Experimental Effects of Program Management Approach on Teachers' Professional Ties and Social Capital

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Abstract

Theory and empirical work suggest that teachers' social capital influences school improvement efforts. Social ties are prerequisite for social capital, yet little causal evidence exists on how malleable factors, such as instructional management approaches, affect teachers' ties. In this cluster-randomized trial, we apply a decision-making perspective to compare a literacy intervention managed under a "fidelity-focused" approach, in which teachers were expected to implement researcher-designed procedures faithfully, versus a "structured adaptive" approach, in which teachers collaboratively planned program adaptations. In the short term, the adaptive approach increased teachers' accessing of intervention-related social capital, but decreased their accessing of social capital unrelated to the intervention. Short-term effects varied based on participants' role in the intervention. No group differences were found on social capital measures one year later, suggesting that the structured adaptive approach did not make teachers more likely to form ties that would be useful outside of the intervention.

Key words: Social capital, social network analysis, teacher networks, fidelity of implementation, adaptive implementation, cluster-randomized trial

Experimental Effects of Program Management Approach on Teachers' Professional Ties and Social Capital

In a growing body of literature, education researchers are applying social network theory to study teacher learning and school improvement, toward the ultimate end of understanding how policymakers and practitioners might leverage networks in advancing student learning (Spillane, Hopkins, & Sweet, 2014). Theory and empirical research suggest that teachers' professional ties, and the social capital that such ties enable, influence teachers' learning, instructional improvement, and the success with which reforms take hold in schools (e.g., Atteberry & Bryk, 2010; Bryk & Schneider, 2002). While social capital can take on a variety of forms, the term generally refers to the potential for individuals to "secure benefits by virtue of membership in social networks or other social structures" (Portes, 1998, p.6). Such benefits may come through the flow of information or material resources, obligations and expectations, trust, or norms and sanctions. In education, researchers have shown the importance of teachers' social capital for numerous outcomes, including the success of instructional reform efforts (Bryk & Schneider, 2002; Coburn, Russell, Kaufman, & Stein, 2012; Daly, Moolenaar, Bolivar, & Burke, 2010; Frank, Zhao, & Borman, 2004), the content and extent of teachers' learning and instructional improvement (Atteberry & Bryk, 2010; Coburn & Russell, 2008; Parise & Spillane, 2010), the diffusion of instructional innovations and best practices (Frank et al., 2004; Sun, Penuel, Frank, Gallagher, & Youngs, 2013; Sun, Wilhelm, Larsen, & Frank, 2014), and teacher satisfaction and retention (Johnson, 2004).

Given the importance of ties and their implications for school improvement, theory and practice would be advanced by research into the organizational and instructional management factors that decision-makers can manipulate to effectively shape tie formation and social capital

exchange within schools – factors such as the level of autonomy given to teachers, collaborative work structures, and the type of professional development offered. Such research could help school and district leaders predict the ways in which interventions and organizational restructuring efforts that manipulate these malleable factors might affect professional networks. This would enable administrators to influence tie-formation and leverage social capital in support of school-wide instructional improvement. However, little is known about the ways in which different instructional management approaches may differentially affect ties, and no experimental studies exist on the matter, making causal inference elusive. Furthermore, we lack empirical evidence on the effect that interventions with varying instructional management approaches might have on teachers' ties and exchanges of social capital relevant to instructional matters unrelated to the intervention. The expected direction of such an effect is not obvious, as there is reason to anticipate that teachers might use newly-formed intervention-related ties to exchange social capital unrelated to the intervention, or, conversely, that newly-formed intervention-related ties might crowd out ties unrelated to the intervention. Our study answers the call made by education network researchers for randomized designs that enable causal inferences about teacher network outcomes (Sun et al., 2013).

In this study, we use data from a cluster-randomized trial of READS, a summer literacy program for 4th graders that includes school- and home-based program components, to present the first experimental evidence on the formation of teachers' professional ties. Specifically, we compare two versions of the program: 1) Core READS, which takes a fidelity-focused management approach in which teachers are expected to faithfully implement researcher-designed program procedures, and 2) Adaptive READS, which takes a structured adaptive management approach in which teachers work within formal collaborative structures to adapt the

program in ways they believe will improve its effectiveness. Guided by the decision-making perspective on tie formation, we examine how the contrasting program management approaches affect educators' consultation decisions (Nebus, 2006) – specifically, does program management approach affect the size of teachers' consultation networks, the people from whom teachers seek consultation, or the content and frequency of consultation? We separately examine these outcomes for consultation on instructional matters related to the intervention, and instructional matters unrelated to the intervention. We also ask whether these effects differ depending on the individual's role in the intervention. Because ties and consultation are prerequisite for social capital exchange (Spillane et al., 2012), it is important to understand the malleable factors that affect them, separately from understanding what characterizes social capital exchanges that lead to improved student outcomes (a topic which we leave to future study).

We begin by providing background on network theory and the relevance of teacher ties to school improvement. We then summarize the decision-making perspective on how ties are formed, outline different approaches to instructional management, and consider the theoretical predictions regarding how contrasting approaches to instructional management may differentially affect tie formation among teachers. Next, we describe Adaptive and Core READS, the two models of intervention management studied here. Finally, we describe the methods, present results, and discuss implications.

Network Theory, Social Ties, and Social Capital

Social network theory can refer to theory about how individuals derive benefits from social capital or to theory about how and why individuals form social ties with one another (Borgatti & Lopez-Kidwell, 2011). Social ties and social capital are deeply connected, as social capital is something that "exists in the *relations* among persons" (Coleman, 1988, p.100-101,

emphasis in original). Social capital "facilitate[s] productive activity" (Coleman, 1988:101) and can take the form of obligations and expectations, norms and sanctions, or information-flow capability (Coleman, 1988). Across its varied forms, a defining feature of social capital is that social ties are necessary (though not sufficient) for its development (Spillane et al., 2012). As discussed below, education researchers have focused on particular aspects of social ties that are especially relevant to school improvement: the capacity of ties to transmit advice and information, support the implementation of reform initiatives, diffuse innovation, and serve as a source of moral support for teachers.

How are Social Ties Relevant to School Improvement?

Information and advice transmission. The information-transmission potential in social ties is of interest to education researchers because instructional improvements require teacher learning, and advice and information are critical components of learning (Elmore, 1996; Hill, 2004). Teaching is complex, uncertain, and non-routine (Hawley & Valli, 1999); when faced with such tasks, people often seek consultation from others (Nebus, 2006). Sharing information through social ties leads to new knowledge by allowing individuals to integrate the information with previously-held knowledge (Choo, 1998), and facilitates joint sense-making (Coburn, 2001; Daly & Finnigan 2010; Frank et al., 2004; Uzzi, 1997). Through the transmission of advice and information, social ties therefore have the potential to help teachers improve instruction and student learning. Indeed, research shows that teachers become more effective when other effective teachers join their grade-level team (Jackson & Bruegmann, 2009; Sun, Loeb, & Grissom, 2017)

Innovation diffusion. Both weak and strong ties play a role in the diffusion of innovations within and across schools. As transmitters of information, weak ties - or ties that

serve as "bridges" between separate intra-connected networks - are important for innovation diffusion because new information gained by an "ego" (the focal individual in a particular network analysis) through a weak tie is less likely to already be circulating among the ego's close network ties (Granovetter, 1973). For example, Sun and colleagues (2013) found that when teachers attended out-of-school professional development (PD), the strategies presented in the PD diffused through the attendees' schools. In this case, the attending teacher's weak tie with the PD provider served as a bridge introducing particular teaching methods to the more insular network of the school. Stronger ties among individuals within a school can also help innovations take hold in the school, through the influence of social pressure to implement the innovation (Frank, Zhao, & Borman, 2004).

Reform efforts. The ties held among teachers within a school have implications for the success of reform initiatives at that school, given that tie structure influences the flow of resources among network members (Daly et al., 2010). When teachers work in isolation and hone their skills through solitary trial and error, the development of shared, commonly-held principles of pedagogy is stifled (Lortie, 1975). In contrast, when teachers are well-connected with one another, standards of practice are able to develop and to be enforced through social norms (Frank et al., 2004). Ties can therefore serve as a useful resource in a reform initiative, given that changes become more embedded in practice when individuals interact around them (Daly et al., 2010). In the context of instructional reforms, more interaction around the reform has been associated with more collective action related to the reform (Daly et al., 2010), and with better and more sustainable implementation (Coburn et al., 2012; Frank et al., 2004). The underlying networks in a school, then, can be leveraged in order to support and improve instructional reform.

Teacher morale. Finally, ties among teachers can be valuable because of their role in promoting a feeling of connectedness in the workplace. Teachers who are disconnected from advice and support networks tend toward feeling uncertain, unsupported, overwhelmed, and ineffective (Johnson, 2004). Over time, these feelings can lead teachers to exit the profession (Johnson, 2004). Consequently, interventions that help build ties, even if these ties do not result in the exchange of social capital that directly improves instruction, can indirectly contribute to school improvement by reducing teacher turnover.

The Decision-Making Perspective on Tie Formation and Dissolution

Despite the indispensable role that ties play in building and transmitting social capital in its various manifestations, little is known about the ways in which contrasting instructional management approaches may differentially affect the networks and social capital within schools. Understanding this will allow for the prediction of how adopting different instructional management approaches, or introducing interventions with varying instructional management approaches, might affect professional networks. Such an understanding will enable school leaders to leverage ties and social capital in support of school-wide instructional improvement.

Following Nebus (2006), we adopt a decision-making perspective on how information and advice ties[1] are formed. Building on expectancy theory, Nebus (2006) sought to explain why an ego contacts a particular "alter," or potential advice-giver. He proposed that an ego's decision to contact an alter for consultation on some matter was a function of two things: 1) the ego's expectancy on what Nebus calls the "first-level outcome," or the ego's perception of the probability that the request would result in the receipt of advice, and 2) the ego's expectancy on the "second-level outcome," or the ego's perception of the probability that the received advice will be useful in advancing the goal that motivated the advice-seeking. In deciding when to

contact whom and for what purpose, the ego weighs the perceived value of receiving advice from a particular alter against the perceived cost of contacting that alter. Costs include opportunity costs because time or resources spent contacting or interacting with one alter to advance one second-level outcome cannot be applied toward contacting or interacting with some other alter, or advancing some other second-level outcome (Nebus, 2006).

Given that the number of ties one can simultaneously maintain is limited (Granovetter, 1973), the accumulation over time of decisions to contact one alter rather than another can result in the dissolution of network ties (Nebus, 2006). Relatedly, it is often easier to maintain currently-held ties than to form new ones (Nebus, 2006). Theory therefore predicts, and empirical work provides evidence, that people often use ties they formed for one purpose in order to access information or advice related to some other purpose (Coleman, 1988; Cross & Sproull, 2004).

In one study examining tie formation in a school setting, Spillane and colleagues (2012) found that shared individual characteristics such as race and gender predicted teachers' advice ties (a common phenomenon known as homophily), but teachers' organizational positions, such as shared grade-level assignment and holding a formal leadership position, were more important predictors. Relatedly, a change in grade-level assignment predicts the dissolution of ties with former grade-level colleagues (Spillane & Shirrell, 2017). In the context of accountability pressures, teachers are more likely to seek advice from high, rather than low, value-add teachers (Wilhelm, Chen, Smith, & Frank, 2016). All of these findings can be explained by the decision-making perspective, in that they provide examples of additional factors that individuals consider when weighing the value and costs of pursuing a tie. Teachers seeking instructional advice are more likely to expect that teachers in their same grade level, or with higher value-added scores,

will have useful advice (compared to teachers outside their grade level or with lower value-added scores); similarly, teachers may expect that people in leadership positions will have helpful advice, or will be more likely to respond to requests for advice.

Teacher Networks and Instructional Management Approaches

The decision-making perspective on tie-formation is helpful when considering how different approaches to instructional reform and management might affect the networks and social capital in schools. Two common and contrasting management approaches to instructional improvement are what we will call the "fidelity-focused" and the "structured adaptive" approaches (McDonald, Keesler, Kauffman, & Schneider, 2006). These approaches differ in their underlying assumptions about the nature of the work of teaching, and by extension, the role that teachers should play in school improvement efforts. As discussed below, these differences may result in contrasting effects on ties and social capital flow.

Improvement efforts taking the fidelity-focused approach are based on the assumption that instruction should be standardized and regulated, and that the teacher's job is primarily to implement prescribed instructional routines faithfully (Rowan, 1990; Rowan & Miller, 2007). Contrariwise, interventions taking the structured adaptive approach are rooted in the view that teaching is a non-routine task that cannot be standardized; rather, high quality instruction requires that teachers diagnose problems and make judgments about how to adapt instruction to best fit a given situation (Rowan, 1990; Rowan & Miller, 2007). Interventions rooted in this view promote collaborative learning among teachers and aim to help teachers understand instructional principles, which they can then draw from flexibly as they adapt instruction (Penuel et al., 2011; Rowan & Miller, 2007).

Effects of fidelity-focused vs. structured adaptive instructional management on teacher ties. As discussed above, the decision-making perspective (Nebus, 2006) suggests that fidelity-focused and adaptive approaches to educational interventions will lead to different outcomes for teachers' networks. Given that the goals (or the second-level outcomes) of teachers participating in these interventions differ, teachers' perceived value of seeking advice related to the intervention will likely differ. While the fidelity-focused approach presents teachers with a series of tasks to implement, the structured adaptive approach charges teachers with the non-routine, complex task of adapting instruction for a given situation. Because such challenges have no single correct solution, egos will seek consultation from alters for insight into possible paths and their likely results (Nebus, 2006). Instructional adaptation requires ongoing knowledge development, which is facilitated by professional ties and interactions among teachers (Spillane et al., 2012). In other words, the adaptive approach may introduce more of a perceived value to contacting alters, resulting in more tie-generation and social capital exchange compared to the fidelity-focused approach.

Effects on ties related and unrelated to an intervention. The evidence cited above suggests that the introduction of an intervention or reform into a school may affect teachers' network ties and their activation of social capital. However, past studies have not distinguished between ties through which teachers seek advice on intervention-related matters, and ties through which teachers seek advice on instructional matters unrelated to the intervention. As such, even less is known about how an intervention may differentially affect teachers' ties or social capital in areas related and unrelated to the intervention. Theory offers two contrasting possibilities.

According to the theory outlined above, acquiring information can be costly (in terms of expending time, energy, or resources), and therefore people often use ties maintained for one

purpose to acquire information for other purposes (Coleman, 1988; Cross & Sproull, 2004). Teachers who form a professional tie through their participation in an educational intervention may therefore use that tie to access information and expertise in some other instructional setting. Relatedly, if those with whom participants form new ties provide helpful consultation related to the intervention, the "halo effect" (Nebus, 2006) predicts that participants will expect this new tie to have helpful advice in other areas as well. Consequently, we might expect to see that increases in the number of people from whom teachers seek intervention-related advice are accompanied by increases in the number of people from whom the teacher seeks advice on other intervention-unrelated instructional areas.

At the same time, theory offers reasons as to why the opposite may be true. Due to the finitude of time and resources, cultivating or maintaining one tie presents opportunity costs for cultivating or maintaining another tie, and seeking advice for one purpose means a lost opportunity for seeking advice for some other purpose. With limits to the amount of consultation that one can receive over a given period of time, expanding one's network in one area may require a counter-balancing de-activation (at least temporarily) of network ties in another area. Over the longer term, attention to certain ties at the expense of others may result in the dissolution of inactive ties (Nebus, 2006). Relatedly, when actors focus their attention on using their ties to access social capital in one area, this may require an offsetting decrease in the amount of social capital accessed for other purposes.

Effects by position in the organizational structure. An individual's position in the organizational structure of an intervention may also influence the effect that participating in the intervention has on his or her network outcomes (Lincoln, 1982, as cited by Cross & Sproull, 2004). Responsibilities vary by organizational position, and therefore so do second-level goals.

The decision-making perspective suggests that this will motivate egos to seek different types of expertise from different alters, depending on the ego's position. For example, managers or administrators tasked with overseeing the execution of some project face different challenges compared to people tasked with executing the project. As such, people working on the same project may exhibit different choices regarding the formation of ties and the type of social capital accessed through their ties.

Although no direct evidence exists on the differential effects of contrasting instructional management regimes on network outcomes, or on whether these effects vary depending on one's position in the school's organizational structure, researchers have used observational data to study reform initiatives, organizational role, and social capital. In descriptive cross-sectional data, schools participating in reform initiatives tended to exhibit more ties among teachers (Weinbaum, Cole, Weiss, & Supovitz, 2008). Results from studies using longitudinal single-group/treatment-only designs suggest that instructional reforms with built-in collaborative structures may help schools develop instructional support networks (Atteberry & Bryk, 2010; Coburn, Mata, & Choi, 2013). Furthermore, the establishment of formal structures for teacher interaction has been associated with the depth of teachers' interactions, and teachers take advantage of opportunities to seek advice from instructional coaches when coaches are introduced into a school (Coburn & Russell, 2008). Malleable organizational structures therefore represent a potential tool for school leaders hoping to build teachers' social capital. However, an untested question is whether educational interventions with different underlying assumptions about the role of the teacher, and with different approaches to organizing the teacher's work, differentially affect teachers' ties and social capital.

Effects in the long-term. Social networks are dynamic, and changes to an ego's network that are precipitated by exogenous forces (such as a change in instructional management approach) may or may not be maintained over the longer term (Kossinets & Watts, 2006; Lubbers, Molina, Lerner, Brandes, Avila & McCarty, 2010). Just as the decision-making perspective can be applied to predict tie formation, so can it be used to predict the tie dissolution. For example, if teachers have a strong incentive to consult with their grade-level colleagues about instruction (Spillane et al., 2012), teachers who change their grade-level teaching assignment will likely form consultation ties with their new grade-level colleagues and weaken or dissolve consultation ties with their former grade-level colleagues (Spillane & Shirrell, 2017). Similarly, just as the introduction of a structured adaptive management approach may motivate teachers to seek new consultation ties, the removal of a structured adaptive instructional management approach may reduce teachers' incentives for seeking instructional consultation, resulting in the dissolution of ties. At the same time, tie-persistence has been shown to be predicted by closeness, frequency of contact, and the centrality in one's egocentric network (Lubbers et al., 2010). Consequently, if teachers form meaningful ties through participation in a structured adaptive intervention, or develop new intervention-unrelated incentives for seeking consultation through these ties, the ties may be maintained in the longer-term even after the adaptive intervention ends.

Summary and Research Questions

Theory and empirical work have illuminated the important role of social capital, and of the social ties that enable social capital, in teacher learning and school improvement. At the same time, little is known about how different approaches to instructional reform and management may differentially affect the network ties and social capital within schools, and no

causal evidence on this question exists. The decision-making perspective on tie-formation suggests that an adaptive, collaborative intervention may promote the development of intervention-related social capital more so than an intervention with a fidelity-focused approach to management. These effects may differ depending on the individual's role in the intervention, given that one's role determines one's second-level outcomes. Theory also offers contrasting predictions about how an intervention's management approach may affect participants' social capital in instructional areas unrelated to the intervention. On the one hand, teachers may use ties they formed or strengthened through their participation in an adaptive, collaborative intervention to access instructional resources unrelated to the intervention; on the other hand, limits to teachers' time and resources may require that an increase in intervention-related ties and social capital be offset by a decrease in intervention-unrelated ties and social capital. Finally, the decision-making perspective would suggest that ties formed through participation in a structured adaptive intervention may dissolve at the conclusion of the intervention, unless intervention-unrelated incentives develop for teachers to maintain those ties.

In this study, we contribute to the literature on teacher networks by presenting unique causal evidence on these issues; in particular, we examine the effects of implementing a particular intervention through a structured adaptive management approach, as compared to a fidelity-focused management approach. Using data from a school-level cluster-randomized trial of READS for Summer Learning, a summer reading program for fourth graders, we ask the following research questions:

1a) What are the *immediate* effects of a structured adaptive approach to educational program management (as compared to a fidelity-focused management approach) on: teachers' number of *intervention-related* ties overall, teachers' *intervention-related* ties with alters in

specific intervention roles, and the frequency with which teachers consult with alters for different *intervention-related* purposes?

1b) Do these immediate effects on *intervention-related* outcomes depend on the ego's role in the intervention?

2a) What are the *immediate* effects of a structured adaptive approach to educational program management (as compared to a fidelity-focused management approach) on: teachers' number of *intervention-unrelated* ties overall, the presence of *intervention-unrelated* ties with participants in specific intervention roles, and the frequency with which teachers access social capital for different *intervention-unrelated* purposes?

2b) Do these immediate effects on *intervention-unrelated* outcomes depend on the ego's role in the intervention?

3a) What are the *one-year follow-up* effects (i.e., one year after the conclusion of the intervention) of a structured adaptive approach to educational program management (as compared to a fidelity-focused management approach) on: teachers' number of *intervention-unrelated* ties overall, the presence of *intervention-unrelated* ties with participants in specific intervention roles, and the frequency with which teachers consult with alters regarding *intervention-related* and *intervention-unrelated* instructional areas?

3b) Do these follow-up effects depend on the ego's role in the intervention?

Methods

Intervention Procedures

READS for Summer Learning. READS for Summer Learning is a program designed to narrow income-based reading skill gaps. We compare two versions of READS - Core READS and Adaptive READS – which were randomly assigned to be executed at different

schools over the 2014-2015 school year and summer of 2015. For both versions of the program, only fourth grade students, their teachers, and school coordinators (described below) participated. Core READS is an evidence-based program (Kim, Guryan, White, Quinn, Capotosto, & Kingston, 2016) representing a fidelity-focused approach in which teachers receive training and resources to support their adherence to researcher-designed program procedures. In contrast, Adaptive READS takes a structured adaptive approach by having teachers work collaboratively with their grade-level teams to adapt READS in ways they believe will increase the program's effectiveness.

Core READS. Students in Core READS receive books in the mail over the summer, which are matched to their reading level and interests. Each book includes a "tri-fold" that leads students through the "READS reading routine." This routine, which is designed to engage students and scaffold their reading, includes a pre-reading activity that focuses students' attention on important text elements and a post-reading comprehension check. Students are expected to mail back completed tri-folds (with postage prepaid).

Core READS teachers attend a two-hour training during which they learn how to implement six scripted lessons at the end of the school year that prepare students for independently applying best practices for reading comprehension with their matched books over the summer. In order to bridge the home and the school, students and their families are invited to a READS Family Night (RFN) in the spring. At this event, families learn about READS and the tri-folds. Also in the spring, students complete a reading comprehension assessment and reading interest survey; this information is used in an algorithm to match students to books. Over summer break, students receive 10 books: 8 personalized matches and 2 books from the end-of-

year lessons. In the Core condition, the only implementation expectation of teachers is that they adhere to the six end-of-year lesson scripts.

Adaptive READS. Teachers at schools assigned to Adaptive READS attended an orientation session in November 2014 in which they learned the underlying principles of READS. Teachers received school-specific data from a previous year of (Core) READS implementation (e.g., data on tri-fold return rates and RFN attendance) and examined these data with their grade-level teams in order to develop hypotheses about ways the program may be improved in their school. After this initial meeting, teachers could opt for earning district PD credit by completing six online modules in December to learn more about the research-based principles underlying READS (81% of teachers surveyed in the spring participated in the modules). Teachers then met twice more formally – once in January and once in February – to finalize a plan, based on the data and the research-based principles, for how they would adapt READS. Examples of potential adaptations include developing new strategies to better scaffold the summer reading process, improving the quality of comprehension instruction at the end of the school year, developing strategies to strengthen the home-school connection, or using more detailed information about students' interests and reading levels to improve the summer book matches.

School Coordinators and CIS READS Leads. The non-profit organization Communities in Schools – North Carolina (CIS-NC) served as an implementation partner for all participating schools. In each district, CIS assigned a "CIS READS Lead" to work with all participating schools in the district (Core and Adaptive). The role of the CIS READS Lead differed slightly for each condition. For Core READS schools, Leads served as managers ensuring that components (e.g. teacher trainings, RFN) were executed as planned; in Adaptive READS

schools, Leads had this same responsibility but also led the February working group meeting and worked with teachers and School Coordinators to support them in executing their adaptation plans as needed.

At each school, the principal chose an instructional leader (e.g. literacy specialist, instructional coach, etc.) or teacher from outside of the fourth grade teaching team to serve as the school's READS School Coordinator (SC). In Core READS, SCs served as the school's contact person for the CIS READS Lead and provided assistance and answered questions for participating READS teachers as needed. In Adaptive READS, SCs had the additional responsibility of leading teachers in developing and executing their adaptations. Adaptive READS SCs participated in monthly phone meetings with Leads and the research team in order to plan any upcoming working group meetings or implementation activities, and address questions as they arose. In Adaptive READS, teachers received a $600 stipend and SCs received $1000; in Core READS, teachers received $300 and SCs received $600.

As discussed earlier, the effect of instructional management approaches on social capital outcomes may differ depending on an ego's position in the organizational structure, given that different roles inspire different second-level outcomes. In READS, SCs play more of a management/supervisory role compared to the teachers; consequently, the effect of a fidelity-focused approach versus a structured adaptive approach on SCs' network outcomes may differ from the effect on teachers' network outcomes. It will therefore be important to examine whether the effects of the Adaptive condition differ for teachers versus SCs in order to determine whether any observed main effects mask variation in effects across intervention roles.

Setting, Design, and Participants

Twenty-seven high-poverty elementary schools in seven North Carolina school districts participated in READS over the 2014-2015 school year and summer of 2015. All participating schools were recruited from a pool of schools that had participated in Core READS for at least one year prior. Schools with READS experience were recruited because their familiarity with the READS procedures would better enable Adaptive READS schools to make productive program adaptations. Although each participating school had experience implementing Core READS, the prior READS experience of participating teachers varied because in past years, students and teachers were randomly assigned to READS within schools.

Within districts, pairs (and one triad) of schools were matched based on school poverty level and performance on the state standardized test. Within each of these randomization blocs, one randomly-selected school was assigned to Adaptive READS; the other schools were assigned to Core READS. All fourth grade teachers at each participating school were required to implement their school's version of READS. In order to preserve the exogeneity of treatment assignment, we only include in our models teachers who were in the schools at the time of randomization.

Measures

To answer our research questions about immediate effects, we administered a web-based survey to teachers and School Coordinators in the spring of 2015 with questions about participants' intervention experiences (including constructs not examined here; see Kim, Burkhauser, Quinn, Guryan, Kingston, & Aleman, 2017; Quinn & Kim, 2017). The survey included original items and items adapted from other researchers' previously-validated surveys. In developing the survey, we went through several rounds of review with external experts in the areas of social networks and survey development. We also piloted the items with teacher

consultants prior to finalizing the survey. In order to answer our research questions about long-term effects, we administered a one-year follow-up survey in the spring of 2016.

Network ties (intervention-related and intervention-unrelated). We measure participants' ties through survey questions based on a previously-validated teacher network survey (Pitts & Spillane, 2009), with some adaptations made to align the survey with recommendations from the network survey literature (de Lima, 2010a; Marsden, 2011). Because our interest was in the effects of management approach on participating teachers' ties and consultation behavior, we took an egocentric approach to network analysis.

Immediate effects. For our outcomes measured immediately after the program period, we first surveyed teachers about their ego networks for consultation on instruction unrelated to READS. For this survey item, teachers were shown a list of faculty from their school (including administrators, other school leaders such as literacy coaches, and teachers in grades 2-5), along with their CIS READS Lead, and were asked to select the names of colleagues with whom they had consulted about teaching in general (unrelated to READS) over the past 2 months. They were told that the consultation could have taken place in a group setting, one-on-one, in person, over the phone, or over email. Respondents were also provided with two blank text boxes in which they could enter the names of anyone not on the list (respondents were given the opportunity to indicate that they had not consulted with anyone over the past two months, but no respondent selected this choice). On a subsequent survey item, participants were shown the same roster and were told to select the names of people with whom they had consulted about READS over the past school year. Respondents were given the same list of possible settings in which consultation could have taken place.

As discussed above, egos may be differentially motivated to contact alters holding different organizational positions. Past research shows that teachers are far more likely to have advice ties with other teachers in their grade level than with teachers outside of their grade-level (Spillane et al., 2012). Grade-level teams are dense networks (i.e., a relatively high proportion of potential ties are realized), and the theory of weak ties discussed earlier suggests that alters outside of an ego's primary network are particularly important for exposing egos to novel information, perspectives, or advice. As such, we examine the effect of Adaptive READS on egos' propensity to form ties with alters inside and outside the immediate school READS team, and in specific intervention roles (CIS lead, SC).

Using the two survey items described above, we constructed the following intervention-related outcome variables: 1) "Num. READS Alters (Total)", the total number of intervention-related ties, 2) "Consult CIS Lead on READS," a binary indicator for whether the respondent consulted with his or her CIS Lead about READS, 3) "Consult SC on READS," a binary indicator for whether the respondent (teachers only) reported consulting with his or her SC about READS, 4) "Num. READS Alters from READS Team," a count of the number of people from the respondent's school READS team (other 4th grade teachers, SC) with whom the respondent consulted about READS, and 5) "Num. Non-READS Team READS Alters," a count of the number of people at the respondent's school who were not on the school's READS team with whom the respondent consulted about READS. We created an analogous set of outcome variables related to consultation on instruction in general, unrelated to READS.

One-year follow-up effects. Our one-year follow-up survey included the network question from the original survey, in which teachers were asked to select the names of colleagues with whom they had consulted about "teaching in general" over the past two months. From

these survey questions, we created two variables similar to those described above for the short-term survey: "Num Alters (Total)," and "Consult CIS Lead."

Frequency of consultation for various content. The structured adaptive approach to organizing READS is hypothesized to affect not only to the presence or absence of particular ties for participants, but also the frequency and content of participants' consultations with their colleagues.

Immediate effects. For intervention-related consultation, we asked participants how often they had consulted with colleagues over the past two months about: 1) how to implement READS as designed by researchers, and 2) changes they are making to READS that will improve the program for their students. Answer choices for these questions included "never," "once or twice a month," "about once a week," "a couple times a week," and "daily or almost daily," which were assigned values of 1-5 before being standardized to a mean of 0 and *sd* of 1. We named these outcomes "Consult on READS Implementation" and "Consult on READS Adaptations."

For intervention-unrelated consultation, we asked teachers how often they had consulted with colleagues over the past 2 months on the following topics: subject matter content knowledge, planning course content, instructional strategies, preparing students for the North Carolina state test, and classroom management. Answer choices for these questions were the same 5 frequency categories listed above. We conducted a principal components analysis on these five items (α=.87), which yielded one factor with an eigenvalue above 1 (3.33), positively weighting all items and explaining 67% of total variation. We used these predicted component scores, standardized to a mean of 0 and *sd* of 1, as the "Freq. General Consult Index."

One-year follow-up effects. On our one-year follow-up survey, we asked participants two sets of questions about the frequency of particular types of consultation. Because teachers had not been involved with READS over the previous school year, we did not ask them about implementing or adapting READS (as in the original survey). However, using the same question formats as described above, we asked teachers how frequently they consulted with colleagues over the past two months about five literacy-related activities that READS was designed to impact (teaching students a reading comprehension routine, matching books to students for independent reading, engaging students' families in student literacy, supporting students' independent reading, and increasing students' engagement in reading). We used PCA to form these items (α=.87) into a "Freq. of Literacy Consultation" index, standardized to mean 0 and *sd* 1 (PCA yielded one factor with an eigenvalue above 1 at 3.32, positively weighting all items and explaining 66% of total variation). Secondly, we repeated the same procedures as described above to form a one-year follow-up version of the "Freq. General Consult Index" (α =.85, one factor with eigenvalue above 1 at 3.22, positively weighting all items and explaining 64% of total variation).

Analytic Plan

For each of the outcomes described above, we begin by fitting models of the form:

$$Y_{is} = \beta_1 ADAPTIVE_s + \beta_2 SC_i + \beta_3 NumPeers_s + \pi RB_s + \epsilon_{is} \quad (1)$$

where Y_{is} represents the relevant outcome for respondent *i* in school *s*, and ϵ_{is} is an error term assumed to be normally distributed. In this model, *ADAPTIVE* is a binary indicator for whether the respondent was in a school randomly assigned to the Adaptive READS condition (versus the Core READS condition), *SC* is an indicator for whether the respondent is the school coordinator, and *RB* is a vector of indicator variables representing randomization blocs. The meaning of the

NumPeers variable differs depending on the outcome being analyzed. When the outcome is the number of READS team colleagues with whom the focal teacher consulted (about READS or non-READS), *NumPeers* represents the total number of peers on the teacher's READS team; when the outcome is the total number of teachers outside the READS team with whom the teacher consulted, *NumPeers* represents the total number of teachers outside the READS team; *NumPeers* equals the sum of these when the outcome is the total number of colleagues with whom the teacher consulted, or any of the remaining outcomes.[2] In all models, we use school-level cluster-robust standard errors (with proper adjustments for finite group-level sample size).[3] To test whether the effect of Adaptive READS differed for teachers and SCs, we fit additional models that add to model 1 an interaction between *SC* and *ADAPTIVE* (interactions were not included on follow-up analyses due to small cell sizes).

Results

Descriptive Statistics

In Table 1, we present descriptive statistics by condition for baseline characteristics (top panel) and for outcome variables (bottom panel). As seen, random assignment was successful in creating groups of schools that were similar in terms of student percent free or reduced-price lunch and reading achievement. Teachers in both conditions were similar on years of experience and education. A higher proportion of teachers in the Adaptive condition had prior experience with READS, and Adaptive READS teachers were slightly more likely to be female compared to Core READS teachers. Importantly, the size of the READS teams tended to be slightly larger in the Adaptive schools (5.3 members on average, compared to 4.46 in Core READS schools), making this variable a critical control variable for the outcomes measuring teachers' number of

ties (gender and prior READS experience were not significant outcome predictors and were not included in the models; key findings are robust to their inclusion).

All teachers submitted the first spring survey. On the one-year follow-up, usable social network data were obtained from approximately 60% of teachers, and rates did not differ by condition.

<Insert Table 1>

RQ 1: Immediate Effects on Teachers' Intervention-Related Ties and Consultation (RQ1a), and Interaction Effects by Ego's Position in Intervention (RQ1b)

To address our research question 1a, we examined immediate effects of the structured adaptive approach on teacher outcomes. In Table 2, we present models predicting intervention-related ties. As seen in column 1, Adaptive READS caused participants to expand their intervention networks, with those in Adaptive READS reporting having consulted with approximately .8 more people about READS, compared to Core READS participants. In column 2, we see that the effect of Adaptive READS on participants' READS ties was descriptively larger for teachers as compared to SCs (RQ1b; $p<.10$). For teachers, Adaptive READS expanded the size of their READS network by 1.1 person, on average, while a post-hoc test revealed that the effect of Adaptive READS was not significant for SCs (b=-.33, p=.61).

<Insert Table 2>

In the remaining columns of Table 2, we see that these overall effects on participants' intervention-related ties mask variation in effects based on the role of the potential alter. Specifically, the overall effects are driven by Adaptive READS increasing the likelihood that teachers consulted with their CIS READS Lead (columns 3 and 4) and with other teachers

outside of their READS team (columns 8 and 9). Adaptive READS also may have made teachers more likely to consult with their SCs (p<.10, column 5).

In Table 3, we examine the immediate treatment effects on the frequency of teachers' READS-related consultations. As expected, we find evidence that, compared to teachers in Core READS, teachers in Adaptive READS consulted less frequently with their peers about implementing READS with fidelity (-.67 *sd,* column 2). However, the effect on this outcome for SCs differed (as demonstrated by the significant Adaptive*SC interaction term in column 2); for SCs, the effect was null and positively signed (1.255-.667=.58; p=.13).

<Insert Table 3>

As seen in column 3 of Table 3, Adaptive READS caused participants to more frequently consult with colleagues about adaptations to READS (.58 *sd*). However, as seen in column 4, this effect was driven by SCs; while the effect for teachers was not significant (ES=.38 *sd*), the effect for SCs was (1.37 *sd;* subgroup effects were significantly different from each other). The null effect of the Adaptive condition for teachers may be reflective of the time period inquired about; that is, it appears that teachers did not discuss adaptations after their formal READS meetings had ended.

RQ2: Immediate Effects on Intervention-unrelated Ties and Consultation (RQ2a), and Interaction Effects by Ego's Position in the Intervention (RQ2b)

In Table 4, we present the results of models testing the effect of the structured adaptive approach to READS on participants' ties in instructional areas unrelated to the intervention. We find that the structured adaptive approach had no significant overall effect on participants' total number of non-READS consultation ties (column 1), and the effect did not differ by intervention role (column 2).

<Insert Table 4>

This non-significant overall effect masks interesting variation in effects on different types of ties, however. Adaptive READS made teachers and SCs more likely to consult with their school's CIS READS Lead on non-READS instructional matters (columns 3 and 4). This positive effect was counter-balanced by making teachers and SCs *less* likely to discuss non-READS matters with other members of their READS team (columns 6 and 7).

In Table 5, we examine the effect of structured adaptive management on the frequency with which participants consulted with their colleagues about non-intervention instructional matters. While Adaptive READS had no significant overall effect on the frequency with which participants consulted with colleagues on non-READS instructional matters (column 1), effects differed for teachers and SCs (column 2). The condition caused teachers to consult with colleagues about general instructional matters significantly less often compared to Core READS teachers (-.45 *sd*); for SCs, the effect was not significant (b = -.452+.965=.51, p=.24).

<Insert Table 5>

RQ3: One-year follow up Effects

In Table 6, we present results from the one-year follow-up survey. As seen, random assignment to the Adaptive condition in the previous school year had no effect on the total number of alters with whom participants consulted on instructional matters (column 1) or the probability that a participant would consult with his or her former CIS Lead about instruction (column 2). The follow-up survey also showed no sustained effects on the frequency with which participants consulted with colleagues about literacy areas related to READS (column 3) or unrelated to READS (column 4).

<Insert Table 6>

Discussion

This study offers the first causal evidence on how the management structure of an educational intervention can affect teachers' social capital, as measured by consultation ties and frequency of different types of consultation. Immediately following the intervention, the collaborative, structured adaptive approach increased teachers' accessing of social capital related to the intervention, but decreased their accessing of social capital unrelated to the intervention. Furthermore, the organizational positions of participants influenced whether they sought consultation and whether they were sought for consultation. However, one year after the intervention, we found no lasting effect on our social capital indicators.

Immediate Intervention-related Outcomes (RQ1a & RQ1b)

Effects on ties. By charging participants with a complex task (i.e., to adapt the researcher-designed program) and providing a collaborative support structure for participants as they engaged with that task, Adaptive READS caused participants to increase the size of their READS-related egocentric networks. Furthermore, this effect was driven by teachers, who differed from SCs in that they were directly responsible for developing the adaptations, compared to SCs who were expected to play more of a supervisory role. The increase in network size came not because Adaptive READS teachers were more likely (compared to Core READS teachers) to consult with their grade-level team about READS, but because Adaptive READS teachers were more likely to consult with colleagues outside of their grade-level team, as well as the CIS Lead (and possibly the SC). Interpreting this result in light of the decision-making perspective, this suggests that charging people with an open-ended, complex, non-routine task provides a stronger level-2 incentive for an ego to consult with a greater number of alters. The

reason why teachers experienced larger effects compared to SCs may be because teachers' roles in the intervention induced more perceived value at level 2 in contacting alters for consultation.

The decision-making perspective can also help us understand the simultaneous null effect on egos' ties with READS team alters and positive effect on egos' ties with colleagues outside of the READS team. Faced with a more complex challenge, Adaptive READS teachers have motivation to expand their advice networks to include alters from whom they are more likely to get a fresh perspective; that is, they are more likely to access consultation through a weak tie. For example, teachers in the Adaptive READS condition may be interested in making adaptations to READS Family Night that will encourage higher attendance rates or will more effectively invest families in the program. Seeking advice from school personnel outside of the READS team would be a way of injecting novel ideas into such planning. Additionally, weak ties are more effective for transferring simple – rather than complex – knowledge (Hansen, 1999), making weak extra-grade-level ties well-suited exchanging simple planning strategies. For more complex knowledge-sharing, Adaptive READS teachers may have looked more toward their fellow READS team members, with whom they held stronger ties. Finally, some teachers from outside of the fourth grade team had experience implementing READS in previous years of the experiment, and the more complex work of Adaptive READS may have incentivized teachers to seek out these colleagues. In contrast, the Core READS teachers have the more straightforward task of implementing the prescribed program procedures, which induces less perceived value in contacting alters from outside the current READS team.

Consultation content and frequency. Given the differing second-level outcomes across conditions, it is also not surprising that Core READS would cause participants to more frequently consult with colleagues about implementing READS as designed by researchers while

Adaptive READS would cause participants to more frequently consult with colleagues about adaptations to the program. But why would the effect of Adaptive READS on frequency of implementation consultation be negative for teachers while SCs experienced a significantly different and positively signed but null effect? The answer likely lies in the different roles that teachers and SCs play in READS. In both versions of the program, SCs are responsible for managing the school's READS team as they execute their version of the program. Despite the fact that Adaptive READS teachers are expected to adapt the intervention, the structures through which schools develop adaptations – that is, the working group meetings and online modules – were not subject to adaptation. Given that Adaptive READS SCs managed this overall process, they had more reason to seek advice on implementation than did teachers in Adaptive READS (note, however, that Adaptive READS SCs also consulted with colleagues about adaptations).

Immediate Intervention-unrelated Outcomes (RQ2a & RQ2b)

The decision-making perspective also helps make sense of the observed short-term effects on non-intervention instructional ties and consultation. If Adaptive READS increased the perceived value of contacting alters for READS-related consultation, the flip side to this would be an increase in the perceived cost of contacting alters for consultation unrelated to READS. In principle, participants could have re-allocated time and resources from any number of other activities toward their increase in READS-related network activities. In practice, however, participants may have decided to decrease their consultation on non-READS related matters because time and opportunity for teachers to consult with colleagues are limited to common prep periods or before or after school. If teachers are using these opportunities to consult on READS-related matters, they have less opportunity to consult on other instructional matters. These results suggest that teachers may have some limit – either psychologically or in terms of actual

available time – to how many ties they can keep active over any given period of time, or to the number of topics about which they can consult with some fixed number of alters over a given period of time. Follow-up analyses provide supporting evidence of this notion: Adaptive READS had no effect on teachers' total number of unique ties (related or unrelated to READS; see online Appendix B).

One-year Follow-up Effects (RQ 3)

One year after the intervention ended, no lasting effects of intervention management approach were found on the size of participants' (intervention-unrelated) instructional networks, or on the probability that participants would consult with their former CIS Lead. While this may not be surprising given that management approach did not affect the overall size of participants' intervention-unrelated networks even in the short-term (Table 4, columns 1 and 2), it provides evidence that the intervention-related network ties formed in the short-term did not morph into intervention-unrelated ties after the intervention's conclusion. One possibility is that the structures in Adaptive READS did not produce ties of the sort that have been found in previous research to be durable over time – namely, ties that are strong, central to one's network, and contacted frequently (Lubbers et al., 2010). Doing so may require a longer intervention duration or structures specifically designed to generate intervention-unrelated ties. However, the lack of long-term effects may also be related to the fact that we surveyed participants specifically about their instructional consultation (professional ties), as opposed surveying them about their relations (e.g., closest colleagues). Frequent exchanges can lead to emotional closeness, whereby a tie becomes a relation that is valued in and of itself (Lawler & Yoon, 1996; Lawler & Yoon, 1998). If teachers' more frequent instructional consultation with one another under

Adaptive READS led them to develop relations that continued beyond the intervention, but with more personal (rather than professional) content, our survey would not have detected this.

The one-year follow-up also showed that management approach did not, in the long-term, affect the frequency with which participants consulted with colleagues about literacy areas related to the intervention or instructional matters outside of those areas. Considering that the structured adaptive approach caused short-term decreases in the frequency with which teachers consulted about intervention-unrelated instructional matters, this second finding is reassuring. It suggests that we perhaps need not worry that introducing a temporary structure that redirects teachers' attention to accessing social capital for some specific purpose will have negative long-term consequences for participants' social capital in other areas.

Implications for Policy and Practice

We began this article by arguing that the formation of teachers' consultation ties, and their frequencies of consultation about instructional matters, are important to understand because ties are prerequisite for the flow of social capital – including the transmission of information and innovation – and affect teacher learning, teacher morale, and the extent to which reform efforts take hold (Atteberry & Bryk, 2010; Daly et al., 2010; Johnson, 2004; Parise & Spillane, 2010). From the perspective of school- or district leaders, then, teacher ties are not likely to be seen as ends in and of themselves, but rather as potential facilitators of processes that ultimately lead to higher student achievement. As such, the findings in this study will be most useful when used alongside evidence about the circumstances under which social capital exchange leads to meaningful teacher learning and instructional improvement.

The contribution of this study lies in its illumination of the effects on the channels through which social capital flows – to whom, from whom, and under what management

approaches. We leave it to practitioners to decide how this evidence is informative to their context and their goals. For example, if – as suggested by our findings - network ties and consultation are zero-sum matters, this has implications for schools' decisions to adopt particular interventions or professional development experiences. Careful thought should be given to the endeavors around which schools decide to build social capital to ensure the social capital is built to support the activities that will yield the most benefit to students in a particular context. Some school or district leaders may prioritize building teachers' social capital around a particular instructional reform, and may not mind that consultation related to this reform may displace consultation on other instructional matters. Relatedly, different lessons may be taken from this evidence by leaders who are afraid that increasing teacher ties will only further entrench an existing toxic culture, compared to leaders who witness individual teachers making positive innovations should spread across classrooms.

Limitations and Future Research

As described above, Adaptive READS teachers received a slightly larger stipend compared to Core READS teachers, given the greater time investment required of them. Consequently, we cannot rule out the possibility that the network effects observed here were due in part to compensation differences (though we have no reason to believe it to be the case). Relatedly, we should acknowledge that the greater time investment required of Adaptive teachers must be considered part of the intervention in this case. That is, the Adaptive treatment is the combination of the charge to adapt the program, the training, and the additional collaborative time and structures given to teachers to develop their adaptations. Effects may have been different, for example, if we had compared the structured adaptive management strategy to a

third type of instructional management strategy in which teachers worked collaboratively to support one another toward faithful implementation of READS.

As discussed earlier, ties are necessary, but not sufficient, for the formation of social capital. Similarly, not all consultation yields learning or increased productivity. In this study, we do not have measures of the quality of participants' consultation or of the extent to which ties facilitated the flow of productive social capital. While the negative effect of the structured adaptive approach on the frequency of intervention-unrelated consultation (and on number of non-READS ties outside of the READS team) could be a sign that less productive consultation was replaced by more productive consultation, it is also possible that this shift had no effect, or even a negative effect, on the quality and productivity of social capital exchanged among educators. Further research is needed on the conditions under which these types of effects on ties and flows affect teacher learning, instruction, and ultimately, student learning.

Given that high-poverty schools were purposely selected for this study, we cannot know the extent to which these findings might generalize to other types of schools. High poverty schools are more likely to experience accountability pressures, and accountability pressures may cause teachers to seek advice from higher-, rather than lower-, value-add colleagues (Wilhelm et al., 2016). The extent to which these forces might interact with different instructional management approaches in affecting teacher network outcomes is unknown.

Further study is also needed to understand the extent to which instructional management approaches and baseline school context influence the productivity of these tie effects and social capital flows. For example, it may be that for school contexts in which teachers are inexperienced or ineffective, an increase in social capital servicing a structured adaptive approach to instructional management would be less effective than an increase in social capital

servicing a fidelity-focused approach that aims to improve the adherence to a research-based instructional program (Rowan, 1990). Similarly, critics of "contrived collaboration" (Hargreaves, 1991) have argued that increasing collaboration in schools in which teachers lack shared trust or high standards may actually be detrimental and result in a downward leveling of norms (de Lima, 2010b; Portes, 1998). These are important questions for future research that are beyond the scope of the present study.

Conclusion

To our knowledge, this is the first experimental study exploring how instructional management approaches to educational interventions affect teachers' social ties and the flow of social capital through those ties. The results suggest a complicated system of causes and effects, in which the short-term effects of instructional management approaches differ depending on the organizational position of the ego, the organizational position of the alter, and whether it is intervention-related or intervention-unrelated social capital that is of interest. These patterns offer evidence about how educational interventions affect the channels through which social ties and social capital can improve educational outcomes. This is an important step in the direction of being able to anticipate interventions' effects on schools' networks and social capital, and to harness social ties in service of instructional improvement. At the same time, these results call attention to questions about the conditions under which short-term effects on social capital might be sustained over the long-term, and under which effects on these first-level network outcomes might enable schools to better accomplish their second-level outcomes of improving student learning outcomes.

Notes

[1] Nebus (2006) uses the term "advice" and the term "consult" to describe the seeking of advice. Many social network surveys query respondents about whom they turn to for "advice" (e.g., Pitts & Spillane, 2009). As described in the Methods section, we asked respondents to identify colleagues with whom they had "consulted." We chose this term so as to include in-depth exchanges (Coburn & Russell, 2008) as opposed to only the transfer of discrete pieces of "advice."

[2] Results for the count outcomes were largely robust to using Poisson regression (see online Appendix A); we present count outcome analyses using linear models for ease of interpretation (residual plots suggest that linear models provide a reasonable summary of the data).

[3] A challenge in many social network analyses is that individuals' tie outcomes are not independent of one another, and complex modeling strategies have been developed to address this concern. In the current study, such complex modelling is not necessary given that the inference of interest regards a randomized treatment, and outcome dependencies are constrained within schools. As such, school-level cluster-robust standard errors are sufficient to account for dependencies.

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Table 1.
Descriptive Statistics by Condition

	Core READS			Adaptive READS				
	Mean	SD	N	Mean	SD	N	Adj. T-C Diff	*p*-value
Background Characteristics								
School-level variables								
School percent free or reduced-price lunch	84.61	10.39	14	85.81	6.5	13	1.38	0.54
Average score on 4th grade state reading test	441.72	3.08	14	442.08	3.18	13	0.12	0.87
Percent of 4th graders scoring proficient or above on state reading test	41.84	14.61	14	43.66	13.34	13	0.79	0.84
Teacher-level variables								
Number years working in field of education	9.74	7.76	53	10.46	6.71	54	1.19	0.14
Number of years teaching in current grade level (grade 4)	4.41	4.96	54	4.08	4.03	53	-0.3	0.52
Number of years working at current school	4.61	5.73	54	4.81	5.42	54	0.26	0.65
Worked with READS before this school year? (1=Y, 0=N)	0.55		56	0.68		56	0.13	0.05
Have, or working toward, master's degree? (1=Y, 0=N)	0.54		54	0.56		54	0.02	0.67
Female (1=Y, 0=N)	0.88		56	0.96		56	0.08	0.05
Black (1=Y, 0=N)	0.2		54	0.31		54	0.12	0.19
White (1=Y, 0=N)	0.67		54	0.57		54	-0.1	0.23
Number on School READS Team (teachers & school coordinator)	4.46	0.81	56	5.3	1.37	56	0.82	0.03
Num. Peers	20.61	4.39	56	23.61	5.6	56	2.67	0.14
Outcomes								
Immediate-term								
Num. READS alters	4.04	1.64	56	5.14	2.05	56	1.07	<0.01
Consult CIS READS Lead on READS (1=Y, 0=N)	0.25	0.44	56	0.38	0.49	56	0.14	0.01
Consult SC on READS (1=Y, 0=N)	0.67	0.47	43	0.78	0.42	46	0.13	0.13
Num. READS alters from READS team (teachers & SC only)	3.02	0.9	56	3.71	1.34	56	0.68	0.02
Num. Non-READS team READS alters	0.77	1.24	56	1.05	1.12	56	0.26	0.21
Freq. consult on READS implementation (std)	0.2	0.96	56	-0.23	0.94	56	-0.4	0.05
Freq. consult on READS adaptations (std)	-0.33	1.03	56	0.26	0.82	56	0.61	<0.01
Num. non-READS alters	8.43	4.47	56	8.21	5.04	56	-0.14	0.87
Consult CIS Lead on non-READS (1=Y, 0=N)	0.14	0.35	56	0.23	0.43	56	0.09	0.07
Consult SC on non-READS (1=Y, 0=N)	0.51	0.51	43	0.46	0.5	46	-0.02	0.86
Num. non-READS alters from READS team (teachers & SC only)	2.91	0.9	56	3.16	1.23	56	0.25	0.4

Num. non-READS alters outside READS team	5.38	4.07	56	4.82	4.36	56	-0.47	0.51
Freq. general consult index (std)	0.1	0.98	56	-0.07	0.99	56	-0.14	0.5
One-year follow-up								
Num. alters (total)	10.35	4.62	34	9.79	5.37	33	-0.34	0.53
Consult CIS Lead (1=Y, 0=N)	0.03	0.17	34	0.08	0.28	37	0.06	0.2
Freq. Literacy Consult Index (Std.)	-0.04	0.97	34	0.17	0.95	35	0.26	0.26
Freq. General Consult Index (Std.)	0.03	1	34	0.22	0.75	37	0.15	0.26
Num. Peers	20.88	5.26	34	22	5.71	37	1.18	0.46

Note. Means and *sd* are unadjusted. Adj. T-C Diff=difference estimated from regression that controls for fixed effects of randomization blocs. P-value is for test of the null hypotheses that T-C=0 (standard errors clustered at the school level). SC=school coordinator.

Table 2.
Immediate Treatment Effects on READS Consultation Ties (RQ1a, RQ1b)

	(1) Num. READS Alters (Total)	(2) Num. READS Alters (Total)	(3) Consult CIS Lead on READS	(4) Consult CIS Lead on READS	(5) Consult SC on READS	(6) Num. READS Alters from READS Team	(7) Num. READS Alters from READS Team	(8) Num. Non-READS Team READS Alters	(9) Num. Non-READS Team READS Alters
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Adaptive	0.807**	1.096***	0.149**	0.225*	0.175$^{\sim}$	0.081	0.141	0.355$^{\sim}$	0.496*
	(0.228)	(0.267)	(0.053)	(0.091)	(0.098)	(0.079)	(0.111)	(0.192)	(0.216)
SC	1.584***	2.222***	0.226	0.393$^{\sim}$		0.402$^{\sim}$	0.530**	0.973***	1.285***
	(0.362)	(0.332)	(0.152)	(0.195)		(0.205)	(0.179)	(0.216)	(0.314)
Num. Peers (Spr.)	0.136***	0.136***	0.001	0.001	-0.016	0.758***	0.757***	-0.021	-0.021
	(0.028)	(0.027)	(0.007)	(0.007)	(0.010)	(0.029)	(0.030)	(0.019)	(0.019)
Adaptive*SC		-1.423$^{\sim}$		-0.373			-0.286		-0.695
		(0.741)		(0.300)			(0.439)		(0.449)
N	112	112	112	112	89	112	112	112	112
R^2	0.406	0.428	0.121	0.146	0.358	0.624	0.626	0.226	0.240

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. SC=School Coordinator. Model 5 does not include SCs. For each model, Num Peers represents total possible number of peers that focal teacher could have selected for given outcome; in models 1-5, Num Peers=total number of alters listed on survey.
$^{\sim}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3.
Immediate Treatment Effects on Frequency of READS Consultation on Implementation and Adaptation (RQ1a, RQ1b)

	(1) Freq. Consult on READS Implementation (Std.) b/se	(2) Freq. Consult on READS Implementation (Std.) b/se	(3) Freq. Consult on READS Adaptations (Std.) b/se	(4) Freq. Consult on READS Adaptations (Std.) b/se
Adaptive	-0.412$^{\sim}$	-0.667**	0.579*	0.378
	(0.215)	(0.213)	(0.228)	(0.234)
Sch. Coordinator	0.262	-0.300	0.188	-0.255
	(0.215)	(0.234)	(0.218)	(0.265)
Num. Peers (Spr.)	0.009	0.009	0.015	0.015
	(0.022)	(0.022)	(0.020)	(0.020)
Adaptive*SC		1.255**		0.989*
		(0.358)		(0.365)
N	112	112	112	112
R^2	0.148	0.215	0.221	0.262

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. Outcomes are standardized versions of a metric that originally represented frequency categories ranging from 1=never to 5=daily or almost daily. Num Peers=total number of alters on teacher's network survey.
$^{\sim}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4.
Immediate Treatment Effects on Instructional (non-READS) Consultation Ties (RQ2a, RQ2b)

	(1) Num. Non-READS Alters (Total)	(2) Num. Non-READS Alters (Total)	(3) Consult CIS Lead on Non-READS	(4) Consult CIS Lead on Non-READS	(5) Consult SC on Non-READS	(6) Num. Non-READS Alters from READS Team	(7) Num. Non-READS Alters from READS Team	(8) Num. Non-READS Alters outside READS Team	(9) Num. Non-READS Alters outside READS Team
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Adaptive	-0.716	-0.770	0.115**	0.114*	-0.004	-0.348*	-0.348*	-0.636	-0.696
	(0.631)	(0.603)	(0.040)	(0.054)	(0.096)	(0.150)	(0.144)	(0.563)	(0.589)
SC	5.765***	5.646**	0.323*	0.321*		0.054	0.053	5.402***	5.269**
	(1.392)	(1.621)	(0.119)	(0.146)		(0.233)	(0.296)	(1.253)	(1.496)
Num. Peers (Spr.)	0.348**	0.348**	-0.003	-0.003	-0.005	0.726***	0.726***	0.266*	0.266*
	(0.099)	(0.100)	(0.006)	(0.006)	(0.010)	(0.059)	(0.058)	(0.112)	(0.112)
Adaptive*SC		0.264		0.005			0.003		0.296
		(2.773)		(0.251)			(0.488)		(2.447)
N	112	112	112	112	89	112	112	112	112
R^2	0.432	0.432	0.249	0.249	0.583	0.533	0.533	0.414	0.414

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. SC=School Coordinator. Model 5 does not include SCs. For each model, Num Peers represents total possible number of peers that focal teacher could have selected for given outcome; in models 1-5, Num Peers=total number of alters listed on survey.
$^{\sim}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5.
Immediate Treatment Effects on Frequency of Instructional (non-READS) Consultation (RQ2a, RQ2b)

	(1) Freq. General Consult Index (Std.) b/se	(2) Freq. General Consult Index (Std.) b/se
Adaptive	-0.256	-0.452*
	(0.176)	(0.179)
Sch. Coordinator	-0.186	-0.618*
	(0.233)	(0.279)
Num. Peers (Spr.)	0.040**	0.040**
	(0.014)	(0.014)
Adaptive*SC		0.965*
		(0.454)
N	112	112
R^2	0.145	0.183

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. Outcome is a standardized PCA-derived index comprised of survey items on the frequency with which participants consulted with colleagues about subject matter content knowledge, planning course material, instructional strategies, classroom management, and preparing students for the state test (1=never, 5=daily or almost daily). Num Peers=total number of alters on teacher's network survey.
$^{\sim}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 6.
One-year Follow-up Treatment Effects on Instructional (non-READS) Consultation Ties, Literacy Consultation Frequency, and General Instructional Consultation Frequency (RQ3a, RQ3b)

	(1) Num. Alters (Total)	(2) Consult CIS Lead	(3) Freq. Consult on Literacy (Std.)	(4) Freq. General Consult Index (Std.)
	b/se	b/se	b/se	b/se
Adaptive	-0.113	0.069	0.280	0.124
	(0.640)	(0.050)	(0.235)	(0.153)
Num. Peers	0.094	0.002	-0.042$^{\sim}$	0.009
	(0.083)	(0.003)	(0.024)	(0.022)
Sch. Coordinator	2.836*	0.113	-0.319	-0.259
	(1.023)	(0.086)	(0.389)	(0.368)
N	67	71	69	71
R^2	0.492	0.342	0.218	0.187

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. Freq. Consult on Literacy (Std.) = standardized PCA-derived index comprised of survey items on the frequency with which participants consulted with colleagues about various matters related to literacy. Freq. Consult Overall (Std.) = standardized PCA-derived index comprised of survey items on the frequency with which participants consulted with colleagues about subject matter content knowledge, planning course material, instructional strategies, classroom management, and preparing students for the state test (1=never, 5=daily or almost daily). Num Peers=total number of alters on teacher's network survey.
$^{\sim}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Online Appendices

Online Appendix A. Sensitivity Analyses using Poisson Regression (Count Outcomes), Logistic Regression (Binary Outcome), and Ordered Probit Models (Ordinal Outcomes).

Table A1.
Immediate Treatment Effects on READS Consultation Ties (RQ1a, RQ1b), Poisson Regression Models (Count Outcomes, Models 1-2, 6-9) and Logistic Regression Models (Binary Outcomes, Models 3-5)

	(1) Num. Consult on READS (Total)	(2) Num. Consult on READS (Total)	(3) Consult CIS Lead on READS	(4) Consult CIS Lead on READS	(5) Consult SC on READS	(6) Num. READS Faculty Consult on READS	(7) Num. READS Faculty Consult on READS	(8) Num. non-READS Faculty consult on READS	(9) Num. non-READS Faculty consult on READS
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Adaptive	0.167***	0.253***	0.769**	1.258*	1.281$^{\sim}$	0.007	0.028	0.463*	0.770*
	(0.050)	(0.058)	(0.256)	(0.523)	(0.761)	(0.027)	(0.031)	(0.231)	(0.348)
Sch. Coordinator	0.326***	0.490***	1.110	2.048*		0.116*	0.163**	0.893***	1.316***
	(0.064)	(0.058)	(0.698)	(0.990)		(0.053)	(0.051)	(0.167)	(0.308)
Adaptive *Sch. Coordinator		-0.334**		-1.960			-0.096		-0.808*
		(0.124)		(1.417)			(0.109)		(0.380)
Num. Peers (Spr.)	0.029***	0.029***	0.012	0.015	-0.104	0.216***	0.215***	-0.034	-0.033
	(0.006)	(0.006)	(0.040)	(0.044)	(0.070)	(0.011)	(0.011)	(0.023)	(0.022)
Constant	0.540**	0.499**	-1.826	-2.196$^{\sim}$	2.786	0.116*	0.109$^{\sim}$	-0.143	-0.350
	(0.196)	(0.187)	(1.122)	(1.292)	(1.922)	(0.054)	(0.057)	(0.578)	(0.583)
N	112	112	112	112	61	112	112	112	112

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. SC=School Coordinator. For each model, Num Peers represents total possible number of peers that focal teacher could have selected for given outcome; in models 1-5, Num Peers=total number of alters listed on survey. Some observations dropped from logistic regression models due to perfect prediction within strata.

Table A2.
Immediate Treatment Effects on Frequency of READS Consultation on Implementation and Adaptation (RQ1a, RQ1b), Ordered Probit Models.

	(1) Consult READS Implementation (Std.) b/se	(2) Consult READS Implementation (Std.) b/se	(3) Consult READS Adaptations (Std.) b/se	(4) Consult READS Adaptations (Std.) b/se
Adaptive	-0.532*	-0.874***	0.737**	0.487~
	(0.241)	(0.254)	(0.282)	(0.286)
Sch. Coordinator	0.337	-0.360	0.241	-0.388
	(0.244)	(0.273)	(0.279)	(0.375)
Num. Peers (Spr.)	0.013	0.013	0.028	0.027
	(0.026)	(0.027)	(0.028)	(0.028)
Adaptive*Sch. Coordinator		1.608***		1.344**
		(0.460)		(0.519)
N	112	112	112	112

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. Num Peers=total number of alters on teacher's network survey.

Table A3.
Immediate Treatment Effects on (non-READS) Consultation Ties (RQ2a, RQ2b), Poisson Regression Models (Count Outcomes, Models 1-2, 6-9) and Logistic Regression Models (Binary Outcomes, Models 3-5)

	(1) Num. Consult on non-READS (Total)	(2) Num. Consult on non-READS (Total)	(3) Consult CIS Lead on non-READS	(4) Consult CIS Lead on non-READS	(5) Consult SC on non-READS	(6) Num. READS Faculty Consult on non-READS	(7) Num. READS Faculty Consult on non-READS	(8) Num. non-READS Faculty consult on non-READS	(9) Num. non-READS Faculty consult on non-READS
	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se	b/se
Adaptive	-0.092	-0.101	1.096*	1.312	-0.053	-0.028	-0.025	-0.173	-0.215
	(0.072)	(0.074)	(0.445)	(0.825)	(0.852)	(0.059)	(0.055)	(0.108)	(0.141)
Sch. Coordinator	0.601***	0.588***	2.307**	2.618**		0.007	0.014	0.871***	0.822***
	(0.094)	(0.121)	(0.806)	(0.953)		(0.074)	(0.096)	(0.126)	(0.160)
Adaptive *Sch. Coordinator		0.028		-0.615			-0.015		0.110
		(0.184)		(1.301)			(0.151)		(0.230)
Num. Peers (Spr.)	0.045***	0.045***	-0.034	-0.037	-0.060	0.053***	0.053***	0.178$^{\sim}$	0.180$^{\sim}$
	(0.012)	(0.012)	(0.062)	(0.081)	(0.106)	(0.009)	(0.009)	(0.098)	(0.099)
Constant	0.795*	0.797*	-2.819$^{\sim}$	-2.844	1.985	-0.212	-0.214	0.707	0.715
	(0.347)	(0.346)	(1.592)	(2.288)	(2.238)	(0.209)	(0.213)	(0.490)	(0.488)
N	112	112	90	90	49	112	112	112	112

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. SC=School Coordinator. For each model, Num Peers represents total possible number of peers that focal teacher could have selected for given outcome; in models 1-5, Num Peers=total number of alters listed on survey. Some observations dropped from logistic regression models due to perfect prediction within strata.

Table A4.
Immediate Treatment Effects on Frequency of Instructional (non-READS) Consultation (RQ2a, RQ2b), Ordered Probit Models.

	(1) non-READS Consult Index (Std.) b/se	(2) non-READS Consult Index (Std.) b/se
Adaptive	-0.259	-0.462*
	(0.186)	(0.192)
Sch. Coordinator	-0.140	-0.584~
	(0.252)	(0.310)
Num. Peers (Spr.)	0.046***	0.047***
	(0.014)	(0.014)
Adaptive*Sch. Coordinator		0.979~
		(0.531)
N	112	112

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. Outcome is a standardized PCA-derived index comprised of survey items on the frequency with which participants consulted with colleagues about subject matter content knowledge, planning course material, instructional strategies, classroom management, and preparing students for the state test (1=never, 5=daily or almost daily). Num Peers=total number of alters on teacher's network survey.

Online Appendix B. Effects on Total Number of Unique Consultation Ties.

Table B1.
Immediate Treatment Effects on Total Number of Unique Consultation Ties (READS & Non-READS), and Consultation with SC or CIS Lead (on READS and Non-READS Matters)

	(1) Total Unique Alters b/se	(2) Total Unique Alters b/se	(3) Consult SC b/se	(4) Consult CIS Lead b/se	(5) Consult CIS Lead b/se
Adaptive	-0.191	0.063	0.176~	0.215***	0.293**
	(0.723)	(0.683)	(0.093)	(0.056)	(0.090)
Sch. Coordinator	5.245***	5.805***		0.427**	0.599**
	(1.202)	(1.179)		(0.145)	(0.168)
Num. Peers (Spr.)	0.331**	0.331**	-0.016	-0.004	-0.004
	(0.091)	(0.091)	(0.010)	(0.006)	(0.007)
Adaptive*Sch. Coordinator		-1.251			-0.383
		(2.445)			(0.289)
N	112	112	89	112	112
R^2	0.427	0.430	0.382	0.239	0.263

Note. Standard errors clustered at the school level in parentheses. All models control for fixed effects of randomization blocs. SC=School Coordinator. Models 3 does not include SCs. For each model, Num Peers represents total possible number of peers that focal teacher could have selected for given outcome.