

Accessing Capital Resources: Investigating the Effects of Teacher Human and Social Capital on Student Achievement

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Background: A growing empirical base suggests that there is a positive relationship between teacher social interaction and student achievement. However, much of this research is based on standardized summative assessments, which, while important, may have limited applicability to timely instructional decision making. As such, in this work, we examine the relationship between teacher social interaction and interim benchmark formative assessments, which have been argued to play a more useful role in instructional decision making.

Purpose: In this study we used a human and social capital framework to explore the relationship between teacher social interaction and student achievement on an interim benchmark formative assessment. We hypothesized that teacher social capital would be positively related with student achievement as measured by an interim assessment, even after controlling for student and teacher demographics as well as proxies for teacher human capital.

Population: A sample of 63 teachers from five elementary schools in a midsize U.S. district completed a demographic and social network survey, from which we generated our human and social capital measures. For student-level data, we collected current and prior student achievement from 1,196 third to fifth grade students on an English Language Arts Interim Benchmark Assessment.

Research Design: We used survey data to conduct social network analysis and hierarchical linear modeling to explore the multilevel relationship between human and social capital and student achievement.

Results: Results indicated that even when controlling for student demographics and prior achievement, teachers human and social capital had a significant effect on student achievement as measured by interim assessments. More specifically our results indicated that more teaching experience in the current school was associated with better student performance on the interim assessment. In addition, the act of reaching out to other teachers to share knowledge regarding reading comprehension was associated with higher student scores on the interim assessment even when controlling for demographics and past academic performance.

Conclusions: This study offers a unique insight into the role of accessing capital resources and student achievement in strengthening schools under increased pressure to improve. Our work adds to the growing empirical base that suggests that teacher social interaction has a relationship with student achievement. To encourage social interaction, creating formal policies and structures for teachers to develop social ties with one another related to content may be a useful strategy in supporting student outcomes.

INTRODUCTION

In recent years, accountability policies have raised the stakes for school improvement. The result has been an almost continuous stream of reform efforts to increase student achievement (Coburn, 2003; Henig & Stone, 2008). A range of formal structures and processes often guide the implementation of these reforms with the direct intention of building the individual capacity or human capital of teachers in improving performance (Darling-Hammond, 1993; Datnow, Hubbard, & Mehan, 2002; Fullan, 1992; Fishman, Marx, Best, & Tal, 2003; Spillane, 1999). However, growing evidence on the successes and failures of reform has driven research to look beyond the formal human capital aspects of improvement and focus attention on the relevance of the quality of teacher social interactions in improvement (Bryk & Schneider, 2003; Coburn & Russell, 2008; Daly, 2010; Goddard, Goddard, & Tschannen-Moran, 2007; Horn & Little, 2010; Hubbard, Mehan, & Stein, 2006; Moolenaar, 2012; Penuel, Riel, Krause, & Frank, 2009).

The importance of teacher social interaction in support of educational reform (Baker-Doyle, 2011; Coburn & Russell, 2008; Louis & Marks, 1998; Stoll & Louis, 2007; Wenger, 1998) is underscored by educational scholars across the globe (Carmichael, Fox, McCormick, Procter, & Honour, 2006; Daly & Finnigan, 2011; Hopkins & Reynolds, 2001; James, Dunning, Connolly, & Elliot, 2007; Moolenaar, Daly, & Slegers, 2011). Such collaborative initiatives can encourage teacher professional exchange, knowledge sharing, and joint productive work that potentially supports student achievement (Chrispeels, Andrews & Gonzales, 2007; Feiman-Nemser, 2001; Hargreaves, 1994; Little, 1993; McLaughlin & Talbert, 1993; Newmann & Wehlage, 1995; Stoll & Louis, 2007; Wood, 2007). Moreover, opportunities for interaction may stimulate the exchange of information and practices throughout a school, which can also assist in overcoming long-held traditions of teacher isolation potentially constraining reform efforts in change-weary schools (Bakkenes, De Brabander, & Imants, 1999; Little, 1990). Despite the importance of teacher interaction and its potential impact on student achievement, our understanding of the social side of reform, *social capital*, and its relationship to student outcomes is limited (Coburn & Russell, 2008; Daly, 2010; Datnow, 2012; Penuel et al., 2009). Research does suggest that there is a relationship between teacher collaboration and student outcomes, but there are only limited empirical studies that make that link directly (Lomos, Hofman, & Bosker, 2011; Louis & Marks, 1998; Strahan, 2003; Supovitz, 2002). Although these summative results may be important in assessing a certain type of student achievement, research suggests these assessments may not be as useful in making more timely day to day instructional decisions (Earl & Katz, 2007; Schildkamp & Kuiper, 2010). In response to some of the instructional inadequacies associated with summative assessments there has been a significant increase in the use of interim assessments (Goertz, Olah, & Riggan, 2009).

Interim assessments have been conceptualized as those measures (a) that evaluate specific student knowledge and skills within a regular time frame and (b) whose results can be analyzed across classrooms, schools, and the larger district (Perie, Marion, & Gong, 2009). Interim assessments are usually administered on a more frequent basis than summative assessments and are intended to support teachers in making decisions in targeting their instruction or focusing on specific students needs. As such, these interim assessments have potential to impact teachers daily practice as well as play an instructive role in improving student outcomes (Blanc et al., 2010; Riggan & Olah, 2011).

There is a growing, but limited, body of work on the interim assessments and student achievement (Blanc et al., 2010; Goertz et al., 2009). A few studies have suggested that interim assessments can play a supportive role in improving student outcomes through identifying learning gaps when these measures are embedded in a coherent system of instructional support that includes skilled and knowledgeable staff (Blanc et al., 2010; Bulkley, Christman, Goertz, & Lawrence, 2010; Christman et al., 2009). When used as a part of a coherent systemic strategy for improvement, high-quality interim assessments, due to their frequency and formative nature, may support teaching and student learning by providing teachers with targeted feedback to adjust and improve their instruction. Although interim benchmark assessments are by no means a perfect measure of student achievement, examining these, as opposed to long-cycle, end-of-year, standardized summative measures, may provide additional instructional insights that are more closely linked to student performance (Goertz et al., 2009; Perie et al., 2009).

In addition, as interim assessments are typically designed to guide instructional decision making, often in interactions with others, it is important to study the social context in which these assessments are embedded. Often, as is the case

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in the district under study, teachers will collaboratively discuss and analyze the results of these assessments in order to examine instructional gaps, identify students who are not making adequate progress, formulate action plans (individual/grade level), and share instructional strategies. This suggests that when studying the relationship between interim assessments and student achievement it will be important to also account for the impact of teacher social interactions, which to date has not been typically included in studies of benchmark assessments.

In response to the identified gaps in the literature, the suggested utility of interim assessments, and the importance of teacher interaction in improving instruction, this study aims to examine the influence of that interaction, specifically regarding reading comprehension, on an interim benchmark measure of student achievement. Our study takes place in the Avaluar¹ Elementary School District, an urban fringe district that is currently in the third year of progressive governmental sanction for underperformance. In an effort to improve student achievement, the district has initiated and codified a system-wide collaborative instructional reform effort aimed at improving teachers knowledge base related to reading comprehension. In this paper, we use data from 63 teachers and 1,196 students within five elementary schools to examine the relationship between teacher interactions as measured by structural social capital and student achievement on an interim benchmark assessment. In doing so, we aim to add to the limited knowledge base in this area and address our overall research question: To what extent does social capital, as a measure for teacher social interaction around reading comprehension, exhibit a relationship with student achievement as measured by a literacy focused interim benchmark assessment?

THEORETICAL FRAMEWORK

Demands in the United States from the No Child Left Behind Act and, more recently, the Common Core Standards have placed additional pressure on districts and schools to improve performance (Kober & Rentner, 2011; Krieg, 2011). A typical response to this pressure has been to increase the number of reform efforts underway in schools and districts (Mintrop & Trujillo, 2007). One main goal of many of these reform efforts is to improve student learning through strengthening teacher human capital (Spillane & Zuberi, 2009). Human capital, in this sense, refers to an individuals cumulative abilities, knowledge, and skills developed through formal and informal experiences (Pil & Leana, 2009, p. 1103) that may affect an individuals capacity to perform work effectively (Schultz, 1961; Strober, 1990). Teacher human capital can be conceptualized as the body of both professional and personal knowledge developed over time that includes general instructional skills, knowledge of the subject matter to be taught, and pedagogical content (Grossman & Richert, 1988; Shulman, 1986; Tamir, 1991). In the field of education, supporting teacher human capital has played an important role in enacting school reform, improving teacher quality, and teacher certification (Cohen & Hill, 2001; Darling-Hammond, 2004). Through existing and acquired human capital, teachers are regarded as valuable resources and as such their human capital may support and extend work in new ways in enhancing student performance (Coleman, 1988; Milanowski, Heneman, & Kimball, 2011).

Teacher human capital is one important, although heavily debated, element in understanding teachers ability to influence student achievement (Ball & Cohen, 1999; Sanders & Horn, 1998; Sanders & Rivers, 1996; Spillane & Zuberi, 2009; Taylor, Pressley, & Pearson, 2000). Given the importance of human capital, school systems often attempt to develop a coherent instructional system for enhancing teacher human capital in an effort to improve student outcomes (Milanowski et al., 2011). A key ingredient that catalyzes the development of teacher human capital is investment in opportunities for a variety of interactive professional development activities that can support instructional skills, which in turn will likely increase student achievement (Baker-Doyle & Yoon, 2010; Kilburn & Karoly, 2008; Milanowski et al., 2011).

Even though human capital, as teachers cumulative abilities, knowledge, and skills to teach, is potentially related to student achievement (Spillane & Zuberi, 2009; Taylor et al., 2000), a teachers human capital does not evolve in a vacuum. Recent literature suggests that teacher human capital is developed, enhanced, and shared through social interaction and collaboration resulting in additional knowledge available to the system (Hargreaves & Fullan, 2012; Pil & Leana, 2009; Sigler & Ucelli Kashyap, 2008). Teachers human capital may be enriched when teachers interact with one another and engage in sharing practices and knowledge, which supports a system of learning that may improve organizational outcomes (Halverson, 2003; Little, 2003; Kennedy, 2002; Penuel, Sun, Frank, & Gallagher, 2012) and increase student achievement (Dufour & Eaker, 1998; Louis & Marks, 1998; Stoll & Louis, 2007). Therefore, and especially in times of high stakes reform (Daly, 2009), increased understanding of how teacher social interactions build and support existing human capital in improving student achievement is vital.

TEACHER SOCIAL INTERACTION

A growing body of research suggests the importance of teacher social interaction for school improvement (Baker-Doyle & Yoon, 2010; Hargreaves, 1994; Spillane, 2006) particularly as a way to increase student achievement (Ashton & Webb, 1986; Bryk & Schneider, 2003; Chrispeels et al., 2007; Goddard et al., 2007; Moolenaar, Slegers, & Daly, 2011; Vescio et al., 2008). Teacher interaction has been found to positively affect teaching and learning (Goddard & Heron, 2001; Pounder, 1998) by increasing access to new knowledge and instructional practices (Blanc et al., 2010; Hausman & Goldring, 2001). Schools that provide opportunities and resources for professional interaction may break through cultures of isolation (Bakkenes et al., 1999; Liou & Daly, in press; Little, 1990; Meichtry, 1990) and create more connected networked communities that potentially benefit student outcomes (Haythornthwaite & De Laat, 2010; Katz & Earl, 20062007).

Examining the relationship between teacher interaction and student achievement as measured through interim assessments is particularly important and understudied (Evans-Stout, 1998; Pil & Leana, 2009; Welch, Brownell, & Sheridan, 1999). Furthermore, most studies on teacher social interaction that do examine student outcomes draw on standardized summative tests rather than other short- or medium-term cycle interim assessments, which have been suggested by research as more effective in diagnosing student performance and improving outcomes (Black, Harrison, Lee, Marshall, & Wiliam, 2004; Perie et al., 2009; Riggan & Olah, 2011). This study is also particularly timely given the Common Core Standards, which may necessitate increased teacher collaboration in terms of addressing new standards and assessments.

In this paper, we build on a body of work that suggests that through discussing student assessments teachers may be more likely to share knowledge and practices that may yield increased learning gains (Christman et al., 2009; Clarke, 2001; Fuchs & Fuchs, 1986). Specifically, we argue that teacher social interaction around reading comprehension is a critical activity in improving student outcomes as measured by medium-cycle interim benchmark assessments (Black & Wiliam, 1998; Blanc et al., 2011; Goertz et al., 2009; Sadler, 1998). As teachers engage in sharing and discussing knowledge regarding their instructional practice, it is likely that their knowledge and learning will be enhanced (Black et al., 2004). Therefore, in addition to teacher human capital, teacher interaction is also potentially equally important in the student achievement equation. A useful theoretical lens to understand teacher social interaction and its potential influence on student learning is provided by the concept of social capital.

SOCIAL CAPITAL

While scholars have applied different theoretical lenses to understand teacher social interaction (Grossman, Wineburg, & Woolworth, 2001; Lieberman & Miller, 2008; Little, 2003; Spillane, 2006), we argue that the sociological perspective of social capital offers a well-grounded framework for understanding teacher social interactions and their potential relationship with student achievement. Social capital as conceptualized by Lin (2009), and Coleman (1988) is regarded as resources (e.g., knowledge, information) that can be accessed through social relationships in order to achieve particular purposes (e.g., student outcomes). Thus the lens of social capital, in a structural sense, views teacher social interaction in terms of the exchange (sending and receiving) of resources (e.g., knowledge, information) within a schools social network, as well as the capacity of individual teachers to access these resources (Burt, 1992; Curry, Gearhart,

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Kafka, & Little, 2003; Penuel et al., 2009). To examine teachers structural social capital, we foreground the importance of teachers social network structure and draw on research using social network theory and analysis (Scott, 2000). More specifically in this study we will focus on teachers social network structures that reflect the exchange (sending and receiving) of knowledge around reading comprehension, as this was the target of the specific reform effort underway in the sample schools.

Social Network Structure

Scholars from outside education have suggested that the network structure in which individuals are embedded (e.g., employees in organizations) is consequential for both individual and network level outcomes (e.g., individual work performance and organizational effectiveness) (Lin, 2001; Nahapiet & Ghoshal, 1998; Tsai & Ghoshal, 1998; Wasserman & Faust, 1994). In education, a well-connected school network may enable teachers to reach collective goals of improving teaching and student learning (Baker-Doyle, 2011; Finnigan & Daly, 2012; McLaughlin & Talbert, 2006; Penuel et al., 2009).

The overall structure of a network can facilitate and constrain the effectiveness of exchanges between teachers, such as the sharing of knowledge and information related to content and practices (Coburn, Choi, & Mata, 2010; Daly, 2012; Halpern, 2005; Inkpen & Tsang, 2005; Jackson & Temperley, 2007; Mitchell & Sackney, 2007). For instance, a dense network structure in which there are many ties between actors has been associated with the transfer of tacit or complex information (Ghoshal, Korine, & Szulanski, 1994; Hansen, 1999, 2002; Krackhardt, 1992; Reagans & McEvily, 2003; Szulanski, 1996; Uzzi, 1996, 1997), collaborative problem solving (Uzzi, 1997), and the development of coordinated solutions (Uzzi, 1997). This dense network provides stable and predictable relations (Ghoshal et al., 1994; Song, Nerur, & Teng, 2007; Tsai & Ghoshal, 1998) and offers the opportunity for the seeker and source to be linked in the exchange of resources (Cross, Borgatti, & Parker, 2001; Hansen, 1999; Krackhardt, 1992). Organizations with dense informal network structures within and between organizational units generally achieve higher levels of performance than those with sparse connections (Reagans & Zuckerman, 2001). Many scholars have also identified densely connected networks as a critical source of organizational advantage (e.g., Adler & Kwon, 2002; Katzenbach & Smith, 1993; Kogut & Zander, 1996; Lawler, 1992; Leana & Van Buren, 1999; Nahapiet & Ghoshal, 1998; Walker, Kogut, & Shah, 1997).

Despite literature suggesting that densely connected networks are important in moving complex information, these same structures may not always lead to positive outcomes. Densely connected networks may actually inhibit performance due to the stability of ties and group norms which may limit the introduction of novel information (Szulanski, 1996), reduce flexible organizational response, and primarily move redundant information (Burt, 1992; Hannan & Freeman, 1984). In this sense, a dense network structure may also restrict the overall organization from meeting goals.

In contrast, a sparse network structure is one with few ties between actors (Scott, 2000). Sparse ties are considered important as they are more likely to be the source of nonredundant novel information, whereas dense ties tend to be those with others who possess information the seeker already knows (Granovetter, 1973, 1982). Sparse ties have been associated with the diffusion of innovation (Rogers, 1995) and sources of new information (Constant, Sproull, & Kiesler, 1996). However, network structures comprised of primarily sparse links, while perhaps effective at transmitting innovation, may inhibit advancing complex initiatives as these ties are not as strong (Hakkarainen, Palonen, Paavola, & Lehtinen, 2004). Beyond overall network structure, individual actors also occupy specific structural positions in a social network.

Individual Network Position

Although overall network structure is important for understanding organizational phenomena, individuals within that overall structure occupy specific social positions in a network. These positions are related to the amount and type of relationships an actor possesses. These ties provide opportunities to send and receive resources, which may ultimately affect individual outcomes (e.g., Baker-Doyle, 2011; Liou, 2010; Moolenaar, Daly, & Slegers, 2010). Actors that are sought by many others for resources, such as knowledge (characterized as having a high *in-degree*) or those who seek resources from many others (high *out-degree*), are described as being central in a network (Burt, 1992; Lin, 2009; Wasserman & Faust, 1994, 1998). These individuals, by nature of their social position in a network, are considered to have disproportionate influence over others as they have relatively more relationships through which to access and move resources (Daly, 2010; Hanneman & Riddle, 2005). As such, an individual who occupies a central position in a network tends to have greater advantage in moving and leveraging resources such as knowledge, whereas peripheral individuals have less access to these resources (Tsai, 2001; Tsai & Ghoshal, 1998). In addition, teachers who possess higher levels of structural social capital (exchange of resources through their social network position) may have greater opportunity to use and expand their human capital (accumulated knowledge and experience) in improving practice and student learning. As such, understanding individual teachers network positions (social capital) above and beyond their individual knowledge (human capital) may be useful in understanding how resources such as knowledge and information may support or constrain efforts at improving student achievement (Baker-Doyle & Yoon, 2010; Coburn & Russell, 2008; Moolenaar, Slegers, & Daly, 2011; Penuel et al., 2010).

Network scholars have examined the mutuality of relationships between individuals, referred to as *reciprocity*, as another structural element that may be related to resource exchange (Burt, 1997; Moran & Ghoshal, 1996; Nahapiet & Ghoshal, 1998). Research suggests that reciprocal relationships between individuals are associated with initiating and sustaining change efforts (Daly & Finnigan, 2012; McGrath & Krackhardt, 2003; Tenkasi & Chesmore, 2003). Reciprocal ties, in a social network sense, may signal stronger relationships than unidirectional ties (Coleman, 1988). However, when such reciprocated ties are woven into a sub-group of strong relationships, unique individual action may likely be constrained by the norm of the group (Burt, 1992; Granovetter, 1973; Simmel, 1950). Over time, such reciprocated relationships may therefore limit an individuals behaviors to share, seek, and exchange novel resources given social pressures to conform (Krackhardt, 1999). Although the ideas of resource exchange and reciprocated relationships appear important, there is scarce empirical evidence regarding the effect of teachers unidirectional and reciprocated relationships and student achievement in the context of underperforming schools. Better understanding these relationships may help support and target current efforts at organizing collaborative initiatives (e.g., professional learning communities) in support of improved student achievement, making this an important and relevant line of research (Slegers, Den Brok, Verbiest, Moolenaar, & Daly, in press).

In sum, the educational literature could benefit from insights on the impact of teacher structural social capital (i.e., teacher social interactions in knowledge exchange networks) above and beyond the influence of teacher human capital (i.e., teachers accumulated knowledge and experience) on student achievement as measured by an interim assessment. In exploring this line of inquiry we hypothesize:

A teachers social capital (as assessed by the out-degree, in-degree, and reciprocity that reflect a teachers social network position in a reading comprehension knowledge network) will have a positive relationship with student achievement as measured by an interim assessment, even after controlling for student and teacher demographics as well as proxies for teacher human capital.

METHODS

In this exploratory survey study design we employ a combination of analytic methods to answer our overall research question and test our hypothesis about the relationship between social capital, human capital, and student achievement measured by interim benchmark assessments. We first used a demographic and network survey to gather information on 63 teachers as well as the achievement of 1196 students in five elementary schools. We examined the pattern of knowledge exchanges (sending [out-degree] and receiving [in-degree]) around reading comprehension among the teachers in the sample schools to explore teachers structural social capital. In quantifying social capital, we drew on

social network analysis (SNA) (Scott, 2000; Wasserman & Faust, 1998) and inferential statistics. We then used hierarchical linear modeling (HLM) as our data was nested (students in classes in schools) to explore the multilevel relationship between human and social capital and student achievement. HLM provides the analytic tool necessary to both model and evaluate structural relations in nested data (Raudenbush, Bryk, Cheong, & Congdon, 2004). Controlling for student demographics and prior achievement, as well as teacher demographics and proxies for teacher human capital, we examine the relationships between teacher social capital and student achievement using the English Language Arts Interim Benchmark Assessment (ELA-IBA) as our student achievement outcome measure.

CONTEXT AND SAMPLE

We selected the Avaluar Elementary School District (AESD) as this particular district has been implementing a reading comprehension reform effort that focuses on both teacher collaboration and the use of interim benchmark assessments as a way to enhance practice and increase student performance. AESD is an urban fringe district in California. Being in the third year of sanction from the federal government for underperformance, Avaluar typifies, and as such may serve as a representative case for, systems in the United States, as it is serving a diverse student body and has enacted multiple reform initiatives in order to meet accountability mandates and increase student achievement. The district currently serves over 18,000 students in kindergarten through eighth grade, representing the student diversity found in many schools across California (the most populous state in the United States) and in urban fringe settings across the globe. Avaluars underperformance with low achievement scores in English Language Arts (ELA) prompted the district-wide reform focus on reading comprehension. The district-wide effort includes an intentional focus on teacher collaboration around a literacy curriculum, professional development of school teams in instructional strategies for reading comprehension, and a commitment to a multiyear sustained program. The intent of the reform is to provide a consistent approach to instruction across all elementary schools in the district using interim assessments as a part of its strategy to improve student achievement.

Five elementary schools comprising kindergarten through fifth grade and reflecting the overall district population and performance were selected. The schools represent the range of schools in the district with regard to teacher background, socioeconomic status, and academic performance levels of students. Table 1 provides the demographic data for the district and sample schools including the Academic Performance Index (API) score. API is a California state measure of a schools academic performance on a scale of 2001000 with 800 as a target of minimum desired performance.

Table 1. Sample Demographics: School Level

School	Enroll	% Free/Reduced Lunch	% Hispanic	% White	% African American	API
A	596	62.1	63.4	18.8	5.2	726
B	677	48.1	37.7	47.8	2.4	775
C	679	63.2	73.2	16.9	3.1	709
D	629	72.9	88.5	8.2	1.5	692
E	670	61.4	70.0	20.0	4.9	762
Sample average	650.2*	61.2	67.4	22.3	3.4	732
District average	598	61.0	65.0	25.5	2.9	734

Note. $N = 5$.

*Includes students from all grades

In total, we received surveys from 90 teachers from the five schools, reflecting an 86% response rate. These 90 teachers served Grades 1 to 5. Of the total 90 teachers, we drew on a subsample of 63 third to fifth grade teachers to conduct our analysis. We selected a subsample as we did not have prior year achievement scores for students in first and second grade, which was necessary as a prior achievement control². Table 2 provides the overall teacher demographics of the final sample of 63 teachers from the five schools for which we had access to current and prior student achievement on the ELA-IBA. The sample was primarily female, with teachers in their current schools on average for nine years and in the field of education for 14 years, which is important to note as this local (current site) and overall (years in education) experience likely provided opportunities to develop human capital.

Table 2. Sample Demographics: Teacher Level

Characteristic	% or Mean	SD
Gender		
Male	21.3%	--
Female	78.7%	--
Years at school		
Range 130 years	9.3	6.18
Years as an educator		
Range 135 years	14.1	7.60
ELA-IBA 2008 (Third trimester)		
Range 0100	72.6	9.48
Reading comprehension		
In-degree		
0 (none)	32.2%	NA
.1.499 (low/medium)	33.3%	
.51.00 (high)	33.4%	

Out-degree		
0 (none)	41.4%	NA
.1-.499 (low/medium)	25.3%	
.51-.00 (high)	33.7%	
Ego-reciprocity		
0 (none)	42.2%	NA
.1-.499 (low/medium)	36.7%	
.51-.00 (high)	20.9%	

Note. N = 63.

We also collected student level data from a total 1,196 students in third to fifth grade including: grade level, gender, reduced/free lunch status, special education status, number of days absent, California Standards Test in English Language Arts for 2007 (CST-ELA 2007),³ and results from the ELA-IBA from 2008. These results are reported in Table 3. As can be seen in Table 3, the sample was somewhat evenly distributed across grade levels. The average percent ELA-IBA for the last trimester measure was higher for third graders compared to fourth and fifth graders. This pattern is not surprising, as the English Language Arts curriculum and performance demands become more challenging in fourth and fifth grades.

Table 3. Sample Demographics: Student Level

Grade Level	% Sample	% Female	% Free/Reduced	% Special Education	Days Absent Mean (SD)	CST-ELA 2007 Mean (SD)	ELA-IBA Third Trimester Avg. Percent (SD)
3	28.1	48.2	48.2	6.9	6.0 (6.5)	355.4 (56.5)	75.2 (14.6)
4	31.2	54.1	51.7	6.1	6.5 (6.1)	340.1 (60.6)	70.0 (17.4)
5	40.7	53.0	59.2	6.7	5.7 (5.4)	356.4 (55.7)	71.1 (16.2)

Note. N = 1196.

DATA COLLECTION AND ANALYSIS

Human Capital

In assessing human capital, we draw on previous work (Pii & Leana, 2009; Sigler & Ucelli Kashyap, 2008) that suggest that years of experience may serve as a proxy for human capital. This is based on the assumption that over time a teacher will attend more training and professional development seminars and will have the opportunity to learn more from experience in a specific context, which contributes to human capital over a teaching career. Albeit admittedly incomplete, we use this proxy for accumulated knowledge to represent the human capital possessed by an individual teacher, as we did not have access to a measure that could more specifically assess teachers complete accumulated knowledge and experience. Alternative proxy measures were also considered, such as national board certification, advanced degrees, and university from which the teaching degree was obtained, but based on previous work (Pii & Leana, 2009; Sigler & Ucelli Kashyap, 2008) we opted for using a straightforward measure of teachers years of experience as our human capital measure. We acknowledge that the research has been varied and debated as to whether teachers experience is related to teacher effectiveness (Harris & Sass, 2008). To assure a stronger proxy, we therefore include two measures for teachers human capital, namely years in education, which serves as a measure of overall teaching experience, and years at the same school, which serves as a measure of local context knowledge as well as potential exposure to the ongoing mandatory professional development at each school (Moolenaar, Daly, Slegers, & Karsten, in press).⁴

Social Capital

In collecting data on structural social capital in Avalor, we developed an online survey that comprised multiple distinct networks questions. In late April of 2008, we asked teachers at each of the five schools to indicate the frequency of interaction with other educators on a variety of relationships. These network questions were generated from previous social network research (Cross & Parker, 2004; Daly, Moolenaar, Bolivar, & Burke, 2010; Moolenaar, Slegers, Karsten, & Daly, 2012). For this study we focused on the network of knowledge about reading comprehension as this relationship was most directly related to the reform effort underway as well as the ELA student achievement outcomes we were interested in examining. The network data was generated by the prompt, Please select the frequency of interaction with teachers with whom you share knowledge regarding reading comprehension? Respondents indicated the frequency of interaction in the relationship on a four-point scale ranging from one (one to two times in six months) to four (one to two times a week). Participants within each school received a roster with teachers from their schools in rows and the frequency of interactions for each relationship in columns. This bounded method is a social network strategy that provides a more complete picture of the network and thus supports valid results (Scott, 2000).

While the data collection process rendered social networks at various frequencies of interaction, we chose to focus on the most frequent ties, meaning interactions that occurred from two to four times a month (three and four on the rating scale). We selected the most frequent ties as respondents tend to be more accurate at identifying ongoing patterns than determining occasional interactions (Carley & Krackhardt, 1999) and as we were interested in more stable patterns of relations (Krackhardt, 2001). Moreover, the most frequent interactions may reflect stronger links that may be capable of transmitting more complex information (Daly & Finnigan, 2011; Krackhardt, 2001) and as such may support the exchange of instructional practices related to student achievement. We then calculated a series of individual network measures using the UCINET software (Borgatti, Everett, & Freeman, 2002) around the reading comprehension knowledge network.

In addition, we created a graphic representation of each schools full reading comprehension network using Netdraw (Borgatti, 2002), which provides a visual image of the network and illustrates overall relational and achievement patterns to better understand the data. We then calculated degree centrality measures for each of the individuals in the networks to determine the total amount of ties an individual sends (out-degree) and receives (in-degree) in the reading

comprehension knowledge network. Given that our prompt asked teachers with whom they share knowledge regarding reading comprehension, a teachers out-degree reflects the number of individuals with whom a teacher indicates they share reading comprehension knowledge, meaning a teacher with a high out-degree is a teacher who seeks out more individuals with whom to share knowledge, whereas a teacher with a low out-degree seeks fewer individuals with whom to share knowledge. In contrast, a teachers in-degree reflects the number of individuals that have chosen a particular teacher with whom to share knowledge. In other words, a teacher with a high in-degree is a teacher who is more often sought for the sharing of reading comprehension knowledge, whereas a teacher with low in-degree is less sought.

Centrality has been thought of as an index of activity (Freeman, 1979), with highly central actors in a network having increased access to resources and potential to create new linkages that may enhance social capital (Stuart, 1998; Tsai, 2001). A central position can be considered as a point of intersection in the network, with central individuals able to disproportionately and more quickly amass and distribute resources, thus allowing them to influence the knowledge that flows in a network (Raider & Krackhardt, 2001). In contrast, those who are less central occupy a more peripheral position in the network and as such may share less knowledge around reading comprehension and not have the same opportunities to gain from the resources and information as those in more central positions.

For our analysis we computed normalized in-degree and out-degree centrality for teachers within their own school networks. Normalized in-degree and out-degree reflect the actual actor degree as a percentage and can vary on a scale of zero (the teacher has no incoming and outgoing relationships and occupies a marginal position in the social network) to 100 (the teacher initiates all the incoming and outgoing ties in a network and occupies a highly central position).

We also computed the measure of ego-reciprocity to establish the percentage of reciprocal relationships for each teacher. Reciprocal relationships have been associated with increased opportunities to deepen knowledge and build communities of practice as well as potentially having a constraining effect on knowledge exchange (Honig & Ikemoto, 2008; Kilduff & Tsai, 2003; Lave & Wenger, 1991; Wenger, 1998). Ego-reciprocity is calculated as the proportion of reciprocated ties in which an individual is involved, divided by the total number of ties to and from that actor. As such, an ego-reciprocity score of zero indicates that none of the relationships in which an individual is involved are mutual, while 100 indicates that all relationships in which the actor is involved are reciprocated. The normalized degree scores as well as the ego-reciprocity measure account for the size of the network, thus making these network measures comparable between individuals and across schools.

The means and standard deviations for the network measures are included in Table 2. Results for the most frequent relations indicate that teachers are only using 4% of available ties for incoming relations and 4% for outgoing. These findings suggest that on average the reading comprehension network is relatively sparse with few outgoing and incoming frequent ties (meaning sharing knowledge regarding reading comprehension between two to four times a month). In regard to ego-reciprocity, on average only 23% of the most frequent ties are reciprocated in the reading comprehension network. This indicates that less than a quarter of ties are mutual in terms of both teachers selecting one another in regard to sharing knowledge about reading comprehension. As network data is typically not normally distributed, for the social capital measures of in-degree, out-degree, and ego-reciprocity we created three categories for our analysis: no ties, midrange, and high, each representing roughly a third of the population (see Table 2). These categories provided us with the ability to be responsive to assumptions of normal distribution in the sample and compare among teachers with different levels of social capital.

Variables and Analysis

As our main analytic strategy was a hierarchical linear model, in the subsequent paragraphs we outline the dependent and independent variables we used to create our models.

Dependent variable: Student achievement. The benchmark scores for each trimester range between zero (reflecting low performance) to 100 (reflecting high performance) on benchmark assessments. Our dependent variable was derived from the student population (1,196 students) from each of the five sample elementary schools using the ELA-IBA results from the May 2008 administration in third to fifth grade.

Interim Benchmark Assessment. As part of their overall instructional improvement effort, the Avaluator school district has been using the Houghton Mifflin (HM) benchmark assessments. These benchmark assessments are provided by HM and are designed to align with the reading series the district has adopted to support its focus on reading comprehension. The district administers these assessments three times over the course of the year (November, February, and May). The trimester benchmarks have been designed to cover areas such as reading comprehension, vocabulary and concept development, and literary response and analysis. Each assessment contains an average of 6575 multiple-choice items to make sure that skills are adequately assessed during each administration. Resulting scores are reported as a percentage rank reflecting overall performance bands with 059 reflecting far below standard performance; 6074 basic; 7589 proficient; and 90100 above proficiency.

As reported on the district web page and codified in publicly available improvement plans, AESD supports the collaborative analysis and discussion of benchmarks results through collegial conversations in an effort to improve instruction as a part of an overall systemic improvement effort. Teachers, coaches, and principals meet monthly in grade-level team meetings to analyze benchmark assessment data and use the results of this analysis to formulate grade-level action plans designed to identify gap areas and improve classroom instruction and student performance. In addition, the grade-level action plans identify students who are not making progress and the strategies to be used with those students to help them to meet goals. This use of interim benchmark assessments suggests the formative nature of the measures, and as a part of a larger coherent instructional improvement effort, may have potentially more impact on the immediate instructional practices of teachers than yearly summative standardized tests (Blanc et al., 2010; Riggan & Olah, 2011). Moreover, this approach indicates that the districts reform effort and use of these interim benchmark assessments was directly linked to an intentional focus on teacher social interaction and knowledge exchange as a means to improve student achievement in ELA.

Independent variable: Teacher human capital. Given studies regarding the influence of teacher human capital (Pill & Leana, 2009; Sigler & Ucelli Kashyap, 2008) we control for this variable. In order to operationalize the level of human capital for the teachers in the sample, we collected two proxies for human capital, namely years in education and years at the same school. For this study we make the assumption that given the length of time that the majority of teachers have been in education and the ongoing mandatory professional development that teachers would have experienced at a school site, both years as an educator and at a school site serve as reasonable proxies for teacher human capital.

Independent variable: Teacher social capital. We assessed teacher structural social capital through a variety of network measures including: in-degree, which represents the normalized incoming ties a teacher receives in relation to knowledge about reading comprehension; out-degree, which reflects normalized reading comprehension outgoing ties; and ego-reciprocity which is a measure of mutual relationships related to the sharing of knowledge around reading comprehension.

Independent variables: School level control variables. We included several control variables in our initial models, such as school-level (mean) achievement scores, school-level (mean) prior achievement scores, school-level (mean) special education ratio, and school-level socioeconomic status.

Independent variables: Teacher level control variables. We included teacher gender as a control variable as previous research has indicated that teacher gender may be related to position in a social network (Moolenaar et al., in press).

Independent variables: Student level control variables. In these analyses we controlled for student grade level (fifth is

the reference category) as well as gender and special education status. Approximately 7% of students in the sample were enrolled in some sort of special education instruction. We also controlled for number of days absent in school, which on average was six days ($SD = 5.9$) and the socioeconomic status (SES) of each student. We used participation in the free or reduced-cost lunch as a proxy for SES and employed a dummy variable to capture if students received free or reduced-cost lunch. In total, over half (56.7%) of our student sample received free or reduced-cost lunch. Finally, we also controlled for students prior year achievement using the California State Standards English Language Arts test in 2007 (CST-ELA 2007). We had to use the state standards test as a control as the district had inadequate benchmark data from 2007 (pilot year for the assessment). Unlike the benchmark assessment outcomes, the CST-ELA 2007 reports scale scores. The mean CST-ELA 2007 test scores (and standard deviation) in spring 2007 for third (355.4, $SD = 56.5$), fourth (340.1, $SD = 60.6$), and fifth (356.4, $SD = 55.7$) grades are presented in Table 3.

Analysis strategy. In order to account for the nested structure of our data (students of teachers in schools), we applied multilevel analysis (HLM) to examine our hypotheses. We started with a random intercept model (the baseline model) to decompose the variance of the dependent variable (student achievement) into a student level component, a teacher level component, and a school level component. After including and controlling for student, teacher, and school level control demographics (Model 1), we then added two human capital measures (years as educator and years in school in Model 2), and then added three social capital measures (in-degree, out-degree, and ego-reciprocity in Model 3) to test the relationship with ELA-IBA in the last (third) trimester to align with when we collected the social network data.

RESULTS

As a first step we ran a series of Pearson correlations. Results (see Table 4) indicate that a teachers experience measured by years at school was positively and significantly correlated with ELA-IBA in last trimester in 2008 (.30, $p < .05$) and CST-ELA in spring 2007 (.36, $p < .05$). These findings suggest the presence of a significant relationship between more years at a particular school site and higher scores on formative English Language Arts Benchmarks assessment and standardized testing (CLS-ELA 2007). Moreover, there were no significant relationships between teachers human and social capital, suggesting that the measures are assessing unique aspects of teacher capital related to reading comprehension. In addition, correlation results indicate no significant relationship between the three measures assessing social capital.

Table 4. Correlation Matrix of Study Variables

	1	2	3	4	5	6	7
1. ELA-IBA third trimester 2008	-						
2. CST-ELA 2007	.68***	-					
3. Years at school	.30*	.36*	-				
4. Years as educator	.13**	.19***	.71***	-			
5. Reading comp. ego-reciprocity	-.19	.09	-.03	.02	-		
6. Reading comp. out-degree	.17	.20	-.06	-.09	.15	-	
7. Reading comp. in-degree	.17	.33*	.05	.01	.17	.22	-

Note. $N = 63$. * $p < .05$, ** $p < .01$, *** $p < .001$.

As our data are nested we used hierarchical linear modeling (HLM) because of its capacity to model and evaluate structural relations in nested data (Raudenbush et al., 2004). Our multilevel models accounted for the fact that individuals and groups cannot be separated conceptually or empirically. We examined the impact of three distinct teacher social capital measures on student achievement using the ELA-IBA as the outcome measure.

The HLM models are reported in Table 5. In these analyses we included 1,196 students from 63 teachers from the five elementary schools. The models reported in Table 5 represent the most parsimonious models that fit the data well.⁵ We first undertook an unconditional analysis decomposing the total variance between the student, teacher, and school level (Model 1). Findings indicated that 68.2% of the variance among students ELA-IBA scores could be accounted for at the student level (192.04, $p < .001$). The teacher level accounted for 24.0% of the variance among students scores (60.54, $p < .001$), and the school level explained 7.8% of the variance among students (20.73, $p < .05$).

Table 5. Results of HLM Analyses for Student Performance^a in 2008

Variables	Model 1	Model 2	Model 3
	Parameter Estimate (SE)		
Intercept	69.08*** (1.48)	69.34*** (1.81)	71.32*** (1.86)
Level 1: Students			
Third grade (ref: fifth grade)	4.20* (1.54)	5.09* (1.51)	3.03 (1.34)
Fourth grade (ref: fifth grade)	2.77 (1.58)	3.89 (1.64)	2.94 (1.34)

Days absent	-0.13* (0.05)	-0.12* (0.06)	-0.11 (0.06)
Prior yr achievement	0.19*** (0.01)	0.19*** (0.01)	0.18*** (0.01)
Level 2: Teachers			
Years in school		0.26* (0.10)	0.31** (0.09)
Reading comp. ego-recip. (ref: none)			
Low/medium			-2.22 (1.29)
High			-6.89*** (1.56)
Reading comp. out-degree (ref: none)			
Low/medium			-1.06 (1.38)
High			3.05* (1.36)
-2 log likelihood	9,078.5	8,208.7	7,931.4
Deviance (df)		2 vs. 1 (1)	3 vs. 2 (4)
χ^2		869.9***	277.3***
Deviance (df)			3 vs. 1 (5)
χ^2			1147.7***
School variance	0.0386	0.0831	0.0607
Teacher variance	0.1344	0.1041	0.0591
Student variance	0.8270	0.8128	0.8802

Notes: Null model for benchmark percent (last trimester): $\chi^2_{\text{Null}}(4) = 9,986.6$; School variance: 7.8%; Teacher variance: 24.0%; Student variance: 68.2%. $\text{ICC}_{\text{Benchmark}} = .078$, $\chi^2(1) = 191.3$, $p < .0001$. $N = 5$ schools, 63 teachers, 1196 students.

^a Student achievement is measured by last (third) trimester benchmark assessment (in percent).

^b Prior year achievement is measured by CST-ELA standardized test scores in spring 2007.

* $p < .05$ ** $p < .01$ *** $p < .001$

Our first model examined the relationship between student level demographics on student achievement (Model 1, Table 5). The results indicate that students in third grade (4.20, $p < .05$) had higher ELA-IBA scores compared to students in fifth grade. We found that students with more days absent had significantly lower ELA-IBA scores (-0.13, $p < .05$). We also found that students' prior achievement standardized test score (CST-ELA 2007) was positively and significantly related (.19, $p < .001$) to student achievement as assessed by ELA-IBA (in the last trimester in 2008) (see Table 5).

In Model 2, we then added the human capital measures (years in education and years in school) to examine the relationship between the human capital and achievement. The final model rendered a positive significant association between teachers years at the same school and students ELA Benchmark scores (.26, $p < .05$) (see Table 5). This model added significantly to the baseline model ($\chi^2_{2 \text{ vs. } 1}(1) = 869.9$, $p < .001$) (see Table 5).

THE RELATIONSHIP BETWEEN SOCIAL CAPITAL AND STUDENT ACHIEVEMENT

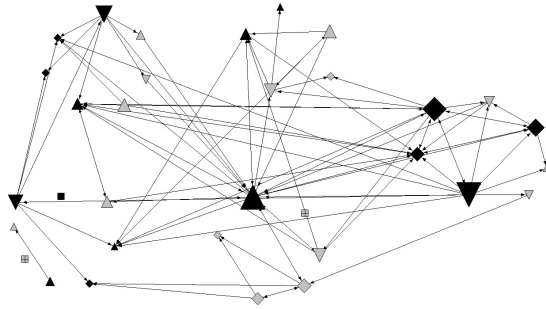
We examined the relationship between the three structural social capital measures (in-degree, out-degree, and ego-reciprocity) on student achievement in Model 2. The final, most parsimonious model rendered a positive relationship between teachers out-degree (high vs. none) and ELA-IBA scores (3.05, $p < .05$). ELA-IBA scores were also positively related to the human capital proxy of teachers years in school (.31, $p < .05$). Teacher ego-reciprocity (high vs. none) showed a negative association with ELA-IBA scores in the last trimester (-6.89, $p < .001$). The social capital model (Model 3) added significantly to the first baseline model ($\chi^2_{3 \text{ vs. } 1}(5) = 1147.7$, $p < .001$). Similarly, the social capital model (Model 3) added significantly to the second model, which included student level demographics, prior achievement, and teacher level human capital ($\chi^2_{3 \text{ vs. } 2}(4) = 277.3$, $p < .001$) (see Table 5). In sum, our results suggest that even when controlling for student demographics and prior achievement, teacher human and social capital have a significant relationship with student performance as measured by interim assessments. Moreover, teachers social capital (in terms of out-degree and ego-reciprocity) is related to students achievement on the interim benchmark assessment even above and beyond teachers human capital (as assessed by the proxy measure of years of experience in the school).

In sum, teachers who have more human capital, or accumulated knowledge and experience through spending more years at their school, have students who on average score higher on the ELA-interim benchmark assessment. In addition, teachers social capital is also related to students scores on the interim benchmark assessment. To be more specific, the more teachers seek out others to share reading comprehension knowledge (out-degree) and the less they engage in mutual knowledge exchange (ego-reciprocity), the higher the achievement of their students on the ELA interim benchmark assessment. As such, teachers social capital contributes to student achievement above and beyond teachers human capital.

While the HLM provides the statistical results of our data, these findings can also be portrayed graphically (see Figure 1). The sociogram in Figure 1 portrays relationships of teachers who frequently interact around reading comprehension from a representative school in our sample. The nodes are organized by grade level with first grade at the bottom of the graph and moving in clockwise order ending in the fifth grade team on the far right.⁶ The nodes in Figure 1 are sized by out-degree (larger size indicates more outgoing ties), which was shown in our HLM to be a significant positive predictor of performance on the ELA-IBA. In the sociogram the nodes are colored by achievement rankings (with darker nodes reflecting above proficient performance [75 and above] and lighter colored nodes below proficiency [below 75]). In addition, the nodes are shaped by the human capital control measure of years in school with diamonds referring to those in the school the longest (13 years and greater), up triangles (8-12 years), and down triangles (less than seven years)⁷, with similar shape meaning similar years at the school.

Figure 1. Representative School Reading Comprehension Knowledge Network with Human and Social Capital and

Student Outcomes



Note. Nodes are organized by grade level with first grade at the bottom and moving clockwise order ending in the fifth grade team on the far right; colored by achievement ranking (darker: \geq proficient; lighter: $<$ proficient); sized by out-degree (outgoing relationships); colored by achievement ranking (darker: \geq proficient; lighter: $<$ proficient); shaped by years in the school (diamond: 13+; up triangle: 8-12; down triangle: \leq 7).

As can be seen in the sociogram from the representative sample school, those teachers who have been in the school for longer periods of time (diamonds), the proxy for more human capital, are often the ones with higher student achievement (darker in color). In addition, those teachers who have more social capital, reflected by outgoing ties (larger sized nodes), are typically the ones with higher student achievement outcomes (darker in color). However, what is also clear from this sociogram is that teachers in different grade levels vary in terms of the amount of human and social capital, meaning that these resources are not evenly distributed across individuals or grade levels. For example, over one third of the teachers in the fifth grade team (on the right side of Figure 1) have been at the school less than seven years and there are few ties within that grade level regarding knowledge exchange related to reading comprehension. Moreover, there is only one teacher in the fifth grade whose students performed at proficient and above on the ELA-IBA. In terms of social capital it is also evident that within a couple of grade levels certain teachers have amassed greater social capital through sharing knowledge (i.e., larger nodes). In this sense social capital is also not evenly distributed across the school/grade level, with certain teachers perhaps having greater social advantage in terms of exchanging knowledge that may support student performance. While the analysis of this sociogram highlights grade-level differences that were not apparent from our multilevel models, this fine-grained analysis of a single school provides additional insight into the role of human and social capital and how these two types of capital may support or constrain achievement at both the individual and grade level as well as across a school.

DISCUSSION

As more elementary schools adopt structures for teacher social interaction in support of knowledge exchange particularly during the implementation of large-scale educational changes, such as the Common Core Standards, there is a need to better understand how schools may capitalize on these opportunities in ways that improve student learning. In this study, we argue that teachers social capital is an important element in the process of educational improvement and increasing student outcomes. Using social network analysis and hierarchical linear modeling, we examined the relationship between social capital, measured by teachers social position in the reading comprehension knowledge network, and student achievement as assessed in five elementary schools on an interim benchmark assessment. This work adds to the growing empirical base that suggests that teacher social interaction has a relationship with student achievement (Baker-Doyle, 2011; Bryk & Schneider, 2003; Chrispeels et al., 2007; Goddard et al., 2007; Moolenaar et al., 2011; Vescio et al., 2008). As most studies draw on standardized assessments as a measure of student achievement, this study contributes to existing research by examining how teachers knowledge sharing is related to a student achievement measure that may be more directly connected to the formative process of teaching, namely an interim benchmark assessment that was part of the larger district improvement effort.

Our findings suggest that this interim assessment of student achievement is positively associated with the level of human capital of teachers, in the form of length of time at the same school, reflecting studies which have employed standardized achievement scores as outcomes (e.g., Pii & Leana, 2009). Above and beyond the importance of human capital for student achievement, our results also suggest that social capital of teachers is associated with higher student achievement on the interim assessment, meaning the act of reaching out to other teachers to share knowledge regarding reading comprehension is associated with higher student scores on the ELA interim benchmark assessment controlling for demographics and past performance. Results also suggest that while increased sharing of reading comprehension knowledge is associated with higher student achievement, an increased number of mutual relationships (ego-reciprocity) may signal lower student achievement. Perhaps if ties are primarily reciprocated they may reflect a more closed system, which may leave little room for the influx of new ideas or practices. Finally, a close examination of the teacher networks across the sample through the network visualization suggests that human and social capital resources may not be evenly distributed both at the individual and grade level. Overall our exploratory work indicates that teachers human and structural social capital are associated with student achievement as assessed by an interim assessment. As such, this study offers a unique insight into the role of accessing these capital resources and student achievement in strengthening schools under increased pressure to improve. In the following sections we will discuss each of the major findings and their potential implications on the work of improving school effectiveness through attending to teacher interaction around interim assessment results.

HUMAN CAPITAL AND STUDENT ACHIEVEMENT

Similar to earlier work (e.g., Pii & Leana, 2009), this study found that the length of time a teacher was at the same school (proxy for human capital) was related to higher student achievement on an ELA interim benchmark assessment. This result suggests that similar to other professions, teachers learn by doing and that experience in a specific context may be important in developing craft knowledge to improve student achievement. Teachers with more experience in a specific context are likely to have more knowledge about a student population as well as experience in teaching academic content. Given this knowledge and experience, these teachers may also have a stronger foundation to incorporate new instructional knowledge that is enhanced through opportunities for learning (Kilburn & Karoly, 2008; Milanowski et al., 2011; Parise & Spillane, 2010; Penuel, Fishman, Yamaguchi, & Gallagher, 2007; Wei, Darling-Hammond, Andree, Richardson, & Ophanos, 2009).

The importance of length of time at a school site for student achievement on formative interim benchmark assessments may also be affected by job- and site-embedded professional learning and related opportunities for teacher social interaction and knowledge exchange, which have been underway in the Avaluator school district for a number of years. Such professional learning and opportunities for social interaction that bring together teachers from a particular school site in examining and improving practice, for instance in communities of collaborative inquiry, have been demonstrated to improve outcomes (Andrews, 2005; Chrispeels et al., 2007; Cochran-Smith & Lytle, 1993, 2009; Gallucci, 2008; Little, 1993). The idea underlying this embedded development is that teachers in a particular setting require a unique set of contextually related skills that can best be delivered on-site with teachers at a similar grade level. This model of

professional learning provides support and training closest to where the instruction will be taking place (local school/classroom) and as such values and builds on existing local knowledge in improving instruction (Gallimore, Ermeling, Saunders & Goldenberg, 2009; Hatch, 2009; Penuel et al., 2007). However, it is also important to note that an alternative explanation for this finding is that those teachers with more seniority in the school, as in other institutions, may have increased influence (e.g., Lazega & Pattison, 2001; Moolenaar et al., in press) and as such may receive preferential treatment in terms of which students are assigned to their classes.

SOCIAL CAPITAL AND STUDENT ACHIEVEMENT

Our work also indicates that in addition to teachers human capital, social capital is an important element in understanding student achievement. We examined social capital in terms of outgoing and incoming ties related to reading comprehension as well as the presence of reciprocated relationships. Overall we found a significant relationship between outgoing ties and student achievement as measured by the interim benchmark assessment. This suggests that teachers individual behavior in seeking out others to share knowledge may be supportive of increased achievement for their students. This seems to imply the importance of nurturing a culture in which these interactions are supported as well as ensuring that structures are in place for teachers to share knowledge, as has been suggested in other studies (Baker-Doyle, 2011; Bryk & Schneider, 2002; Chrispeels et al., 2007; Goddard et al., 2007; Penuel, Bates, et al., 2012; Spillane, 2006; Vescio et al., 2008). This process of sharing knowledge may result in both accessing and enhancing instructional knowledge and practices, which may be then applied to improve student outcomes. Research suggests that more intense engagement and joint work is needed to bring about changes in instructional practices, which may result from sharing knowledge (Andrews, 2005; Chrispeels et al., 2007; Little, 2003). Moreover, research around interim assessments suggests that these assessments are most effective when situated in a robust improvement cycle in which assessment data is gathered and jointly interpreted for problems and related solutions and then strategies are shared, enacted, and evaluated in classroom practice (Blanc et al., 2010; Cochran-Smith & Lytle, 2009; Goertz et al., 2009). This process implies the importance of sharing and collaborative efforts necessary for engaging in effective practices.

Teachers who were more central in the network, meaning those with higher out-degree, frequently sought out other teachers in their school to share knowledge as well as having students who performed better on interim assessments than other less central educators. These central teachers amassed more structural social capital and in some sense were at a greater social advantage in terms of accessing and amassing a wider range of knowledge, which may have resulted in comparatively better student outcomes on assessments. However, an alternative explanation may be that those teachers who seek out others to share knowledge do so because their students are in fact doing better, and therefore share their knowledge with colleagues. In order to better tease apart the directionality of the relationship between out-degree and student achievement, future longitudinal work complemented by qualitative research will be important. However, regardless of the direction, our work suggests that the idea of actively sharing knowledge may be useful for supporting student achievement on interim assessments as these high out-degree individuals may serve as potential valuable distributors of resources related to improvement (Coburn, Pearson, & Woulfin, 2010).

Our unexpected results around ego-reciprocity and its negative relationship to student outcomes may be explained when we consider that we were assessing a *knowledge network*. Previous studies regarding knowledge exchange suggest that if an individual is seeking knowledge they are more likely to go to someone perceived to have expertise (Inkpen & Tsang, 2005; Lazega & Van Duijn, 1997). It is less likely that an individual who is sought (expert) is going to reciprocate that knowledge-seeking relationship as they presumably possess the requested knowledge. In trying to understand our finding, perhaps if a teacher is sharing knowledge regarding reading comprehension, which suggests they may also be in search of new/more knowledge, and that relationship is reciprocated by another teacher who is also seeking/sharing knowledge, according to our results, the mutual interaction is not likely to result in higher student achievement results.

Alternatively, our previous work in different settings has also suggested a negative relationship between reciprocal ties and school level outcomes, such as overall team trust (Moolenaar, 2010), and perhaps this can shed light on our results as well. It may be that teachers who engage in reciprocal knowledge sharing relationships tend to turn to those with whom they have a safe and strong relationship instead of seeking knowledge from a wide variety of others. As such, reciprocated ties in this sense may represent a more closed feedback loop, which constrain teachers from considering other sources of knowledge given the strength of the reciprocated tie. This finding replicates earlier work that indicates that increased reciprocity between actors in a social network does not necessarily imply positive effects (Moolenaar, 2010), as increased numbers of mutual relationships may induce clique formation, which potentially results in the circulation of redundant information and wariness of new practices and influences (Frank, Zhao, Penuel, Ellefson, & Porter, 2011).

Hence, just providing teachers with the opportunity to work together and reciprocally share knowledge may not be enough to improve outcomes and may in fact inhibit student performance at least on interim assessments as our data suggests. This finding seems to indicate that not only is it important for teachers to share but that this sharing must be done across a system and include engagement with others with whom a reciprocated relationship may not exist. More research is needed to yield additional and more specific understanding of this paradoxical negative relationship between reciprocal relationships and achievement outcomes.

FORMAL STRUCTURES TO SUPPORT INFORMAL INTERACTIONS

The Avaluar school district intentionally undertook district-wide reform to increase teacher social interaction around reading comprehension for all staff. However, our work suggests that social capital appeared to be unevenly distributed across individuals and grade levels. Some teachers were richer than others in terms of their ability to amass social capital, which was associated with their students experiencing increased achievement. Recent work suggests that formal district policies can affect the informal interactions of teachers and as such may be able to provide access to social capital resources (Coburn, Pearson, & Woulfin, 2010; Coburn, Honig, & Stein, 2009; Sun, Frank, Penuel, & Kim, 2013). Applied to our study this suggests that formal policy can support the development of social interactions that may have an effect on student achievement. Examining ways in which resource exchanges may be facilitated through ongoing and sustained interactions, both formal and informal, may be a useful strategy for increasing collaboration and student outcomes (Baker-Doyle, 2011; Daly, 2010).

Our data also suggests that although individuals and grade levels may be embedded within a school and a larger district context with similar instructional and improvement demands, there may exist differing levels of social capital across schools, which will likely benefit some teachers (and eventually students) more than others. As reforms are layered onto existing social and professional networks, which contain varying amounts of teacher human and social capital, this may in fact constrain efforts in taking hold (Atteberry & Bryk, 2010; Tsai, 2002). To increase the likelihood of reforms being taken up and increasing student outcomes, educational leaders at the district and school level may benefit from a deep consideration of existing teacher networks prior to and during the implementation phase of a reform. Formally creating opportunities and structures to support networks in moving useful instructional knowledge may be an important element of the reform itself (Smylie & Evans, 2006). It bears noting that this emphasis on the more relational aspects of the reform suggests an equally important supplemental role to the more technical aspects of school improvement that are currently demanded by many educational policy instruments (Daly et al., 2010; Spillane, Reiser, & Gomez, 2006).

Considering how to design and orchestrate the necessary conditions that promote network stability and opportunities to develop relationships may provide for increased outcomes (Dhanaraj & Parkhe, 2006; Ebers & Grandori, 1999; Kenis & Knoke, 2002; Madhavan, Koka, & Prescott, 1998). This study shows that a potential route to improvement may be through creating the opportunities for teachers to share knowledge. Enacting reforms, which includes attending to the number and opportunities for ties to form and deepen the quality of exchanges within those relationships, will be critical as large-scale change efforts such as the Common Core Standards face educators. This suggests providing capacity

building in both the reform effort and interpersonal skills such as facilitation, active listening, and questioning appears critical for the improvement of student performance (Cochran-Smith & Lytle, 2009). Providing an intentional focus on, and opportunities for, teacher interaction in a high-trust environment may allow for strengthened teacher networks and better access to and more equal distribution of available knowledge resources, which may in turn support stronger teacher teams as well as student outcomes (Daly et al., 2010). One point from our work is that while reformers may have limited opportunity to impact human capital in terms of length of time at schools, they may be able to design policies that support knowledge exchanges through social interactions (Penuel, Bates, et al., 2012; Penuel et al., 2009). This idea of formal policies influencing informal relations is an area that is ripe for additional exploration (Coburn et al., 2010; Coburn & Russell, 2008; Daly, 2010; Honig, 2008).

DELIMITERS AND AREAS FOR FUTURE RESEARCH

Although our exploratory study provides interesting results that offer support to related work (Pil & Leana, 2009), there are several delimiters that must be noted. Our study is limited in that we have examined a relatively small sample of teachers within elementary schools that are improving, which may have contextual influence of which we have not accounted for in our work. We also used an interim benchmark assessment as our outcome measure for student achievement that may not be as easily comparable across schools. Therefore, it may be difficult to assess what improvement on these assessments may actually reflect and as such suggests the importance of additional qualitative work as has been conducted in other studies on interim assessments (Bulkley et al., 2010; Goertz et al., 2009). Moreover, there is significant debate on the relationship between human capital and student outcomes, so future work will likely need to include more robust measures of human capital beyond just years of experience.

Lastly, although the quantity of social relationships appears important from this study, better attention to the quality of the exchanges between educators is critical. As mentioned in the theoretical framework, more exchanges and sharing does not necessitate better outcomes. The quality and depth of the exchanges between teachers, as well as the content of what is flowing through those ties, is extremely important. Dense networks of poor quality information are not likely to increase outcomes, nor is frequent sharing of bad knowledge. Better understanding of the depth and content involved in the exchanges between teachers is therefore vital. Moreover, understanding the climates in which this work takes place is also imperative as negative and conflictual climates may inhibit both the quantity and quality of exchanges (Daly, 2009). In this exploratory study we asked about sharing knowledge, which presupposes that it is good knowledge that is being shared in a supportive climate, but we lacked an assessment of the content of shared knowledge and overall climate data. This suggests the need for more careful and considered approaches to understanding the role of teacher social interaction, the quality and depth of exchanges, and the climate in which these relationships exist as a way to better understand efforts at improving student outcomes.

The limitations to our work also indicate additional important and rich areas for further examination. First, additional studies that have larger and more varied samples are indicated as well as those that explore different content areas such as math and science in various educational settings. In addition, it would be important to examine the role of district content coaches and principals in supporting reform. As our data is from a subset of schools in one district at a point in time, it would also be interesting to explore all the schools within one district over time in order to capture the potential influence of context and directionality of the relationships. In addition, although we used robust statistical techniques in this study, better qualitative understanding of what flows through the network in terms of the content and depth of knowledge that was shared is critical. We had some interesting findings around which we can only speculate without qualitative data to better inform our suppositions.

ACCESSING CAPITAL RESOURCES

School reform is enacted in an effort to ultimately impact student outcomes. In improving outcomes many systems have created opportunities for increased teacher social interaction and the development of professional learning communities. Although there is a growing body of work associated with teacher social interactions and improved outcomes this is still an area that requires additional study. Moreover, much of the existing work relies on standardized assessments, which many educators indicate are less useful for honing instruction, as opposed to medium- and short-cycle assessments, which will likely take on more importance in the era of the Common Core Standards. Our work provides important findings to support the idea of teacher social interaction as related to student outcomes on interim assessments. This research also suggests that creating formal policies and structures for teachers to develop the social ties to one another in support of reading comprehension may be a useful strategy in accessing capital resources and increasing student performance. The experience and knowledge of an individual teacher is no doubt important for the improvement of student outcomes, but when teachers can be socially connected to one another in a rich network of knowledge sharing supported by formal and informal structures there appears increased potential to improve outcomes for students in underperforming schools.

Notes

1. Pseudonym.
2. Grades 15 are assessed using the ELA-interim benchmark assessments (IBA), but Grade 1 was in a pilot year.
3. Representing the prior student achievement control variable.
4. In addition, we tested two other measures of teachers experience as proxies for human capital, namely years of experience in current position and years of experience in the district, but the use of these measures did not significantly change the model under study and were therefore removed in favor of a more parsimonious model.
5. From our initial models, we removed one of the human capital measures (years in education); one of the social capital measures (in-degree); and several control variables that reflected demographics at the student level (student gender, reduced/free lunch status, and special education status), teacher level (teacher gender), and school level (mean achievement scores, mean prior achievement scores, mean special education ratio, and mean socioeconomic status) in favor of more parsimonious models as these indicators did not contribute significantly to the prediction of student achievement on the ELA-IBA.
6. Only Grades 15 are included as they are the only grades assessed using the ELA-IBA. Even though our HLM only drew on Grades 35 to be able to control for prior achievement, in the figure we include all tested grade levels to portray the overall school network and variation in human and social capital across the school.
7. Missing data is indicated by a square divided into fourths.

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