers as it is a significant measure that determines the awarding of a teaching credential.

A total of 48 pre-service teachers participated in the current study, reflecting a response rate of 96%. Of all the participants, 83% were females and 17% were males. The population consisted of 42% Asian American, 27% Caucasian or White, 15% Latino, 4% African American, 4% Native American, and 8% Other. More than half of the pre-service teachers had a GPA above 3. Demographic information on the study participants is provided in Table 1.

Measures

Dependent variable: pre-service teachers' mathematics teaching performance
We used the mean of 12 rubric scores from the PACT assessment of mathematics teaching as our dependent variable. We examined mathematics teaching performance because of the increased focus on Science, Technology, Engineering, and Mathematics education as a priority in teacher education (White House Office of Science and Technology Policy, 2014).[2]

Independent variables: support network
We collected social network data that reflects the social and emotional support a pre-service teacher reports to receive from peers by asking how frequently they interacted with another cohort member who listened to their feelings and thoughts. Data were then entered into UCINET 6 social network software (Borgatti, Everett, & Freeman, 2002) to generate network measures and analyze network data, for the calculation of Freeman (1979) closeness centrality. As we are interested in the degree of close connectedness a pre-service teacher has with peers, closeness centrality is well suited to provide not only the quantity (the amount of ties), but also the quality (the geodesic distance of ties between and among actors) of

these particular relationships. The closeness centrality measures how 'close' an actor is to the other actors in the social and emotional support network and how efficiently an actor can exchange emotional social support with other actors (Wasserman & Faust, 1994). 'Closeness' is defined by the notion of farness, or how many steps farther an actor is to and from other actors (Wasserman & Faust, 1994), with steps representing other actors. The farness centrality represents the expected time-until-arrival for support resources flowing through the network (Wasserman & Faust, 1994). The smaller the farness for an actor, the more closely connected that actor is to and from others. The closeness is the inverse value of farness and is presented in a normalized format that ranges between 0 and 100 and can be expressed as a percentage. The greater the closeness, the closer (i.e. the less far), and more 'efficiently' in a social network sense, an actor is able to receive and offer social and emotional support to others.

In this study, we examine the extent to which a pre-service teacher's support ties to and from other peers are associated with his/her mathematics teaching performance, which reflects a directional network containing both incoming and outgoing ties. As such the closeness measure can be divided into incloseness and outcloseness. *Incloseness* of an actor n_1 is the proportion of the number of shortest distances/paths required for other individuals to access actor n_1 in a directed network. *Outcloseness* of actor n_1 is the proportion of shortest distances/paths required for actor n_1 to reach other actors in a directed network. For instance, an incloseness of 3.9, in our case, refers to that on average a pre-service teacher is quickly sought by about 4% of his/her peers for social and emotional support. In this manner, we may regard the incloseness of an actor as an index of how efficiently an actor is sought for support from others (providing support) and the outcloseness as an index of how efficiently an actor reaches out to others for support (seeking support).

Independent variables: peer trust

We assessed the relational trust among the pre-service teachers through a modified and previously validated trust scale (Hoy & Tschannen-Moran, 2003). Participants were asked to respond to each of the 10 trust items on a nine-point Likert scale, ranging from 1 'Very strongly disagree' to 9 'Very strongly agree.' Principal component analysis (PCA) on the 10 trust survey items using varimax rotation yielded a single-factor solution. Items that had a communality of less than .50 were removed. The 10 original items were then reduced to a scale of 6 items that explained 74% of the variance with factor loadings ranging from .78 to .92 (α = .92). Table 2 provides the factor coefficients of peer trust.

Independent variables: self-efficacy

We drew upon the Teacher Efficacy Scale used in previous work (Tschannen-Moran & Hoy, 2001) that examined the perceptions of self-efficacy for instructional improvement, which allows us to capture perceptions of individual efficacy about instructional practice. As research literature suggest a strong indicator of pre-service teachers' efficacy beliefs about managing classroom and student behaviors on teaching performance, we further modified the efficacy scale to address this research inquiry and the study context. The self-efficacy scale comprised of three items based on a nine-point Likert scale ranging from 1 'Not at all' to 9 'Always.' PCA with varimax rotation yielded a single-factor solution with factor loadings ranging from .61 to .88 (α = .75), which accounted for 67% of the variance (Table 2 for factor coefficients).

Table 2. Factor loadings for peer trust and self-efficacy scales.

Items	Factor loading
Peer trust (α = .92)	
Even in difficult situations, I can depend on my classmates.	.92
I can always count on my classmates.	.90
I trust my classmates.	.88
I find that my classmates are open to me.	.84
I really care about my classmates.	.81
I also share personal information with my classmates.	.78
Self-efficacy (α = .75)	
How much can you assist families in helping their children do well in school?	.85
How well can you provide an alternative explanation or example when students are confused?	.82
How well can you implement alternative teaching strategies in your classroom?	.79

Note: $n = 48$.

Control variables: demographics

We controlled for demographic information such as individual pre-service teachers' GPA as the performance may be explained by a successful undergraduate experience (D'Agostino & Powers, 2008).

Analysis

We used descriptive and inferential statistics to test our hypothesis. We calculated a series of descriptive statistics including key social network indices to first get a sense of the level of perceptions and structure of the support network. For social network indices, we used the UCINET 6.0 software package (Borgatti et al., 2005) to calculate network density and reciprocity to describe the degree of connectedness of the support network. Network density is the total number of ties that are present divided by the total number of possible ties (Hanneman & Riddle, 2005). Density ranges from 0 (no ties are present) to 1 (all possible ties are present). Network reciprocity refers to the proportion of ties that are reciprocated divided by all possible ties (Hanneman & Riddle, 2005). Network reciprocity ranges from 0 (none of the ties are reciprocated) to 1 (all ties are reciprocated).

Second, we conducted correlation analyses to examine the relationships between pre-service teachers' mathematics teaching scores, demographics, support network (support incloseness and outcloseness), peer trust, and self-efficacy. Third, we conducted stepwise multiple regression analyses to examine the relationships between pre-service teachers' mathematics teaching performance and support incloseness and outcloseness, peer trust, and self-efficacy, controlling for demographic characteristics.

Before conducting regression analyses, we addressed two important methodological concerns: assumption of independence of observations while handling social network data and the risk of multicollinearity. Given the inter-correlated nature of social network data, the assumption of independence of observations is likely violated. Therefore, a risk of multicollinearity needs to be addressed. Previous research found that centrality measures (e.g. closeness in this study) are often inter-correlated at a medium to high level and may inflate error size and weaken the analysis (Brass & Burkhardt, 1993). A parsimonious approach is to place incloseness and outcloseness in separate models to prevent multicollinearity between network measures. A number of scholars suggest the use of the variance inflation factor (VIF)[3] as a good indicator of multicollinearity (Morad,

Shacham, & Brenner, 2007). Our results indicate that there is no VIF value for each of the explanatory variables for determining the presence of multicollinearity, meaning that all of the VIF values are below 10, and further suggesting that all of the explanatory variables are validated as being applicable in the linear regression model. Finally, we triangulate the study results by a sociogram generated via NetDraw social network software (Borgatti, 2002) which uses a spring embedding algorithm to determine actors' network positions.

Results

Descriptives and correlations

The descriptive statistics (Table 3) indicate that the overall teaching scores on the pre-service teachers' math performance assessment are above proficiency level (M = 2.74, SD = 0.60). The results of whole network measure indicate a sparse network structure (density = .06), meaning that only 6% of all possible support ties are present in the current network. In addition, approximately 24% of the ties are reciprocated, meaning about one fourth of all possible support ties are mutually exchanged between pre-service cohort members.

In terms of individual network connectedness, on average, the pre-service teachers tended to turn to their peers when they needed social and emotional support (support outcloseness) more efficiently than they were sought for support from their peers (support incloseness). That is, individual pre-service teachers sought on average approximately 6% of their peers for social and emotional support, whereas individual pre-service teachers were sought for support by 4% of their peers. Attention is also paid to the larger variation of support outcloseness (SD = 4.08) than that of incloseness (SD = 0.76), indicating that some pre-service teachers appeared to efficiently turn to many of their peers for support, whereas some sought such support from none or few of their peers.

In regard to self-perceptions, pre-service teachers perceived overall higher levels of trust for their peers (M = 6.42 'between agree to strongly agree', SD = 1.14) and higher levels of self-efficacy in instructional strategies (M = 6.02 'between some degree to a great deal', SD = 1.04). That is, the pre-service teachers, on average, perceived that they could depend on, care about, were open to, and shared personal concerns with their peers, and also perceived that they could do well in teaching and instructional design.

The results of the correlation analysis (see Table 3) indicated that support incloseness and peer trust were positively and significantly correlated with the mathematics teaching scores.

Table 3. Descriptives and correlation matrix for study variables.

	Mean	SD	Correlation matrix					
			1	2	3	4	5	6
Network density	.06	–						
Network reciprocity	.24	–						
1. GPA	3.38	.22	–					
2. Support incloseness	3.89	.76	.36[*]	–				
3. Support outcloseness	6.42	4.08	−.07	−.02	–			
4. Peer trust	6.42	1.14	−.25	−.18	.07	–		
5. Self-efficacy	6.02	1.04	−.09	−.29[*]	.13	.23	–	
6. Mathematics teaching	2.74	.6	.18	.36[*]	−.01	.38[*]	.2	–

Note: n = 48.
*p < .05.

This suggests that those pre-service teachers who perceived higher levels of trust for their peers and had more close support ties from other peers also tended to have higher teaching scores on the performance assessment. In terms of demographics, support incloseness was positively and significantly correlated with GPA, meaning that those with higher GPA scores tended to also be sought efficiently for support by others. In addition, we found a negative but weak association between self-efficacy and support incloseness. These correlations indicate that in this sample, a pre-service teacher's performance in mathematical instruction is associated with being sought for support, peer trust, and self-efficacy.

Relationships between mathematics teaching performance and support network, peer trust, and self-efficacy

The results of our multiple regression analyses are displayed in Table 4. Model 1 contained three out of four predictors and was reached in three steps with GPA removed. The first model was statistically significant and accounted for approximately 37% of the variance of pre-service teachers' mathematics teaching scores. Each of the independent variables contributes independently to the prediction of mathematics teaching performance. Mathematics teaching performance was primarily predicted by support incloseness and peer trust and to a lesser extent by self-efficacy.

Support incloseness received the strongest weight in the first model followed by peer trust and self-efficacy. With the sizeable correlations between the predictors, the unique variance explained by each of the variables indexed by the squared semi-partial correlation was mild to moderate: support incloseness, peer trust, and self-efficacy uniquely accounted for approximately 24, 14, and 9% of the variance of mathematics teaching performance, respectively. That is, among all the independent predictors, support incloseness and peer trust each explain a greater variance of the outcome variable than self-efficacy does. In this study, the pre-service teachers' mathematics teaching performance can be more conclusively linked to their efficient ties through which they were sought for support by peers as well as by their sense of trust for peers than by their sense of efficacy in teaching. Overall, the results indicate that mathematics teaching performance is positively associated with support incloseness, peer trust, and self-efficacy. This suggests that the pre-service teachers who

Table 4. Results from the multiple regression analyses on mathematics teaching scores.

	Model 1		Model 2	
	B (SE)	sr^2	B (SE)	sr^2
Constant	−89		84	
	(.82)		(.54)	
GPA	.10		.23*	
	(.09)	.03	(.09)	.08
Support incloseness	.39**	.24	–	–
	(.12)			
Support outcloseness	–	–	−.01	.01
	.19**		(.02)	
Peer trust		.14	.23**	
	(.07)		(.07)	.16
Self-efficacy	.16*		.09	
	(.07)	.09	(.08)	.03
R^2	.37		.26	
F	7.36**		6.61**	

Note: $n = 48$. sr^2 is the squared semi-partial correlation. VIFs range from 1.01 to 1.16.
*$p < .05$; **$p < .01$.

were 'efficiently' sought by their peers for social and emotional support perceived higher levels of trust for their peers, and believed in their ability to design alternative instructional strategies as well as assist families in helping their children learn tended to have higher performance levels in mathematics TEs.

Model 2 contained two out of four predictors and was reached in two steps with out-closeness and self-efficacy removed, accounting for approximately 26% of the variance in pre-service teachers' mathematics teaching scores. Peer trust and GPA uniquely accounted for approximately 16% and 8% of the variance of mathematics teaching performance. The results from the second model indicate that mathematics teaching performance is positively associated with peer trust and GPA. This suggests that the pre-service teachers who perceived higher levels of trust for their peers and possessed a higher GPA tended to have higher performance levels on the mathematics teaching assessment.

Support network sociogram: the relationship between study variables

The results from our analyses were further illuminated through a network sociogram presented in Figure 1 that drew from the social support interactions among the 48 pre-service teachers. The sociogram presents actor network positions as well as underlying network structure of interactions along with actor attributes. Nodes are individual pre-service teachers and lines are support ties with arrows indicating the direction of ties (sending or receiving). The sociogram provides the network pattern between individual pre-service teachers' mathematics teaching performance and their degree of incloseness. The pre-service teachers were grouped based on their level of teaching performance. As indicated, the pre-service teachers with higher levels of teaching performance (nodes in black and dark gray colors) tend to be quickly sought by their peers for social support (larger node). This indicates
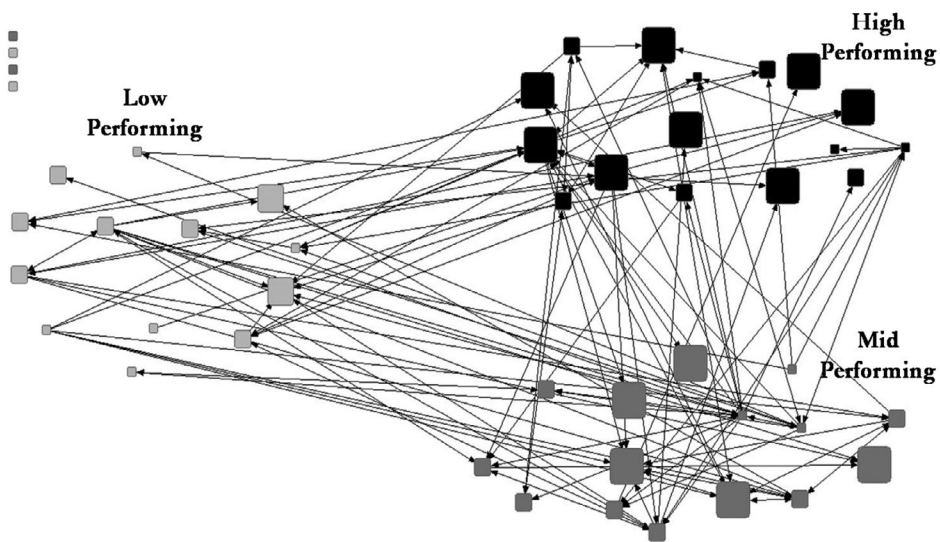
Figure 1. Support network of 48 pre-service teachers by mathematics teaching performance.
Notes: 48 pre-service teachers. Nodes are sized by degree of incloseness (larger/greater incloseness) and colored and grouped by the level of mathematics teaching performance (black/high; dark gray/middle; light gray/low). The four nodes on the left-hand side of the map are the isolates that are disconnected to other pre-service teachers for social and emotional support.

that those pre-service teachers to whom others can efficiently turn to for support (larger node) tended to have higher performance levels in the mathematics teaching performance assessment. The relationships between the teaching performance and perceived peer trust and self-efficacy hold consistently in this type of network analyses.

In sum, our results confirm the second and the third hypothesis that pre-service teachers who perceive trusting relationships with peers and are more efficacious in their teaching tend to have higher levels of mathematics teaching performance. The results partially support the first hypothesis, meaning that only support incloseness significantly contributed to the prediction of pre-service teachers' mathematics teaching performance in this study. This suggests that being sought for social and emotional support more aptly predicts a pre-service teacher's actual teaching outcomes than actively seeking such support from his/her peers.

Discussion

As teacher education is searching for innovative structures to facilitate collaboration among pre-service teachers and increase quality, this study informs these efforts by examining particular social and cognitive conditions as related to pre-service teacher outcomes. In this exploratory study, our results suggest that being sought for social and emotional support, as well as higher levels of peer trust, self-efficacy, and GPA, are significantly and positively associated with better outcomes on one's teaching performance on a high-stakes TE. The results build on previous network studies in education and further extend this important social aspect to the field of teacher education. We will discuss in this section the conditions that are supportive for social and cognitive exchange between pre-service teachers and that have the potential to inform program design for the preparation of effective pre-service teachers in similar settings.

Closely connected support relationships and teaching performance

As pre-service teachers in our case were provided with various opportunities to engage in team-based hands-on laboratory learning experiences, it follows that they were more likely to develop norms of sharing and collaboration with their peers. In our case, providing regular and substantial opportunities for face-to-face social interaction may serve as a meaningful starting point for assisting pre-service teachers to get used to the climate of professional collaboration that counter more isolated practice. These opportunities for exchanges, from a network sense, may allow for more complex and tacit knowledge to flow across the network of support (Pearcy, 2009), which in turn might help generate better individual and collective outcomes (Cakiroglu, 2012).

Corroborating previous work on the influence of teacher social network connections on specific outcome measures such as formative student assessments (cf., Daly et al., 2014), our results indicate that those pre-service teachers who had higher performance levels on the mathematics teaching assessment tend to be the same individuals to whom their peers turn for social and emotional support and as such, are central influencers in the peer support network. Network theory posits that actors occupying such central position have greater influence over a network as they are able to quickly disseminate resources through multiple connections. In our case, one might speculate that those pre-service teachers who feel more confident in designing instructional strategies may also feel more competent

to offer support to their peers and thus are more likely to be the 'go to person' if others have personal concerns. Likewise, 'seekers' identified high-performing peers as sources for emotional support, perhaps demonstrating a perceived connection between technical skills and emotional and social capacity. This suggests the importance of expertise audits in cohorts in which pre-service teachers have the opportunity to learn about the expertise of all their peers. Often knowledge of expertise in a network happens randomly and a more systematic approach may support both a greater sense of efficacy as well as better connecting those individuals who may not be readily acknowledged for their expertise. This argues for the facilitation of both formal and informal opportunities for collaboration within programs. Pre-service teachers should be able to gravitate to peers they identify as sources of support without the barriers of formal program structures, but at the same time provisions must be afforded for access to high-performing peers. Therefore, there remains a need for intentional formal collaborative structures that may influence who has access to these high-performing peers. It is this balance between formal and informal that programs will have to calibrate.

It is noteworthy that our pre-service teachers on average reported seeking out more peers than the number of peers they reported sought them. This suggests that the preparation program has encouraged the norm of sharing and reaching out for support among the pre-service teachers, but has not yet balanced the capacity of individual pre-service teachers to be support providers (or being sought as often for emotional support). As our work suggests the ability to provide social/emotional support is related to higher teaching performance, there remains room for the preparation program to reflect on how to better equip individual pre-service teachers in the skills and capacities necessary to mutually support one another in the development of teaching performance. Teaching the skills and developing the capacities of pre-service teachers to support one another may well have to be done 'intentionally' as opposed to being left to chance. Supporting others is a complex set of skills that we all too often assume is easy to undertake, and yet research would suggest that social/emotional support is not necessarily something that comes readily to all individuals (Jennings & Greenberg, 2009) and requires intentional attention.

Furthermore, as indicated in the support network (Figure 1), there remained four isolated actors with no support ties with their peers in any fashion, be it virtual or face-to-face. From a social network perspective, isolated individuals oftentimes represent untapped expertise and underutilized resources for the cohort and as such may lead to a consequential loss of potential human capital if their knowledge and skills have been neglected and underused. The phenomenon of isolated peers may be indicative of potential gaps/weaknesses in facilitating better 'traffic' for conversation and support (Cross & Parker, 2004). These gaps, if they remain, could potentially turn to structural holes in the support network (Burt, 1992) prohibiting the peer cohort from developing and participating in communities of learning (Lave & Wenger, 1991). As learning takes place through social processes (Bandura, 1977; Easterby-Smith & Lyles, 2011), preparation programs might need to create conditions to support more of these interactions and not leaving them to chance. Opportunities for social interactions may include: engaging student-teachers in the virtual learning community through the use of technology-assisted web space for group project (e.g. Pinterest), and/ or assigning groups of partners to provide community services (i.e. service-learning) so to increase interpersonal skills and communications with parents necessary to deal effectively with elementary school students and adolescents.

Our findings provide evidence of the important social/emotional interaction in support of pre-service teachers' teaching, but we do not exclude other attributing factors that may already exist to shape the peer support relationship such as the use of social networking sites. Despite the ongoing debate and efforts regarding the use of social media to engage students for learning (cf. Guy, 2012; Lederer, 2012; Lester & Perini, 2010), most design that integrates social media in the classroom mainly centers on academic and professional learning activities (Manan, Alias, & Pandian, 2012; Veletsianos & Navarrete, 2012), with little attention to learners' social and emotional needs, which has been identified as critical to professional growth (McCarthy & Youens, 2005; Steele et al., 2013). It is with this in mind that we foreground the social/emotional aspect of learning in a form of interpersonal relationship and further illustrate the network pattern of peer support relationship as a way to identify strengths and weaknesses in need of further attention. For successful teacher preparation, more attention could be included in program design in which the social infrastructure is embedded as part of the learning conditions and not just an additional activity or 'fun' add on. After all, the learning that pre-service teachers engage is layered on an existing base-state of relationships, which may support or constrain the uptake of new learning (Daly, 2010). In being more intentional about the social conditions of support, teacher educators could better help bridge social/emotional resources among and for individual student-teachers creating a deeper appreciation of the social side of teacher education.

Trust as a resource for teaching performance

Studies on trust and educational reform in multiple educational settings were borne out in our work. Our results indicate that better performing pre-service teachers on the high stakes TE tended to perceive higher peer trust. These high-performing pre-service teachers were more willing to provide and exchange social and emotional support with their peers, as has been shown in other studies which posit trust as a key resource for improving schools (Bryk & Schneider, 2002). Such willingness and a sense of social security may help pre-service teachers to engage in more timely and accurate communications and knowledge sharing (Bulu & Yildirim, 2008), reduce a sense of professional isolation (Durksen & Klassen, 2012), and increase team collaboration (Forbes & Billet, 2012). In addition, as multiple agencies in different countries are calling for a collaborative approach to preparing effective teachers (Organisation for Economic Co-operation and Development, 2013), it is important to cultivate a trusting and supportive climate, which has been identified to be critical to team learning, collaboration, and teacher professionalism (Tschannen-Moran, 2009). It is reasonable to infer a similar and positive effect on collaboration among pre-service teachers as well as their teaching performance as they experience in clinical settings (e.g. field placement, practicum). Pre-service teachers in a trusting learning environment may be more willing to take risks in trying innovative, alternative strategies in teaching and learning. This learning cycle may very likely feed back into the system in creating a more supportive, risk-free community of learning. Therefore, attention to not only the quantity of relationships, but the quality of exchanges and social norms that are set in a cohort is likely to be critical.

Building on the previous points, creating supportive conditions for collaboration has implications for successful educational reform in the long term as pre-service teachers enter the field. Nurturing trusting environment for learning is important for teachers, as

demonstrated in many school reform cases in which teachers are more effective when they feel respected, have voice (Noddings, 2005), and trust the people within the school have their best interest at heart (Bryk & Schneider, 2002). We believe this is also the case for pre-service teacher preparation. A number of scholars call for teachers' social and emotional competence (SEC) and well-being in promoting student–teacher relationships and learning outcomes (Jennings & Greenberg, 2009) and starting this work early on may pay dividends. We believe this exploratory study helps to move one step forward in our understanding of the important SEC factor of pre-service teachers and more specifically how it relates to their learning outcome, which remains understudied in teacher education.

Self-efficacy and teaching performance

Our results indicate that those pre-service teachers who perceived themselves as being more confident in their ability to teach well had higher performance scores on the mathematics teaching assessment. This finding reflects previous studies on pre-service teacher self-efficacy in general in which efficacy is positively associated with higher performance (Bates et al., 2011). Perhaps this is not surprising because in our case, pre-service teachers who were more confident in their ability to identify alternative strategies and explanations to address students' questions as well as assist families in helping their children learn were also more likely to be able to incorporate learning strategies into their teaching and manage classroom practices and work-related anxiety. Thus, they may more effectively cope with challenging situations when teaching mathematics, such as linking pedagogical theories to addressing different types of academically struggling student issues in field practice (Anderson & Maninger, 2007). This also suggests the importance of providing mastery experience for efficacy building such as guided practice, role modeling, connections with others who have mastery, and providing laboratory experiments in which pre-service teachers take leadership roles in facilitating group work, demonstrating conceptual understanding and hands-on practice. In the long term, such experience and practice of mastery may potentially close the gap in efficacy beliefs of all pre-service teachers as well as allow them to engage the same sorts of mastery experiences they may likely create for their students.

As collaboration, be it virtual or face-to-face, will continue to be an important part of professional teacher practice across the globe, developing the ability to communicate and work with others becomes even more critical in the development of pre-service teachers. Those who are able to master knowledge and skills through interacting with others may have a greater chance to share instructional ideas so as to develop self-efficacy, which may influence performance in the long term. In our case, the pre-service teachers were provided with various opportunities for collaboration, and it may be the case that the cohort design facilitates and reinforces the norm of social learning and improvement in a safe setting. However, teacher educators may need to be aware of the downside of high self-efficacy, as it may cause individuals to become complacent and thus underestimate the resources necessary for learning, leading to a decrease in work performance (Vancouver et al., 2008). While we do not attempt to make this conclusion regarding high self-efficacy, it is worth mentioning, especially for preparation programs to be successful. To balance the development of self-efficacy, teacher educators may consider integrating mindfulness/ contemplative practice as part of the curriculum (Impedovo & Malik, 2015) and cultivate pre-service teachers' self-awareness of social and professional dispositions (National Council

for Accreditation of Teacher Education, 2008). In so doing, pre-service teachers would be more likely to be committed to the teaching profession (Rots et al., 2007), satisfied with and less stressed by work (Klassen & Chiu, 2010), and ultimately improving their teaching performance (Bates et al., 2011).

Limitations, implications, and conclusion

Our exploratory work offers a promising vantage point on the complex process of pre-service teacher education. We are cautious in drawing definitive conclusions about the relationship between the study variables, as the presentation of these exploratory results is the first of their kind in the literature on pre-service teacher education and we have limited base for comparison.

While this study provides a unique approach to present the interplay between key factors and pre-service teachers' performance using multiple data sources, it also has limitations in design and as such provides useful directions for future studies. First, as this study examines mathematics teaching performance of pre-service teachers as the single measureable outcome variable, we are cautious of making generalized conclusion about the relationships between the degree of connectedness and high-stakes outcomes for other subject matters. In other words, we have limited evidence to make a conclusive or causal statement about greater closeness as related to higher performance in science and language literacy, etc. Future research could further tap into this understudied area.

In addition, we acknowledge that this study took place in a well-regarded teacher preparation program which may not be representative of all types of programs that prepare teachers. Nonetheless, we believe our work may be generalizable to other similar settings and encourage future studies to expand the sample pool of pre-service teachers from a variety of preparation programs. Although we incorporate multiple data sources such as quantitative survey data and social network data, there remains no qualitative data reported in this study. Future work would benefit from stronger causal models and from a mixed-methods design to gain insight into the directionality of these variables as well as trajectories of change. With that, future research could consider a quasi-experimental design to examine the long-term effect of social and emotional support on teaching performance between preparation programs that employ a more collaborative cohort approach and those that apply a more conventional approach to trainings. Research design using a similar approach may allow for a greater degree of generalizations to be made about pre-service teachers across the globe.

Additional study would be also helpful to investigate whether a reciprocated relationship is developed or dissolved over the course of pre-service preparations. As previous network studies (Daly & Finnigan, 2010) suggest a potential positive effect of reciprocated ties in strengthening a mutually connected and collaborative network structure in educational leadership, it might well be informative to the work of pre-service teacher education that aims at cultivating a mutually trusting and collaborative learning environment.

Building on the previous point, although trust has been widely studied in in-service teacher practice, it remains an understudied area in pre-service teacher education, particularly how trust may influence pre-service development. Building and shaping a trusting climate takes time and effort, but breaking it only takes a small incident. Therefore, the level of trust pre-service teachers perceive may be heavily influenced by program structures and the actions and reactions of teacher educators and leaders.

Further, trust levels among pre-service teachers may indicate their willingness to contribute to a trusting environment within a program and ultimately a school or district. Although our data suggest a positive relationship between trust and teacher performance, further study of trust and the role it plays in pre-service teacher development could further illuminate how the development of trust and collaboration supports effective teacher education.

Connecting social and emotional ties, peer trust, and efficacy, our work indicates that higher performing students had higher levels of self-efficacy and that these students also had higher levels of trust and closely connected social ties with peers. These trends lay some groundwork for continued study of the role social capital plays in the development of self-efficacy. More specifically, we know little about how the design of teacher education programs may improve the development of less efficacious pre-service teachers over the course of preparation. Future work could conduct a cohort study to document a series of characteristics and events related to these key variables within a group of pre-service teachers in order to gain an in-depth and longitudinal understanding of the causal linkages in support of pre-service teacher development.

Finally, preparation programs may be best able to move these important ideas into practice through ongoing professional development that incorporates the notion of situated learning (Brown & Duguid, 1991) using a so-called realistic approach to teacher education (Korthagen, Kessels, Koster, Wubbels, & Lagerwerf, 2001). This approach emphasizes opportunities for peer support learning in which professional knowledge is situated in the interaction of peers and can be distributed across peers. For instance, the ALACT model described in Korthagen's (2011) work provides a good illustration of realistic teacher education in which student-teachers are encouraged to reflect on their problems encountered in teaching practice and discussed within their pair before the scaffolding support of teacher educator. This type of professional development is grounded in collaboration and exchange of ideas which is commonly seen in school settings. We believe pre-service teacher preparations that attend to the design of social aspect both in the program and perhaps beyond may better sustain the development of the program but also the continuing growth of the teacher profession.

Our work foregrounds the social side of pre-service teachers. The lives of teachers and their social and professional concerns have long been put on the back burner of educational policy. As this work demonstrates the importance of social, emotional, and cognitive factors in teaching performance, we urge the education community to prioritize the social side of the important work of teacher development. Engaging in the *affective* realm for *effective* practice requires intentional instruction on new inter/intrapersonal skills and capacities for pre-service teachers. In this age of collaboration and greater connectedness, we cannot afford to merely hope these skills and capacities are picked up, rather we have to be equally intentional and committed to the same level of instruction for inter/intrapersonal skills we provide for the technical core of teaching. Cultivating such networks of support will likely enhance teaching performance of pre-service teachers and perhaps ultimately nurture more effective teachers who remain committed to the profession.

Notes

1. For detailed information regarding the assessment items, please refer to http://www.pacttpa.org/.
2. It is noteworthy that we also investigated teaching performance in science, language arts, and history and social science, and our models indicated a consistent pattern of predictors in explaining per-service teachers' outcome performance. For instance, we found the pre-service teachers' science teaching performance is significantly associated with peer trust, self-efficacy, and incloseness and indegree with adjusted R^2 of .35 ($F = 5.24$, $p < .01$). As for teaching performance in history and social science, the model indicates a series of significant relationships between the outcome variable and peer trust, self-efficacy, and degree centrality with adjusted R^2 of .23 ($F = 3.38$, $p < .05$). In the current study, to provide more focused study results, we reported findings from mathematics teaching performance.
3. Generally, the VIF of 10 is has been proposed as a cut-off value. If the value of VIF is greater than 10, it is likely that the multicollinearity is influencing the least squares point estimates.

Disclosure statement

No potential conflict of interest was reported by the authors.

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